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MATHEMATICS TEACHERS' ACCEPTANCE OF ICT IN TEACHING AND LEARNING: AN EXTENDED TECHNOLOGY ACCEPTANCE MODEL

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Abstract

The research sought to assess mathematics teachers' acceptance of Information and Communication Technology (ICT) integration into teaching and learning at the secondary schools. This study was a cross-sectional survey that gathered data with structured questionnaire. The population was mathematics (core and elective) teachers of secondary schools within the Ashanti region of Ghana. Purposive sampling was used to select mathematics teachers from 41 secondary schools in the region. In all, there were 207 usable questionnaires for the study. Structural Equation Modelling (SEM) was run in Amos (v.23) to estimate the path coefficients of the various hypotheses, using Technology Acceptance Model (TAM). The study established that perceived ease of use predicted both perceived usefulness and attitude towards use; perceived usefulness predicted attitude towards use and behavioral intention; attitude towards use of technology predicted the behavioral intention to adopt technology in teaching and learning, while behavioral intention also predicted actual usage of ICT in teaching and learning of mathematics. As an extension to the original TAM, the study found school related factors as percussor to perceived usefulness and perceived ease of use. Similarly, ICT training was found to greatly influence perceived usefulness and perceived ease of use.
Keywords: *ICT, mathematics education, structural equation modelling, technology acceptance model*

Introduction

Information and Communication Technology (ICT) is defined as the software, computers, networks, satellite links, and other similar systems which enables humans to access, analyze, generate, share, and utilize data and information (Barakabitze, 2019). In the educational sector, the integration of ICT is regarded as a very critical tool for improving educational quality (Teeroovengadum et al., 2017). The adoption of ICT in education helps to improve the learning and teaching process, and this has been keen interest for governments worldwide. By reason of this, national governments of various nations have invested heavily in ICT integration in education. In Ghana for example, practical steps are being taken by successive governments to favor the spread of ICT in schools. The ICT for Accelerated Development (ICT4AD) policy for example, was adopted in 2003, as a framework upon which ICT will be used to enhance the educational sector of the country (Republic of Ghana, 2003). ICT4AD sought to provide quality life-long learning opportunities to all Ghanaians, irrespective of their geographical location. In 2011, the government of Ghana started the distribution of free laptops for students and teachers at the secondary and tertiary institutions. Successive governments have followed suit, although it has not been an all-encompassing policy to provide for all students. In 2017, the government of Ghana also introduced the free Wi-Fi policy for second cycle institutions, although this project

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has mainly benefited schools in urban areas because they have the supporting infrastructure (Communications Bureau, 2017).

The emergence of the global COVID-19 pandemic has even added to the numerous reasons for the integration of ICT in education to create a blended or hybrid teaching and learning approach. Social distancing was one of the key measures in curbing the upsurge of COVID-19 which made institutions to re-strategize work schedules for staff to work from home, with the assistance of communication technology (Rachmadtullah et al., 2020). The educational sector was not left out as many schools closed their doors for physical student-teacher interactions and started providing educational services through online platforms (Prokopenko & Berezhna, 2020). Although physical distance is a constraint in online delivery, teacher's creativity in learning activities helps to make the online delivery as efficient as face-to-face delivery (Han & Sa, 2021). Teacher's acceptance of technology in teaching and learning, thus, becomes paramount for the success of ICT integration in education. The present study, therefore, focused on teachers' acceptance of ICT in studying and teaching of mathematics in the secondary educational institutions in Ghana.

Extant literature has demonstrated diverse approaches and strategies in enhancing the educational quality and improving the overall learning process (Arthur et al., 2021; Alayoubi et al., 2020). In the context of mathematics education, the same has been experienced with studies focusing on learning conditions, parental involvement, school curriculum, teacher training, and standardized testing (Lazarides & Buchholz, 2019; Lazarides & Schiefele, 2021). This notwithstanding, not much is explored on the adoption of technology in studying and teaching of mathematics (Marbán & Mulenga, 2019).

Studies have demonstrated ICT as a powerful tool which facilitates inclusive education, as well as a well-integrated educational curriculum (Chen & Wu, 2020). Salam et al. (2018), however, have observed that changing from traditional mode of teaching to an ICT integrated teaching, is not an easy task and demands effective strategies to successfully integrate ICT in public schools. The integration of technology in learning and teaching of mathematics leads to a more student-centered teaching strategy, since the student-teacher interaction and the mode of content delivery are fundamentally altered (Lau & Yuen, 2013). These changes have been realized to improve mathematics teaching and learning processes (Barakabitze et al., 2019). The adoption of ICT into mathematics education, increases students' accessibility to mathematics education, develops the problem-solving skills of students, enhances students' comprehension of mathematics concepts, facilitates higher levels of mathematical thinking by students, and enhances general performance of students in mathematics (Chen & Wu, 2020). Despite the potentials of ICT in mathematics education, it has been realized that not many teachers integrate ICT into their teaching of mathematics, especially in developing countries (Agyemang & Mereku, 2015). Past studies have identified beliefs and attitude of teachers toward the adoption of ICT as key barriers in the use of ICT in education (Marbán & Mulenga, 2019; Ottenbreit-Leftwich et al., 2018). This current study, therefore, used Technology Acceptance Model (TAM) (Davis et al., 1989) in assessing the adoption of ICT into the teaching of mathematics.

