

## Article

## A Multi-Dimensional Model Towards Digital Readiness In Senior High Schools In Ghana

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### ABSTRACT

Technological advancement has led to the integration of Information and Communication Technology (ICT) in almost every aspect of the education system in Ghana. However, effective utilization can be determined by the digital readiness among teachers and students. This study, therefore, sought to examine the digital readiness of Senior High Schools in Ghana toward the integration of ICT in education. The study adopted the convergent parallel design. The study used questionnaires and interview guides to gather and collect both qualitative and quantitative data. Descriptive and inferential statistics were used to analyze quantitative data with the aid of SPSS while thematic analysis was used to analyze qualitative data. The study found that the digital readiness of teachers was much higher than students. The study again found that teacher, infrastructure, and student factors are the major factors that influence the adoption of ICT in teaching and learning in senior high schools. The study further found that the aspects of digital education relevant to improving teaching and learning in senior high schools include digital eligibility, digital content and courses, personalized learning, content, instruction, assessment, and accountability and funding. The study concludes by making recommendations for practice, policy, and theory.

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### Introduction

A multi-dimensional model is composed of several models for digital learning that can be annotated and extended to support digital learning in senior high schools. Most Senior High Schools have computer laboratories, computers, and its accessories (Mereku et al, 2009). The

Government of Ghana through Educational Reform in 2007 has made ICT compulsory core subjects in all Senior High Schools (SHS) as a way of promoting and encouraging the use of ICT among students. The policy of Ghana's ICT in education focuses on education management, capacity building, infrastructure, e-readiness, and access. It includes ICTs for curricula, content develop-

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-ment, technical support and maintenance, and monitoring and evaluation (Mary Burns et al., 2019). All these foci, aimed at supporting the digital education system in the country, contribute to the nation's development and growth. Integrating ICT into education and using it in the classroom was not easy as noted by Pelgrum and Anderson (1999). This clearly shows that adoption and, effective implementation of digital learning was not automatic but depends on many factors. Also, Ghana as a country has not wholly accepted digital education at the Senior High School level. Thus, Ghana's readiness for digital education was questionable and there was the need for assessment of Ghana's readiness towards digital education at the Senior High School level. This study seeks to use a multi-dimensional model to assess Ghana's readiness for digital education in Senior High Schools. In Ghana, the Ministry of Education in Ghana on "e-readiness assessment of second cycle institutions in Ghana" revealed that teachers have basic ICT skills, with few having advanced ICT skills, thereby undermining, the effective, use of ICT for teaching and learning.

Thus, previous studies have shown that digital learning depends on many factors, including ICT infrastructure and equipment. ICT infrastructure represents the equipment and software necessary to implement and operate systems and networks for communications services as well as support applications, digital content, and learning (Hughes, 2013). However, these and other studies did not use any percussive models for assessment of the country's readiness for digital education. This study therefore adopts Rogers' Model (1983) to assess Ghana's digital readiness in senior high school education.

It is important to note that digital learning adoption and its implementation depends on many factors including the usefulness of digital learning to teachers, students, administrators, and the parent; ICT infrastructure and internet connectivity. Teachers are the facilitators and success or otherwise of digital learning depends largely on them. Thus, teachers' ICT skills and knowledge and positive attitude, towards digital learning are inevitable. This was confirmed in many studies such as Termit and Samli (2014) in Malaysia and Abdullah (2012) in Ghana. Students are the beneficiaries of digital learning and the patronage depends largely on their ICT skills and attitudes. In situations where students have inadequate ICT skills, they do not effectively patronize digital learning, making digital learning a failure (Chien, Wu, and Hsu, 2014). Educational administrators seeks to the well-functioning of digital learning in schools and their attitudes matter a lot. Educational administrators

who have positive attitudes towards digital learning have allocated enough funds to support its implementation and the opposite was true when educational administrators have negative attitudes (Afshari et al., 2012; Mwalongo, 2011). Parents mostly assisted their wards in learning and as such they ideally trained them and have the knowledge of using information and communication technology so that they help and guide their children in this field (Stevenson et al, 2011). Thus, the parents of ICT skills and attitudes towards digital learning in a way influence that of their wards. Students are likely to develop positive attitudes towards digital learning when their parents have positive attitudes towards digital learning (Kalibova, 2016). Another digital learning factors is ICT infrastructure. ICT infrastructure comprises of space of ICT laboratory, furniture in ICT laboratory, ICT equipment such as computers and these are well noted in literature across the globe to influence successful implementation of digital learning (Türel & Johnson, 2012; Isibika, 2013).

This study focuses on a multi-dimensional model towards digital readiness in senior high schools in Ghana. The study focuses on the usefulness of ICT in teaching and learning at Senior high Schools and the state of ICT infrastructure in the schools. The study further assess the factors that influence the adoption of ICT in teaching and learning and the effect of ICT on teaching and learning in Senior High Schools.

## Theoretical Framework

This study reviews various theories of ICT use for teaching and learning. These theories include Technology Acceptance Theory (Davis, 1986), Constructivist theory of Learning (Woolfolk, 2006; Gredler, 2000) and Rogers' Model (1983). However, the Rogers' Model formed the basis for model development in this study.