The use of TAM in assessing the adoption of ICT in educational setting has been studied by a number of researchers. Sánchez-Prieto et al. (2019) measured teachers' acceptance of AI-driven assessment in e-learning, included AI anxiety and relative advantage as added variables to the original TAM. Dele-Ajayi et al. (2017) added external factor (ICT experience) as an extension of TAM in assessing digital educational games acceptance by teachers. Hong et al. (2021) assessed technology acceptance by pre-school teachers' during COVID-19, by adding perception of external control, computer self-efficacy, and job relevance, as extension of the original TAM. Specifically in mathematics education, Mailizar et al. (2021) examined the behavioral intention of teachers towards use e-learning in the teaching of mathematics, by using prior experience in ICT as an added variable to the original TAM, similar to Marbán and

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Mulenga (2019) who assessed the teaching style and attitude of pre-service primary teachers towards the adoption of technology in mathematics education. Perienen (2019) also considered frameworks for ICT integration in teaching of mathematics. This current study is a further contribution to the theory of TAM by including two new variables deemed to be crucial in providing a wholistic view of TAM. First, the study considered school related factors such as the support from management, availability of ICT infrastructure such as internet, computer labs, etc. The school related factors when favorable could influence teachers' assessment of ICT's usefulness and ease of use. ICT training is also a useful variable which could potentially determine teachers' perception of ICT's usefulness and ease of use.

Theoretical Review and Hypotheses Development

TAM is a behavioral psychology theory which was propounded by Davis et al. (1989), using two existing theories, which were, Theory of Planned Behavior (TPB) (Ajzen, 1985) and Theory of Reasoned Action (TRA) (Fishbein et al., 1980; Fishbein & Ajzen, 1975). TAM used five factors in explaining the adoption of a precise technology, which were, perceived usefulness, perceived ease of use, attitude towards use, behavioral intention, and usage of the technology. Perceived ease of use was explained as "*the degree to which the prospective user expects the target system to be free of effort"* (Davis et al., 1989, p.985). That is, teachers of mathematics have higher propensity to integrate technology into mathematics teaching when they perceive the integration of technology as stress-free (Mailizar et al., 2021). Perceived ease of use is found to positively affect perceived usefulness and the attitude towards the use of the technology. Perceived usefulness represents *"the consideration that using a specific application system will increase his or her job performance within an organizational context*" (Davis et al., 1989, p.985). That is, mathematics teachers at the secondary schools are more likely to integrate technology into mathematics teaching, when they consider ICT as useful in their job execution (Marbán & Mulenga, 2019). The attitude pertaining to the adoption of ICT is formed by the individual's belief regarding the technology, and this is jointly influenced by perceived ease of use and perceived usefulness (Weng et al., 2018). The attitude of mathematics teachers towards the adoption of technology is a key hindrance towards the success of ICT integration (Ertmer et al., 2012). Studies have identified attitude towards use as greater predictor of behavioral intentions (Prestridge, 2012). A positive attitude towards technology will lead to higher ICT adoption in teaching and learning, while a negative attitude will discourage the integration of ICT (Sangcap, 2010). The adoption of ICT in learning and teaching of mathematics is only feasible when teachers accept that technology will improve students' motivation towards mathematics learning, will improve mathematics learning of students, and enhance students' confidence in solving mathematics problems (Perienen, 2020). Similarly, when teachers accept that the adoption of technology will retard students' ability to solve mathematical problems, they are more likely not to integrate it (Lau & Yuen, 2013). The fourth factor in the TAM is behavioral intention which is affected by perceived usefulness and attitude towards the adoption of ICT (Sánchez-Prieto et al., 2020). Behavioral intention has to do with purposeful decision-making to adopt the use of ICT (Prieto et al., 2014), which forms the basis of actual usage or adoption of the ICT (Lazim et al., 2021). Intention to change the old ways of doing things and integrating ICT into one's activities is determined by attitudes and beliefs (Tay et al., 2012). Behavioral intention is found to highly determine the actual usage of the technology. In mathematics education, teachers' behavioral intention will lead to the adoption of technology in learning and teaching of mathematics (Teeroovengadum et al., 2017).

Past studies have identified some limitations in the use of TAM as predicting the adoption of a technology. This resides in the fact that there was no external variable in the original TAM, which determined perceived usefulness and perceived ease of use (Mailizar & Maulina, 2021).