### *Technology Acceptance Model*

The Technology Acceptance Model (TAM), is simply an extension of Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) a well-known model related to technology adoption and use, originally proposed by Davis in 1986 and later revised in 1989 (Davis 1986, Davis et. el 1989). According to Davis et al. (1989), TAM was one of the most widely and empirically tested theories which draws on social psychological approach to explain adoption of technology and the factors that influenced its adoption. The TAM theorizes that an individual's behavioral intention to use technology is basically determined by two beliefs and these are

perceived usefulness and perceived ease of use. Perceived usefulness was the extent to which a person believes that using the system has enhance job performance, and perceived ease of use is the extent to which a person believes that using the system has be free of effort. (Davis et. al 1989). The TAM model is shown in Figure 1.

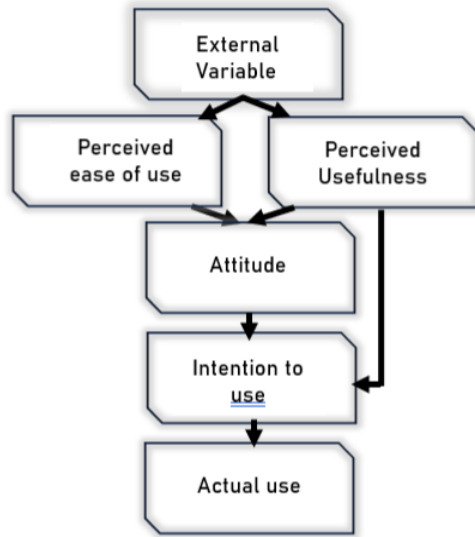


Figure 1. The Technology Acceptance Model (Davis, 1986;1989)

From Figure 1, perceived usefulness and perceived ease of use of digital learning technology influence the attitude and intension of educational stakeholders to adopt the technology for senior high schools which then led to actual use of the technology by teachers and students. This study adopted TAM because it predicted that factors that influence adoption of digital learning technology as perceived usefulness and ease of use. In Ghana, use of any technology was perceived to be influenced by how easier it was to use the technology relative to the existing one. This factor was very important as many factors posses’ as challenge to the use of technology in Ghana. This motivates stakeholders to think about factors that would be more convenient to use the technology.

*Constructivist Theory of Learning*

Honebein (1996) advanced a set of goals that aid the design of constructivism in learning settings. According to Honebein (1996), learning process ought provide experience with the knowledge construction process and encourage multiple modes of representation; and self-learning. One of the best ways to promote self-learning was through digital learning where students can easily access learning materials and study on their own with

**Conceptual Framework**

The conceptual framework for this study is shown in Figure 2 below:

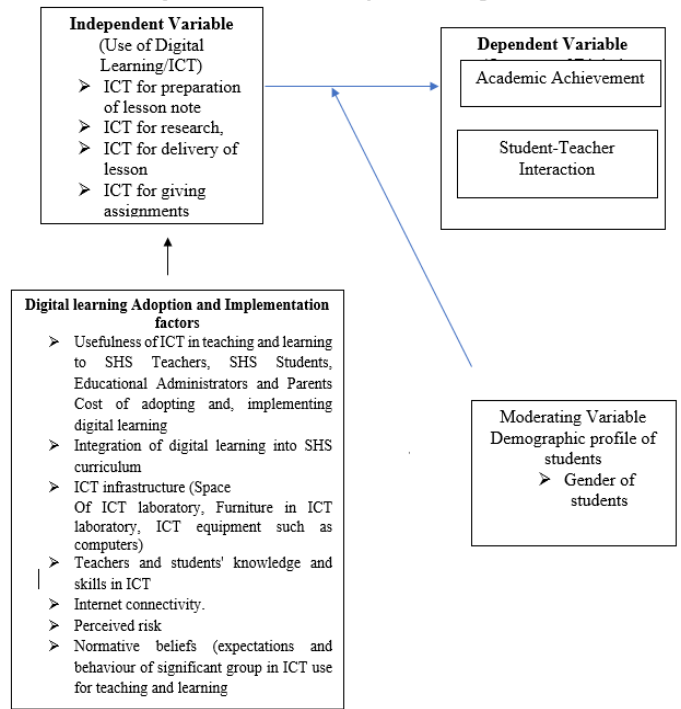


Figure 2: Conceptual Framework

Adapted from Technology Acceptance Model and Rogers' Theory (1983)

The conceptual framework in Figure 2 shows that whether or not digital learning has been adopted and effectively implemented in Senior High Schools in Ghana and elsewhere depends on many factors. These factors on the basis of Technology Acceptance Model and Rogers' Theory (1983) are grouped into usefulness of ICT in teaching and learning to SHS Teachers, SHS Students, Educational Administrators and Parents; cost of adopting and implementing digital learning, integration of digital learning into SHS curriculum ; ICT infrastructure (Space of ICT laboratory, Furniture in ICT laboratory, ICT equipment such as computers); teachers and students' knowledge and skills in ICT, internet connectivity; legal framework; perceived risk and normative beliefs (expectations and behaviour of significant group in ICT use for teaching and learning).

Education has one expected outcome and that was improvement in academic achievement of students and this became possible when there was also good student-teacher interaction. Thus, digital learning in any school environment is expected to improve student academic achievement and student-teacher interaction. However,

whether or not digital learning affects students' academic performance and student-teacher interaction depends on sex of the students. Thus, gender of students was expected to play significant role in digital learning-students' performance and digital learning and student-teacher interaction relationship.