In meeting this limitation, some studies have considered the ICT experience of the adopter, as a percussor to perceived usefulness and perceived ease of use (Sukendro et al., 2020). This present study proposed two variables, school related factors and ICT training, as percussors to perceived usefulness and perceived ease of use (Teeroovengadum et al., 2017). School related factors such as the support from management, strategic ICT policy of the school, available ICT infrastructure, etc., are key elements in determining mathematics teachers' perceived usefulness and perceived ease of use of ICT integration in the learning and teaching of mathematics (Dele-Ajayi et al., 2017). Good institutional support available to the mathematics teachers in the use of ICT will greatly determine the rate of ICT integration. Instructional support, effective leadership, support from cooperating teachers, accessibility to ICT infrastructure, technical support, availability of technical staff and the availability of up-to-date software and hardware, are very important in teachers' adoption of ICT (Deshpande et al., 2012).

It is also expected that training teachers on the use of ICT will also determine their perceived usefulness and perceived ease of use. Training and development make teachers skillful in the use of ICT, and therefore makes the use of ICT less stressful (Lau et al., 2013). The ability to easily operate a technology influences one's judgment on its perceived usefulness and perceived ease of use (Barakabitze et al., 2019). This training may have been conducted inhouse by the school or done privately by the mathematics teacher. The purpose of ICT training is to enhance the ICT literacy of the teachers and prepare them in the adoption of technology in learning and teaching. The ICT skills of teachers represent key factor in the success of ICT integration in schools. Some studies have shown that ICT literacy was a key determining factor in ICT integration by teachers. ICT training will enhance mathematics teachers' competencies in using specialized ICT tools for mathematics lessons in the classroom (Peeraer & Van Petegem, 2012). The technical skills of teachers have been found to greatly influence the integration and success of ICT adoption in teaching and learning (Fathema & Sutton, 2013).

Figure 1 presents the conceptual framework of the study. From the above discussions, the study hypothesized that:

H1: School related factors have direct positive effect on perceived ease of use by mathematics teachers.

H2: School related factors have direct positive effect on perceived usefulness by mathematics teachers.

H3: ICT training has a direct positive effect on perceived ease of use by mathematics teachers.

H4: ICT training has a direct positive effect on perceived usefulness by mathematics teachers.

H5: Perceived ease of use has a direct positive effect on perceived usefulness by mathematics teachers.

H6: Perceived ease of use has a direct positive effect on mathematics teachers' attitude towards the use of ICT.

H7: Perceived usefulness has a direct positive effect on mathematics teachers' attitude towards the use of ICT.

H8: Perceived usefulness has a direct positive effect on mathematics teachers' behavioral intention toward the use of ICT.

H9: Mathematics teachers' attitude toward the use of ICT has a direct positive effect on their behavioral intention.

H10: Mathematics teachers' behavioral intention has a direct positive effect on the actual usage of ICT in teaching and learning.

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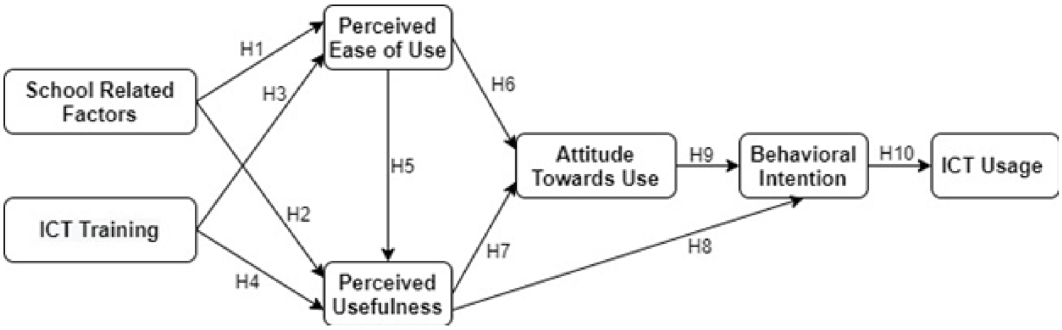
Figure 1
Conceptual Framework



Research Methodology

Research Design

There are two main approaches to research; deductive and inductive. This research was deductive in approach, as it was founded on well-established theory or model; Technology Acceptance Model. The hypotheses of this research were also derived from literature. The research was also quantitative, as data was collected using a structured questionnaire. Data analysis was also quantitative in approach, as the study used Structural Equation Modelling (SEM). The data collection took place in July 2021.

A survey research design was adopted for the research. Saunders et al. (2015) explained that surveys usually go with deductive research and are normally conducted by adopting questionnaire as the research instrument. Surveys help researchers to study a sample and make generalization to the population, by conducting inferential and descriptive statistics. This research studied a sample of mathematics teachers, for the purposes of generalizing the study to all mathematics teachers in Ghana. Surveys are also quantitative in nature.