From the conceptual framework, study variables are related in several ways as follows; Firstly, adoption of digital education in senior high schools was enhanced or otherwise by technology adoption factors, such as usefulness of ICT in teaching and learning to SHS Teachers, SHS Students, Educational Administrators and Parents, cost of adopting and implementing digital learning, integration of digital learning into SHS curriculum ICT infrastructure (Space of ICT laboratory, Furniture in ICT laboratory, ICT equipment such as computers), teachers and students' knowledge and skills in ICT, internet connectivity, legal framework, perceived risk and normative beliefs (expectations and behaviour of significant group in ICT use for teaching and learning) has influence on adoption of digital education in senior high schools in Ghana.

Secondly, digital education has influence on academic achievement of students, as well as student-teacher interactions.

Thirdly, gender of students has influence on students' academic achievement and student-teacher interaction.

### Statement of the Problem

This is an evaluation of Multi-dimensional Model towards digital readiness in Senior High Schools in Ghana. Specifically, the study addresses the following silent concerns:

1. To what significant extent was the current status of ICT infrastructure and equipment in senior high schools in the Kumasi Metropolis ?
2. To what significant extent was the readiness of the respondents to ICT as to:
  - 2.1. Teachers' knowledge and skills teaching among Senior high school students;
  - 2.2. Students' knowledge and skills learning; and
  - 2.3. Decision tools among Educational administrators?
3. What aspect of digital education was relevant for improving teaching and learning in Senior High Schools in the Kumasi Metropolis of Ghana?
4. What multi-dimensional model towards digital readiness for senior high schools in Ghana can be formulated?

### Research Hypotheses

Based on the above problem statements, this study will formulate and test the following hypotheses:

**Ho1:** ICT in teaching and learning does not significantly influence academic achievement of students in Senior High Schools in the Kumasi Metropolis of Ghana.

**Ho2:** ICT in teaching and learning does not significantly influence student-teacher interaction in Senior High Schools in the Kumasi Metropolis of Ghana.

### Methodology

Research approaches include qualitative, quantitative, and mixed methods approaches that provide specific direction for procedures in a research design (Creswell, 2014). The researcher does not only select qualitative, quantitative, or mixed methods to conduct the study, he also decides on a type of study within these three choices. In this study, the researcher adopted the mixed research design. In this study, questionnaires were administered and the results presented using quantitative format. Also, the interviews were recorded in field notes, tablet, computer and mobile phone and transcribed verbatim for qualitative analysis.

Based on the research approach, this study used convergent parallel design. Convergent parallel design is a design in which a researcher collects both quantitative and qualitative data, analyse them separately, and then compares the results to see if the findings confirm or disconfirm each other (Creswell, 2004). In other words, convergent parallel mixed method is a form of mixed methods design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. In this design, the researcher collected both forms of data at roughly the same time and then integrated the information in the interpretation of the overall results. Contradictions or incongruent findings were explained and further probed in this design.

On the quantitative design, this study has adopted two main research designs, namely descriptive and quantitative research design. This is because descriptive research design helped to reveal the reality of a phenomenon, thereby helping to answer questions relating why and what is really happening. The explanatory research design offers the opportunity to study cause and effect of a phenomenon, using statistical tools and analysis. Thus, based on descriptive research design, the study has been able to describe the perceptions of usefulness of ICT for teaching and learning among Senior High School (SHS) teachers, Senior High School (SHS) students, Education-

-al administrators and Parents of students; state of ICT infrastructure and equipment in Senior High Schools in the Kumasi Metropolis in terms of space of ICT laboratory; furniture in ICT laboratory; ICT equipment such as computers; and aspect of digital education relevant for improving teaching and learning in Senior High Schools in the Kumasi Metropolis of Ghana. The explanatory research design has help to statistically establish the magnitude of impact of digital learning on academic achievement of students; and, student-teacher academic interactions.

*Population and Sampling Procedure*

The general population for the current research was all students, teachers, and educational administrators in the Kumasi Metropolis. However, among all the senior high schools in the metropolis, six schools, namely Adventist SHS in Bantama, Anglican SHS in Asem-Kumasi, Asanteman SHS in Bantama, Ghana Armed Forces SHS in Bantama, Prempeh College in Sofoline and KNUST SHS were accessible. Thus, the target population of this study were students, teachers and Educational Administrators in Adventist SHS in Bantama, Anglican SHS in Asem-Kumasi, Asanteman SHS in Bantama, Ghana Armed Forces SHS in Bantama, Prempeh College in Sofoline and KNUST SHS. Specific population of each group in each school is shown in Table 1.

Table 1: Study Population

Schools	Students	Teachers
Adventist SHS	3012	161
Anglican SHS	3327	164
Asanteman SHS	2889	132
Ghana Armed Forces SHS	2719	139
Prempeh College	3671	173
KNUST SHS	3316	177
Total	18,934	946

Source: Administration Office of the Schools (March, 29<sup>th</sup>, 2021)

The study determined the sample size for each study population, using Yamane (1967) formulae sample size determination. Based on the formulae, the sample size for students and teachers were 392 and 281 respectively. To determine the sample size for each school, proportionate formulae is used and the required sample size for students and teachers in each school is shown in Table 2.