Sample and Data Collection

The study targeted mathematics teachers of secondary schools in Ashanti region of Ghana. The sampling technique was purposive, as the study specifically targeted mathematics teachers from selected secondary schools. In all, 219 questionnaires were received, but 207 were usable. In all, the mathematics teachers were selected from 41 secondary schools in the region, the second biggest region in Ghana (in terms of population and economic activities). The list of secondary schools in the region was obtained from the website of Ghana Education Service (Scoutafrica, 2021).

The region had 128 upper-secondary schools (Scoutafrica, 2021). However, due to resource limitations, the researcher targeted 70 schools. The researcher employed six trained field assistants to help in the process. The researcher together with the field assistants contacted 70 secondary schools within the region, out of which 41 agreed to be involved in the study. All mathematics teachers of the 41 consenting schools, thus, constituted the sampling frame for this study. Depending on size, some schools had more mathematics teachers than others. Thus, the questionnaires were distributed according to the number of mathematics teachers in each school. The questionnaires, together with postage pre-paid envelopes were posted to the secondary schools using Express Mail Service (EMS) for speedy delivery. The management of the schools administered the questionnaires and returned 219 to the researcher using the postage

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pre-paid envelopes. The entire data collection process also took about 4 weeks (July 2021). Out of the 219 returned questionnaires, the usable (appropriate completed) questionnaires were 207 which were used in the data analysis.

A number of steps were taken to address ethical considerations. The researcher, being a lecturer at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), obtained an introductory letter from the AAMUSTED. The introductory letter, together with a personally written cover letter for the research, were sent to the selected 70 upper-secondary schools. Out of the 70 schools, only the 41 consenting schools were involved in the research. The questionnaire had a brief introduction, which provided definitions for some key terminologies, detailed the purpose of the study, assured respondents of confidentiality and non-disclosure, and the fact that withdrawing as a participant (even after reading the questionnaire) attracted no penalty.

Measures and Questionnaire

The research focused on the TAM, which had 5 original variables (perceived usefulness, perceived ease of use, attitude towards use, behavioral intentions, and actual usage of the technology). The measurement items for these 5 constructs were developed from Weng et al. (2018) and Mailizer et al. (2021). This study added 2 extra variables which were school related factors and ICT training. The measurement items of school related factors were developed from Teeroovengadum et al. (2017), while the measurement items of ICT training were developed from Dele-Ajayi et al. (2017). A sample statement under Perceived Ease of Use was "It would be easy for me to become skillful at using ICT for teaching"; that of Perceived Usefulness was "Using ICT in my work will help me to accomplish task more quickly"; that of Attitude Towards Use was "Using ICT (tools or software) in class is favorable"; that of Behavioral Intention was "I intend to use ICT in my future teaching"; that of School Related Factors was "I am supported and encouraged by my school head to use ICT in teaching"; that of ICT Usage Training was "I undertake personal training about ICT integration in Mathematics"; while that of ICT Usage was "I use ICT in teaching of mathematics". The statements had 5-point Likert scale responses (1=Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, and 5=Strongly Agree*)*

The measurement items were adapted to suit to current study which focused on teaching of mathematics. The researcher also pilot tested the questionnaire using 20 mathematics teachers, and their feedback was used to fine tune the questionnaire. This helped to remove any ambiguity from the statements on the questionnaire. The study was pilot tested using mathematics teachers because Hyman et al. (2006) indicated that a validated questionnaire is most preferable when the environment of the validated questionnaire is similar to that of the new study environment.

Validity and Reliability Analysis

To assess the validity and reliability of the dataset, Confirmatory Factor Analysis (CFA) was run using Amos (v.23) software, as done in previous studies such as Dogbe et al. (2020). Maximum likelihood estimation was used in running the CFA with results indicated in Table 1. The minimum acceptable factor loading was .5, without which the measurement item is supposed to be deleted. The CFA results presented showed the least factor loading of .657 for school related factors, .641 for ICT training, .644 for perceived ease of use, .679 for perceived usefulness, .684 for attitude towards use, .673 for behavioral intention, and .695 for ICT usage, which were all larger than .5.

The reliability of the measurement items was assessed by running Cronbach's Alpha (CA) analysis using SPSS (v.23) software. To claim internal reliability (internal consistency) of the measurement items, the alpha coefficient should be at least .7. This study had all alpha scores being greater than .7, and therefore, internal consistency was achieved. As indicated in Table 1, the CA score for school related factors was .801, for ICT training was .874, for perceived ease of use was .871, for perceived usefulness was .864, for attitude towards use was .835, for behavioral intention was .843, while that of ICT usage was .721.

Average Variance Extracted (AVE) was also used in assessing the convergent validity of the observed variables. Convergent validity is said to be achieved when the AVE score is at least .5 (Fornell & Larcker, 1981). Composite reliability (CR) was also expected to be at least .7. These were achieved for this study as the least AVE was .503 for school related factors, and the least CR was .779 for ICT usage.

As part of the model fit indices, CMIN/DF (Chi-Square/Degree of Freedom) should be less than 3, CFI (Comparative Fit Index) and TLI (Tukey-Lewis Index) should be larger than .9, RMR (Root Mean Square Residual) and RMSEA (Root Mean Square Error of Approximation) to be less than .08, while P-Close should also be greater than .05 (Hair et al., 2010). These were all achieved as presented in Table 1.

Table 1
Confirmatory Factor Analysis

Model Fitness: *CMIN=997.336; DF=548; CMIN/DF=1.820; TLI=.919; CFI=.906; RMSEA=.068; RMR=.072; P-Close=.089*	**Std. Factor Loading**
School Related Factors (Sch_Fact): CA=.801; CR=.835; AVE=.503	
SRF1	.691
SRF2	.707
SRF3	.712
SRF4	.657
SRF5	.774
ICT Training (Training): CA=.874; CR=.852; AVE=.536	
UT1	.664
UT2	.641
UT3	.761
UT4	.778
UT5	.803
Perceived Ease of Use (Ease): CA=.871; CR=.878; AVE=.548	
PEU1	.794
PEU2	.682
PEU3	.801
PEU4	.791
PEU5	.715
PEU6	.644

Perceived Usefulness (Useful): CA=.864; CR=.883; AVE=.558	
PU1	.734
PU2	.692
PU3	.748
PU4	.823
PU5	.794
PU6	.679
Attitude Towards Use (Attitude): CA=.835; CR=.852; AVE=.536	
ATU1	.736
ATU2	.697
ATU3	.751
ATU4	.789
ATU5	.684
Behavioral Intention (Behavioral): CA=.843; CR=.846; AVE=.523	
BI1	.673
BI2	.736
BI3	.745
BI4	.738
BI5	.722
ICT Usage (Usage): CA=.721; CR=.779; AVE=.541	
IU1	.775
IU2	.735
IU3	.695

The descriptive statistics and discriminant validity are shown in Table 2. From the results, behavioral intention had the largest mean score of 4.339, indicating the willingness of the teachers of mathematics to integrate ICT into the teaching of mathematics. The least mean score was 2.678 (< 3.0, the theoretical mean score for a 5-point scale) which was for school related factors. This implies that there is not enough conducive environment for teachers to adopt technology into mathematics teaching. Since the variables were measured on a 5-point Likert scale of 1-strongly disagree to 5-strongly agree, the highest possible mean score is 5.

The study determined the discriminant validity of the latent variables by measuring the square-root of the AVEs (√AVEs) with the correlation coefficients. While convergent validity considers the extent to which observed variables on the same construct corelate with each other, discriminant validity measures the extent to which measurement items are uncorrelated with measurement items on different constructs (Trochim & Donnelly, 2002). As could be seen from Bamfo et al. (2018), discriminant validity is achieved when the smallest √AVE is bigger than the biggest correlation coefficient. As could be seen from Table 2, the smallest value for √AVE was .709, which was larger than the biggest correlation coefficient of .554. This implies that, discriminant validity was achieved, that is, the measurement items uncorrelated with other measurement items on different constructs. It was further concluded that there was no multicollinearity in the dataset, as the highest correlation coefficient of .554 was less than .8.

Table 2
Descriptive Analysis and Discriminant Validity

Variables	Mean ($\bar{x}$)	Std. Dev. (s)	1	2	3	4	5	6	7
Sch_Fact (1)	2.678	1.145	**.709**						
Training (2)	3.467	1.122	.346**	**.732**					
Ease (3)	3.878	.843	.284**	.249**	**.740**				
Useful (4)	3.983	.868	.364**	.243**	.367**	**.747**			
Attitude (5)	4.128	.803	.414**	.280**	.350**	.554**	**.732**		
Behavioral (6)	4.339	.743	.352**	.227**	.511**	.466**	.543**	**.723**	
Usage (7)	3.767	.819	.488**	.365**	.299**	.399**	.465**	.421**	**.736**

*√AVE are bold; ** ~ p-value significant at 1% (.01)*

Research Results

SEM was run in Amos (v.23) to estimate the coefficients of the 10 paths hypothesized for by this study. Table 3 presents the results of the path coefficients, while Figure 2 also presents the structural model (in diagrammatic form) for the study. Results on the hypothesized paths indicated that school related factors had a positive and significant effect on perceived ease of ICT use (). That is, enhancing school related factors caused 37.9% positive change in perceived ease of ICT use among mathematics teachers. H1: *School related factors have direct positive effect on perceived ease of use by mathematics teachers* was thus supported. The effect of school related factors on perceived usefulness of ICT was identified to be significant positive (). That is, an enhancement in school related factors caused about 34.1% increment in perceived usefulness of ICT among mathematics teachers. H2: *School related factors have direct positive effect on perceived usefulness by mathematics teachers*, was thus supported.