Table 2: Sample Size

Schools	Students		Teachers	
	Proportionate sample size	Sample size	Proportionate sample	Sample size
Adventist SHS	0.1591	62	0.1702	48
Anglican SHS	0.1757	69	0.1734	49
Asanteman SHS	0.1526	60	0.1395	39
Ghana Armed Forces SHS	0.1436	56	0.1469	41
Prempeh College	0.1939	76	0.1829	51
KNUST SHS	0.1751	69	0.1871	53
Total	1.0000	392	1.000	281

**Results and Discussion**

Data on the socio-demographic characteristics of the respondents in senior high schools in Kumasi Metropolis was to help provide a clearer picture of the background of the respondents of the study. The socio-demographic characteristics of the respondents include age range, sex, educational level, and rank. A summary of the results is shown in Table 1.

The results in Table 1 indicate that majority of the respondents which comprised of 95 (30.2%) were between the ages of 21-30 years; that 207 (65.7%) were had First Degrees with a frequency count of 194 (61.6%); 116 (36.8%) of the teachers held the rank Principal Superintendent, 120 (38.1%) were Assistant Director II, 49 (15.6%) were Assistant Director I and 30 (9.5%) held the rank of Deputy Director. The data gathered on the teachers signify a significant level of competence and experience that can be useful in providing much insight on digital readiness among senior high schools in Ghana.

Table 1: Socio-Demographic Characteristics of the Respondents

Items (Teachers)	Categories	Frequency	Percentage
Age	21-30 years	95	30.2
	31-40 years	163	51.7
	41-50 years	51	16.2
	51 and above	6	1.9
Sex	Male	207	65.7
	Female	108	34.3
Education	Diploma	56	17.8
	First Degree	194	61.6
	Masters	62	19.7
	Doctorate	3	1.0
Rank	Principal Superintendent	116	36.8
	Assistant Director II	120	38.1
	Assistant Director I	49	15.6
	Deputy Director	30	9.5
Items (Students)			
Age	12-15 years	94	24.0
	16-19 years	143	36.5
	20-23 years	155	39.5
Sex	Male	184	46.9
	Female	208	53.1
Level	Form 1	114	29.1
	Form 2	138	35.2
	Form 3	140	35.7

Source: Filed Data (2023)

### *Current Status of ICT Infrastructure and Equipment*

This section of focused on problem statement one which assessed the current state of ICT infrastructure and equipment in Senior High Schools in the study. The ICT infrastructure and equipment are grouped into three, namely, the ICT laboratory, the ICT laboratory space, and the ICT equipment. Responses to each question under each section were in the form of a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). The study analyzed the responses, using mean and standard deviation where the mean score range 1.00-1.49; 1.50-2.49; 2.50-3.49; 3.50-4.49, and 4.50-5.00 were interpreted as strongly disagree, disagree, neutral, agree and strongly agree. The results are summarized in Table 2. The study further employed the Independent Samples t-test to compare the responses between students and teachers about ICT infrastructure and equipment in the schools. This was done to ascertain whether or not the perception of ICT infrastructure and equipment significantly differs between the students and the teachers who are core beneficiaries of these infrastructures and equipment.

### *Aspects of Digital Education Relevant for Improving Teaching and Learning in Senior High Schools In the Kumasi Metropolis of Ghana*

The digital education relevant for improving teaching and learning was analysed by interviewing teachers and educational administrators in the study area. The interview data was analysed, using thematic analysis. Based on the responses from the educational administrators and teachers, themes such as student eligibility, student access, personalised learning, content, instruction, assessment and accountability, funding and delivery were identified.

#### *Theme 1: Digital Eligibility*

Participants in the study highlighted the digital eligibility of students as a key factor in digital learning. They noted that students now have easier access to information and technology tools, with smartphones being a common resource for conducting searches, clarifying topics, and accessing educational materials. Additionally, students have become proficient in basic computer skills, such as typing, and are familiar with various digital devices and applications, including television sets, sound systems, projectors, and mobile phones.

Increasing teachers' technology knowledge and abilities is crucial in overcoming technological barriers and changing their perceptions. Technology professional development workshops can be effective in altering

**Table 2: ICT Infrastructure and Equipment in Senior High Schools**

Components	Items	Group	N	Mean	Std. Dev.	P-value
ICT Laboratory	ICT Laboratory which is well-stocked with IT resources	Teachers	315	2.7111	.88640	0.000***
		Students	392	4.0612	.81941	
	ICT Laboratory which is well stocked with furniture	Teachers	315	2.7238	.92553	0.000***
		Students	392	4.0867	2.15929	
ICT Equipment	Access to peripheral devices such as projectors	Teachers	315	2.6794	.98171	0.000***
		Students	392	2.1939	.96388	
	Access to fast internet servers for research	Teachers	315	2.6730	.94653	0.000***
		Students	392	2.0638	.79867	
	Access to Computers	Teachers	315	3.9949	1.00118	0.000***
		Students	392	2.7651	.76040	
ICT Space	Well-spaced Audio-Visual Laboratory	Teachers	315	2.7365	.96289	0.000***
		Students	392	2.2908	1.04238	

Source: Field Data (2023); \*\*\**Significant at 1%*

teachers' views over time, with the first year focused on deeper learning. Student-centered approaches have also been successful in reducing teachers' fears about technology, as students assist them in resolving technical issues and introducing new applications.

In summary, students' digital eligibility and teachers' technology proficiency are vital aspects of successful digital education, and efforts to enhance teachers' tech skills can lead to more effective integration of technology in teaching (Ertmer, 2007; Bebell, 2010; Harper, 2008).

*Theme 2: Digital Content and Courses*

The study's participants emphasized that students have access to high-quality digital content and courses. They mentioned various ways in which technology is used for teaching and learning. For example, projectors are utilized in Geography lessons to enhance content delivery (Participant 7). Abstract concepts in subjects like Geography are often explained through YouTube videos (Participants 9), and during lockdowns in 2020, online meetings via Zoom and Google Meet were conducted to continue education (Participant 10). The normalization of smartphone use, especially during the COVID-19 era, helped bridge the gap in teaching and learning (Participant 6). Furthermore, access to appropriate content is considered crucial, as visual materials are particu-

larly effective in aiding student comprehension, especially for visual-oriented learners (Participant 11).

To create effective learning environments, ICT is essential in facilitating the teaching and learning process (Naidu, 2003). ICT should support teachers in enhancing their pedagogy, integrating technology with classroom discussions and relevant materials (Hennessy, 2014). Additionally, educators use ICT to promote democratic principles in education (Linuma, 2016). Specific applications like digital storytelling have been shown to improve listening comprehension more effectively than traditional language instruction (Ratna, 2007). In summary, the integration of ICT in education offers numerous benefits for both teachers and students.

*Theme 3: Personalized Learning*

Participants in the study stressed the significance of personalized learning in a digital education setting. This was observed through various means, such as using digital content from approved providers via the Ghana Education Service, subscribing to subject-focused channels using ICT, and revisiting challenging topics through recorded sessions, particularly during the pandemic.

In schools, personalization manifests differently for teachers, parents, and students (McCarty, 2014). Understanding students' needs, interests, and capabilities relies

on their interactions with educators ([National Forum on Education Statistics, 2019](#)).

Creating a positive school environment involves aspects like fostering relationships between students and educators, implementing effective teaching methods, promoting values and norms, and strengthening community connections ([Anderson, 2011](#)). Schools play a crucial role in shaping a positive school climate, as research highlights that the effectiveness of teachers in supporting students' academic progress is significantly influenced by an environment that prioritizes safety and values the uniqueness of both students and staff ([Collins & Parson, 2010](#)).

#### *Theme 4: Content*

Participants in this study emphasized the critical role of content in digital education as a cornerstone for effective teaching and learning. Content was seen as crucial in fostering knowledge acquisition and the development of higher-order thinking and creative learning skills. However, a prerequisite for students was a sufficient command of the English language to engage with digital educational content effectively in virtual learning environments.

In the context of Ghana, the government provided Teachers Mate 1 (TM1) laptops to enhance teaching in senior high schools. These laptops were equipped with educational programs that allowed teachers to design lesson plans, present digital content, and use planning applications for more effective instruction. The inclusion of subject syllabi on TM1 laptops aimed to diversify teaching and enable educators to handle multiple subjects efficiently.

[McKiernan \(2011\)](#) highlighted distinctions between digital learning and conventional teaching, with digital learning being suited for flexible learning materials and conventional teaching for collaborative or practical subjects. Combining both approaches can enhance instructional effectiveness, although digital learning cannot entirely replace traditional methods. [Yien et al. \(2011\)](#) further underscored differences in the learning environment and participants between digital and conventional education.

#### *Theme 5: Instruction*

The participants emphasized the importance of high-quality instruction in digital education, with the effectiveness of instruction being closely tied to the content provided. In a digital learning environment, many teachers adopt learner-centered teaching methods to enhance

student comprehension. The shift towards more interactive and learner-centric teaching styles has been driven by the Ghana Education Service's directive to incorporate ICTs (Information and Communication Technologies) into education. This change benefits both teachers and students, making teaching and learning more engaging and interactive (Participants 20, 21, 22).

To achieve desired learning outcomes, digital education focuses on engaging students in hands-on learning activities, and the design of educational activities and the flexible use of technology play a crucial role ([Pai & Tu, 2011](#); [Lai et al., 2012](#)). Practical teaching techniques that incorporate current trends and leverage digital learning tools can maximize teaching efficacy.

Additionally, assessment and accountability were highlighted as significant aspects of digital education. The integration of ICTs has led to improved student performance in examinations, which, in turn, influences policies aimed at further digitizing the education system (Participants 23, 24). The use of ICTs has also been observed to enhance students' understanding, as evidenced by improved results in class tests and end-of-semester examinations.

#### *Theme 7: Funding*

Funding emerged as a critical factor in digital education, according to the participants. Participant 25 emphasized that funding is pivotal because it dictates the provision of necessary equipment for facilitating digital education and interactive teaching and learning practices. Participant 26 added that funding serves as an incentive for performance and innovation, fostering higher performance and improvisation, which are crucial in education.