The effect of ICT training on perceived ease of ICT use was identified to be significant positive (). This represented the largest coefficient among all the estimated coefficients, which shows the great extent to which ICT training influenced the ease of using ICT. The coefficient implies that an increase in ICT training activities increased perceived ease of ICT by about 84% increment in perceived ease of ICT among mathematics teachers. H3: *ICT training has a direct positive effect on perceived ease of use by mathematics teachers* was thus supported. The results pointed out that ICT training significantly and positively affected perceived usefulness of ICT (). That is, an enhancement in ICT training caused about 26.5% increment in perceived usefulness of ICT among mathematics teachers. H4: *ICT training has a direct positive effect on perceived usefulness by mathematics teachers* was thus supported.

The presented results indicated that perceived ease of ICT use had a significant and positive effect on perceived usefulness of ICT among mathematics teachers (). This coefficient thus indicates that increased perceived ease of ICT use increased perceived usefulness by about 52.7% among mathematics teachers. H5: *Perceived ease of use has a direct positive effect on perceived usefulness by mathematics teachers* was thus supported. It was further established that perceived ease of ICT use, positively and significantly affected on the attitude towards ICT use among mathematics teachers (). This coefficient thus indicates that increased perceived ease of ICT use increased mathematics teachers' attitude towards the use of ICT in teaching mathematics by a margin of about 24.4%. H6: *Perceived ease of use has a direct positive effect on mathematics teachers' attitude towards the use of ICT* was thus supported.

Paths coefficients as presented showed that perceived usefulness had a significant positive effect on attitude towards ICT use among mathematics teachers (). This indicates that a rise in perceived usefulness will lead to an enhanced attitude of mathematics teachers towards the use of ICT in teaching mathematics by a margin of about 54.8%. H7: *Perceived usefulness has a direct positive effect on mathematics teachers' attitude towards the use of ICT* was thus supported. It was further established that perceived usefulness of ICT had a positive and significant effect on behavioral intentions among mathematics teachers (). The coefficient means that perceived usefulness of ICT by mathematics teachers enhanced behavioral intentions by a margin of about 41.3%. H8: *Perceived usefulness has a direct positive effect on mathematics teachers' behavioral intention toward the use of ICT* was thus supported.

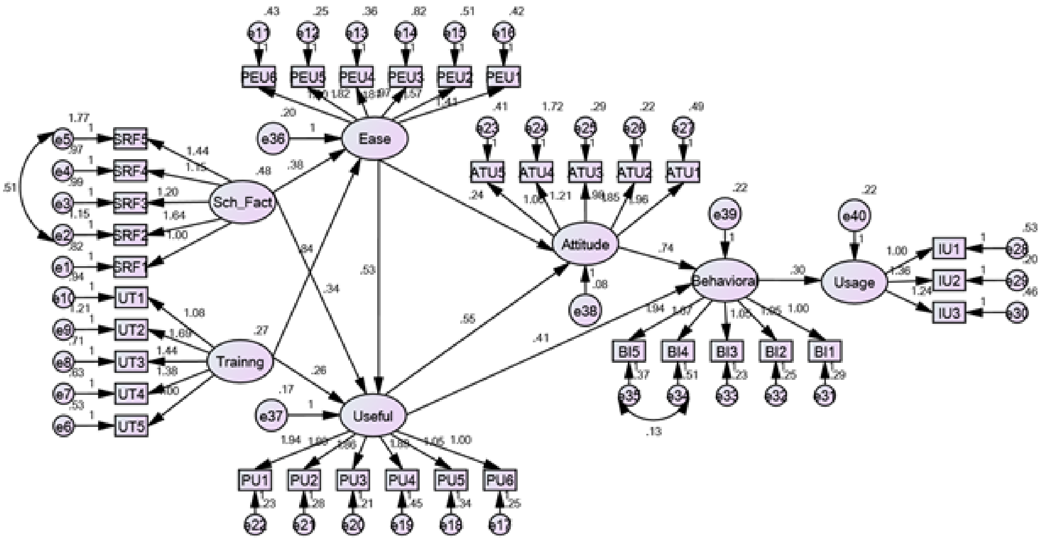
It was further identified that mathematics teachers' attitude towards the adoption of technology into teaching and learning had a positive and significant effect on their behavioral intentions (). This implies that an increase in mathematics teachers' attitude towards the use of ICT enhanced their behavioral intentions in the use of ICT in teaching by a margin of about 73.8%. H9: *Mathematics teachers' attitude toward the use of ICT has a direct positive effect on their behavioral intentions* was thus supported. Finally, it was concluded that mathematics teachers' behavioral intention towards the adoption of technology into learning and teaching of mathematics had a significant positive effect on actual usage of ICT (). The coefficient indicates that an enhancement in mathematics teachers' behavioral intention towards the integration of ICT in teaching and learning of mathematics actually increased the chances of ICT usage by a margin of about 3.1%. H10: *Mathematics teachers' behavioral intention has a direct positive effect on the actual usage of ICT in teaching and learning* was thus supported.