[Chimbunde's research \(2022\)](#) aligns with these observations, identifying inadequate funding as a major challenge for African schools. Sufficient funding enables schools to develop digital infrastructure, implement cybersecurity measures, provide staff training, and secure internet services, all of which are essential for effective teaching and learning in a digital context. The operational costs associated with digital education can be substantial, especially when face-to-face interaction is limited. In summary, funding plays a pivotal role in the successful implementation of digital education, with financial resources enabling schools to create a conducive environment for digital learning.



### *Extent to Which ICT in Teaching and Learning Improve Academic Achievement of Studies*

In the study, various aspects of the impact of ICT in teaching and learning on students' academic achievement were assessed through descriptive analysis. The mean (M) and standard deviation (Std. Dev.) values were used to gauge the respondents' perceptions. Here are the summarized findings: use of ICT makes learning more real: Most students (M=4.33, Std. Dev.=0.71) and teachers (M=4.21, Std. Dev.=0.54) agreed that ICT usage contributes to more realistic learning experiences; ICT enhances instructional outcomes: A majority of students (M=4.33, Std. Dev.=0.59) and teachers (M=4.24, Std. Dev.=0.53) believed that ICTs improve instructional outcomes; students score higher on topics taught with ICT: Most students (M=4.31, Std. Dev.=0.69) and teachers (M=4.35, Std. Dev.=0.52) agreed that students perform better on subjects where ICTs are used; increased student participation: A significant number of students (M=4.31, Std. Dev.=0.71) and a majority of teachers (M=4.37, Std. Dev.=0.57) believed that students are more engaged and participative in lessons involving ICTs; desired instructional outcomes: Most students (M=4.34, Std. Dev.=0.69) and a majority of teachers (M=4.37, Std. Dev.=0.59) agreed that students exhibit the desired instructional outcomes after lessons using ICT; and ICT encourages independent research, where most students (M=4.11, Std. Dev.=0.93) and teachers (M=4.38, Std. Dev.=0.55) recognized that ICT promotes independent research and study.

The p-value analysis revealed significant differences in the perceptions of teachers and students regarding the impact of ICT in teaching and learning, except for ICT's role in improving independent research. In most cases, students had a higher mean score, indicating that they perceived ICT to have a more positive impact on making lessons realistic, improving instructional outcomes, and increasing class participation. Conversely, teachers had a higher perception that ICT significantly enhances independent research, which is essential for effective teaching and learning in senior high schools.

### *Academic Test Score*

The results shown in Table 8 indicate that ICT in teaching and learning has significant positive impact on academic test score (Coef.=5.557; Std Error=2.165; p=0.011). This implies that ICT in teaching and learning significantly improves academic test score of students. As ICT in teaching and learning improves, the academic test of students significantly improves by 5.557).

The Coef -27.725 for male academic test score shows how wider the gap for the male students in SHS in Ghana are getting lower academic test score than female students, and its due to the following; this is sensitivity without generalizations, as academic achievement is influenced by a variety of factors and can vary among individuals. However, there are some cultural factors that may contribute to differences in academic achievement between senior high school boys and girls in Ghana their knowledge in ICT is concerned. It is important to note that these factors may not apply to all boys or girls, as individual abilities and circumstances varies greatly.

The results in Table 9 suggest that ICT in teaching and learning has a positive significant effect on student-teacher interaction in terms of recitation (Coeff= 0.272; Std. Error= 0.110; p=0.014). This shows that ICT in teaching and learning improves recitation. As ICT in teaching and learning improves, the recitation of students improves. Again, the results further shows that ICT in teaching and learning has positive but not significant impact on question and answers (Coeff= 0.172; Std. Error= 0.118; p= 0.145). As such, ICT in teaching and learning improves question and answer sessions of the teaching and learning process. Also, the results further show that ICT in teaching and learning has positive but not significant impact on reporting among the students (Coeff= 0.203; Std. Error= 0.120; p= 0.090). Therefore, ICT in teaching and learning improves reporting among the students. ICT tools have been shown to improve the reading skills and also improve the understanding of children concerning words and how they are pronounced (Chimbunde, 2022). Students that are audio-oriented usually get very eloquent when they frequently make use of ICT gadgets that pronounce words in the way making them confident when speaking (Volman, 2005)

Table 7: How ICT in Teaching and Learning Improves Academic Achievement of Students

Items	Groups	N	Mean	Std.	Std. Error Mean	P-value
				Deviation		
Use of ICT makes learning more real	Students	392	4.3291	.70900	.03581	0.009**
	Teachers	315	4.2063	.54007	.03043	
Use of ICTs enhances instructional outcomes	Students	392	4.3316	.59169	.02988	0.027**
	Teachers	315	4.2381	.52681	.02968	
ICTs enhances comprehension of concepts	Students	392	4.3061	.69205	.03495	0.397
	Teachers	315	4.3460	.52115	.02936	
Students score higher marks on topics where ICTs were used in teaching	Students	392	4.3138	.70512	.03561	0.838
	Teachers	315	4.3238	.57266	.03227	
Attentiveness increases	Students	392	4.3112	.71167	.03594	0.248
	Teachers	315	4.3683	.56794	.03200	
Students’ participation increases in sessions where ICTs are used	Students	392	4.2372	.78499	.03965	0.013**
	Teachers	315	4.3651	.57831	.03258	
Students display desired instructional outcomes post lessons taught using ICTs	Students	392	4.3393	.68576	.03464	0.510
	Teachers	315	4.3714	.59065	.03328	
Informing independent research and studies	Students	392	4.1122	.93396	.04717	0.000***
	Teachers	315	4.3810	.55375	.03120	