Table 3
Path Coefficients

Direct Paths	UnStd. Estimate	Std. Error	C.R.
Sch_Fact → Ease	.379	.078	4.859**
Sch_Fact → Usefulness	.341	.067	5.090**
Training → Ease	.840	.158	5.322**
Training → Usefulness	.265	.105	2.524*
Ease → Usefulness	.527	.129	4.098**
Ease → Attitude	.244	.096	2.546*
Usefulness → Attitude	.548	.111	4.947**
Usefulness → Behavioral	.413	.109	3.789**
Attitude → Behavioral	.738	.238	3.103**
Behavioral → Usage	.301	.083	3.612**

*** ~ p-value significant at 1% (.01); * ~ p-value significant at 5% (.05)*

Figure 2
Structural Paths



Discussion

TAM has been widely used to assess technology adoption or acceptance within the educational sector. This present study also considered how TAM could be used to explain the integration of ICT into the teaching and learning of mathematics among secondary school mathematics teachers. The computer software usually used by the mathematics teachers included drill and practice software, search engines, word processing packages, presentation software, and spreadsheets. Some teachers exploited the used advanced software such as Flash presentations, simulation programs, Java applets, and graphical applications which provide greater opportunity for higher order thinking (Keong et al., 2005).

The first contribution of this study is the introduction of school related factors as precursors to perceived ease of ICT use and perceived usefulness within the TAM. School related factors, which could also be considered as enabling environment, represent the school environmental factors which facilitate the adoption of technology mathematics teaching (Dele-Ajayi et al., 2017). These factors include hardware and software availability, time, internet access, human and technical support, management support, support from colleagues, etc. This current study identified school related environment to positively affect perceived ease of use and perceived usefulness. Findings from this current study were somewhat in line with Teo (2010) who identified that facilitating conditions of an educational institution significantly influenced perceived ease of integrating ICT. Panda and Mishra (2007) also indicated that poor facilitating condition was a key challenge to the adoption of ICT into teaching and learning.

Similar to some past studies (such as Farahat, 2012; Fathema & Sutton, 2013), this research found ICT training to significantly influence mathematics teachers' perception of the ease of ICT usage and the perceived usefulness of integrating ICT into the teaching mathematics. ICT training is crucial in helping mathematics teachers leverage on the benefits of ICT in teaching and learning (Peeraer & Van Petegem, 2012). ICT training could boost teachers' self-efficacy in the use of ICT which greatly influences their perception on the ease of using ICT (Holden & Rada, 2011), and usefulness of ICT in terms of enhancing mathematics pedagogy (Kundu et al., 2020). The present study, however, contradicts studies such as Jimoyiannis and Komis (2007), who explained that the effect of ICT training on ICT adoption in teaching of mathematics will be insignificant when the training is not directly related to mathematics applications. Ottenbreit-Leftwich et al. (2012, p.400) enumerated three items which help teachers to find ICT useful in teaching and learning namely, "knowledge of instructional problems that technology can help solve, knowledge of specific technology that can solve those instructional problems, and knowledge of how the technology can help solve those instructional problems within their own specific educational contexts". The acquisition of these kinds of knowledge is however achieved through ICT training. Greater knowledge on the use of ICT in teaching and learning exposes teachers to what new practices look like (Barakabitze et al., 2019).

Perceived ease of use represents the extent to which mathematics teachers believe that the integration of ICT into teaching and learning was less stressful (Sánchez-Prieto et al., 2019; Weng et al., 2018) and was found to positively influence both perceived usefulness and teachers' attitude towards the use of ICT. The findings were similar to that of Hamid et al. (2016) who also identified that perceived ease of use significantly predicted attitude towards the use of ICT in teaching and learning. Similarly, perceived ease of use was identified by Lee et al. (2013) as an influencer of teachers' attitude towards the use of ICT in teaching. Perceived usefulness is concerned with the extent to which mathematics teachers believe that the integration of ICT into teaching and learning will improve their productivity (Sánchez-Prieto et al., 2020; Lazim et al., 2021) and this was found to directly influence teachers' behavioral intention to use ICT in teaching and learning. Mou et al. (2017) also found perceived usefulness to significantly predict attitude towards the use of ICT in teaching and learning. Perceived usefulness was also identified in some past studies (Al-Gahtani, 2016; Elkaseh et al., 2016; Tarhini et al., 2016) to positively influence behavioral intentions. Similar conclusion was drawn by Holden and Rada (2011) who found a positive effect of perceived usefulness on the attitude towards the use of ICT.