Source: Field Data (2023); \*\*\*Significant at 1% and \*\*Significant at 5%

Table 8: Effect of ICT on Achievement Test Score and Cumulative Weighted Average

Variables	Category	Achievement Test Scores			Cumulative Weighted Average		
		Coef	Std. Error	P-Value	Coef.	Std. Error	P-Value
Constant	-	93.080	8.172	.000***	6.435	.788	.000***
Sex	Male	-27.725	9.628	.004**	-3.698	.928	.000***
Level of Programme	Form One	-2.492	2.282	.275	.059	.220	.787
	Form Two	7.497	2.579	.004**	-.468	.249	.061*
Age	13-15 years	.310	.663	.640	.011	.064	.862
	16-19years	3.607	1.810	.047**	-.543	.175	.002**
ICT	-	5.547	2.165	.011**	.892	.209	.0000** *
No. of Obs.	392				392		
R-square	0.573				0.714		
Adjusted R-Square	0.559				0.692		
F-stats	139.931				173.883		
P-value	0.000**				0.000**		

Source: Field Data (2023); Dependant Variable=Achievement Test Score; and Cumulative Weighted Average; \*\*\*\*Significant at 1%; \*\*Significant at 5% and \*Significant at 10%

Table 9 Effect of ICT use on Recitation, Reporting and Question and Answers

Model	Recitation			Question & Answers			Reporting		
	B	Std. Error	P-Value	B	Std. Error	P-Value	B	Std. Error	P-Value
1 (Constant)	4.563	.387	.000***	4.352	.412	.000***	1.946	.419	.000***
Sex	-.536	.203	.009**	-.257	.216	.235	.054	.220	.807
form1	-.260	.266	.328	-.158	.283	.577	.296	.288	.304
form2	.813	.297	.007**	.435	.317	.171	-.710	.322	.028**
ICT use	.272	.110	.014**	.172	.118	.145	.203	.120	.090
No. of Obs.			392			392			392
R-square			0.050			0.014			0.042
Adjusted R-Square			0.037			0.002			0.030
F-stats			4.056			1.133			3.403
Sig.			0.003			0.341			0.010

### A Multi-Dimensional Model Towards Digital Readiness For Senior High Schools In Ghana

This section focused on the problem statement three, that is exploring the multi-dimensional model towards digital readiness for Senior High Schools in Ghana. To adequately address this problem statement, the study explored several other important factors that can influence readiness of digital learning in senior high schools. The other factors explored include student-related factors, teacher-related factors, and digital learning related factors. The study asked the respondents (both students and teachers) they expressed their extent of agreement or disagreement to each item under each construct regarding their influence on digital readiness of senior high schools in Ghana. Based on the responses, the study computed mean scores and standard deviation, based on which the interpretations of the responses were done. Since the students and teachers responded to the same items, the study further used Independence Samples t-test to statistically compare their responses to determine whether or not their responses significantly differed.

Table 3: Validated Digital Learning Readiness Factors

Digital readiness factors	Unstandardized Coefficient		Standardized Coefficient	t	p-value
	Coeff.	Std. Error	Standardized coefficient Beta		
(Constant)	-.976	.277		-3.524	.000***
Internet connectivity	.885	.020	.942	44.585	.000***
Awareness of IT integration	.082	.021	.069	3.858	.000***
Perceived risk of using ICT	-.050	.016	-.057	-3.079	.002**
The normative belief of ICT use	.150	.019	.014	7.8947	.000***
Perceive ease of use	.053	.018	.059	2.919	.004***
Usefulness to teaching and learning	.135	.046	.043	2.941	.004***
Teacher-related factors	.016	.027	.009	.598	.550
Student-related factors	.025	.039	.009	.634	.527
Digital readiness infrastructure	.140	.031	.019	4.516	.000***

Source: Field Data (2023); Dependent Variable= Digital Learning Readiness; \*\*\*Significant at 1%; \*\*Significant at 5% and \*Significant at 10%

The results in Table 3 indicate that internet connectivity, awareness of IT integration, perceived risk of digital learning, normative belief of digital learning, perceived ease of use, perceived usefulness of digital learning, and digital readiness infrastructure influence readiness of digital learning. However, teacher-related factors and student-related factors do not account for readiness of digital learning in senior high schools in Ghana.

#### Multi-dimension Model Framework

The original model for digital learning readiness in senior

high schools was Acceptance Model by Davis (1989) and Rogers Model (1983). The findings from the fieldwork revealed factors that affect the readiness of digital learning in senior high schools as shown in Table 4.

Table 4 : Validated Digital Learning Readiness Factors

No.	Digital learning readiness factors
1	ICT integration into teaching and learning
2	Internet connectivity
3	Perceived risk of using digital learning
4	The normative belief of digital learning
5	Perceived ease of use
6	Perceived usefulness of use
7	Digital learning infrastructure

Source: Field Data (2023)

Based on Table 4, Roger’s Model (1983) is modified as shown in Figure 1 to explain digital learning readiness in senior high schools in Ghana.