Mathematics teachers' attitude towards the integration of ICT into teaching and learning positively influenced their behavioral intention towards ICT integration. This fell in line with other previous studies (such as, Hussein, 2017; Taat and Francis, 2019) that also identified attitude as an intrinsic motivation variable which predicts behavioral intention in the use of ICT. Similarly, Farahat (2012) found that the effect of attitude towards usage of ICT significantly and positively predicted the behavioral intention of ICT usage. Behavioral intentions on the other hand, were found to positively predict actual usage of ICT or its adoption into learning and teaching of mathematics. This supported the findings of other researchers such as Wang and Wang (2009) who ascertained that behavioral intention positively influenced the adoption of ICT. Basically, findings from the current study aligned with TAM (Davis et al., 1989), who identified that perceived ease of use predicted both perceived usefulness and attitude towards use; perceived usefulness predicted attitude towards use and behavioral intention; attitude towards use of technology predicted the behavioral intention to use the technology, while behavioral intention also predicted actual usage of the technology.

The following managerial recommendations were made. School related factors are also very important in the success of ICT integration into teaching and learning, especially mathematics. ICT infrastructure, technical support, managerial support, peer support, etc. are essential for the success of ICT integration into teaching and learning. Management must demonstrate commitment towards ICT integration into teaching and learning, while also encouraging increased interaction among teachers on the use of ICT. When teachers have a common vision on the use of ICT, it is easier for individual teachers to also adopt, and they could readily seek help from colleagues. Schools must also make technical support available to teachers, as well as well-equipped ICT infrastructure such as internet, ICT lab, software for teaching specific subjects, hardware, etc.

The study ascertained that ICT training was an important variable in determining perceived ease of use and perceived usefulness of ICT integration, which subsequently determined attitude towards ICT, then behavioral intention, and finally, the actual adoption or usage of the ICT. It is therefore recommended to the management of secondary schools, to intensify ICT training for teachers in general and mathematics teachers in particular. The training should be tailor made to suit the unique needs of teachers depending on the course they teach. For mathematics teachers, they must be introduced to graphical visualization tools. For example, in mathematics, the concepts of graphs and functions are abstract. However, the use of graphical visualization tools will provide multiple ideas to be demonstrated to students. Online demonstrations such as Java applets are useful for learning mathematics online and should thus be introduced to mathematics teachers. ICT workshops should be routinely organized for teachers.

Colleges of education which are responsible for training teachers, must also be well-equipped with ICT support systems, so they can train the pre-service teachers on the computer applications relevant to the areas of specialization before they graduate. This will help fill the gap in less-endowed secondary schools, which may not have the technical support readily available. When the teachers are already skilled before being posted, they will need less support or training to integrate ICT into their teaching. ICT-based pedagogical practices must therefore be key in the curriculum of the colleges of education. When teachers are well-equipped in the use of ICT, introducing a blended learning model becomes easier to achieve. There will be less resistance from teachers because they are knowledgeable on the use and benefits of ICT integration. In this era of COVID-19, where many services have been moved fully or partially online, including education services, well-trained teachers are a great success factor in the introduction of blended learning (mix of face-to-face and online teaching).

Finally, the government through the Ministry of Education, could update the national professional standards for secondary school teachers. This update should include a requirement to possess and adequately demonstrate practical ICT skills, necessary for individual teacher's area of specialization. When teachers enter the profession well-equipped, it will be easier for them to integrate ICT into teaching and learning.

Conclusions and Implications

TAM has been widely used by researchers, and this present research made two notable contributions. Firstly, the research included school related factors as an added variable to TAM, and secondly, the research included ICT training as another added variable to TAM. The research concluded that both school related factors and ICT training for teachers, positively and significantly enhanced the perceived ease of use and perceived usefulness of ICT by mathematics teachers. The research further tested applicability of the original TAM in teaching of mathematics studies. The research further concluded that perceived ease of use, had significant positive effects on both perceived usefulness and attitude towards the use of ICT in teaching of mathematics. Also, perceived usefulness had significant positive effects on both attitude and behavioral intentions. Attitude further had a significant positive effect on behavioral intentions, while behavioral intentions also had a significant positive effect on actual usage of ICT in teaching of mathematics. Based on these conclusions, the following recommendations were made for future research.

The study focused on only the direct paths as was done in the original TAM without testing for potential mediating or indirect effects among the variables. Therefore, future studies could limit attention on the direct effect, and focus more on the potential mediating effects among the variables. Secondly, the study focused solely on data generated in Ghana, which happened to be a developing country. While results from the study will be much of interest to other developing countries, generalizing the study to other categories of countries should be done with caution. Future studies could thus focus on more advance economies with well-developed ICT infrastructure.

Also, this study focused on teachers; however, future studies could focus on students. Future studies could ascertain how ICT tools like tablets and computer games, e-readers, etc., could enhance students' performance in mathematics. Finally, in line with many past studies, this study assessed the TAM using quantitative approach. Future studies could, however, use qualitative approach, to assess if results will be different from what the majority of the quantitative studies portray.

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