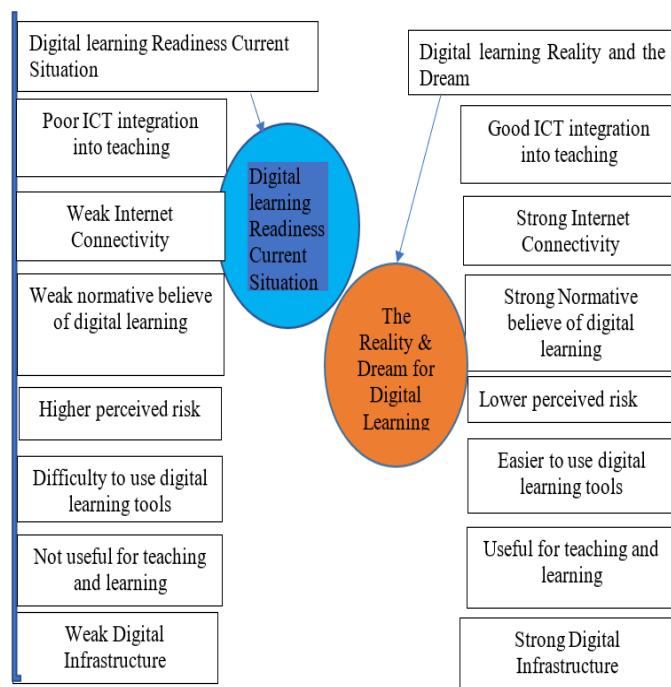


Figure 3: Digital Learning Readiness Model for Senior High Schools in Ghana  
Source: Author’s Construct (2023)

The model suggests the factors that are the reality and the dream of digital readiness in senior high schools which include good ICT integration into teaching, strong internet connectivity, strong normative belief of digital learning, lower perceived risk, ease of use, usefulness for teaching and learning and strong digital infrastructure. . On the other hand, digital learning readiness current situation factors include poor ICT integration into teaching, weak internet connectivity, weak normative belief of

digital learning, higher perceived risk, difficulty in using digital learning tools, not useful for teaching and learning and weak digital infrastructure. The model suggests that when there is proper infrastructure in ICT in senior high schools, it is easier to integrate ICT into teaching and learning which in the long run improves the academic performance of the students. However, when ICT infrastructure is in a much poorer state, it is difficult to integrate ICT into teaching and learning and so it is difficult for both students and teachers to normatively have a belief in using ICT to teach and learn. According to Dalvi-Esfahani et al. (2018), students' desire to keep using technology in the classroom was influenced by things like perceived ease of use and availability of proper ICT infrastructure. It is also common knowledge that users are better able to apply and retain knowledge when they actively participate in their learning (Huang, Jeng, & Huang, 2009). In the same vein, research (e.g. Jimoyianis et al., 2013) demonstrates that the use of technology is crucial to the learning of today's digital students when they are involved in meaningful, pertinent, and intellectually demanding schooling.

Any model for digital learning in senior high schools should consider IT integration in teaching and learning, perceived risk of using ICT, normative believe of using ICT, perceived use of using ICT, usefulness of using ICT, digital infrastructure.

## Conclusions

The study found that the schools have low ICT infrastructure and equipment in ICT and the ICT skills and competence of students and teachers are low, though the teachers significantly have higher ICT skills and competence. These go to indicate that the digital learning readiness of the schools is low.

The study further found that the aspects of digital education relevant for improving teaching and learning in senior high schools include digital eligibility, digital content and courses, personalised learning, content, instruction, assessment and accountability and funding. It was found that digital learning has significant positive impact on cumulative test score but has no significant impact on achievement score. It was found that digital learning has significant positive impact on recitation but has no significant impact on questions and answers and reporting. To address these challenges and improve achievement test scores, it is crucial to enhance ICT infrastructure in schools, provide comprehensive ICT training for teachers, and promote digital literacy skills development among students. Additionally, efforts should be made to

bridge the digital divide and ensure equitable access to ICT resources for all students, regardless of their socio-economic background or geographical location.

The study concludes that awareness of ICT integration, internet connectivity in the school and immediate communities of school, perception of ICT cost and perceived risk of using ICT for teaching and learning were found to have a positive significant impact on digital learning. Perceived risk was however, concluded to have a negative significant impact on digital readiness.

It is concluded that normative belief, teacher ICT skill, student ICT skill, availability of ICT infrastructure, sex and age have a positive but not significant impact on digital readiness.

## Recommendations

The study based on the findings presents the following recommendations that can help improve digital readiness in senior high schools in Ghana:

The study recommends that the Government of Ghana through the Ministry of Education to ensure adaptability and affordability of ICT infrastructure for schools by providing funding that will significantly increase student participation in digital or online education. Schools must be encouraged to digitalisation a part of the students' life by granting easy access to ICT equipment to enhance their comprehension on the use of these gadgets to improve teaching and learning. Again, the study recommends that adequate measures should put in place to aid students of diverse backgrounds by providing uninterrupted power supply and internet connection. This will aid in the teaching and learning process especially when it comes to concepts of culture and other concepts that require site seeing which can be made easily available by the watching snippets of the concepts on YouTube and other educational platforms. The study further recommends that a strong, vibrant and sustainable Public-Private Partnership among key educational stakeholders which includes government, private sector and civil society organizations to map out plans and strategies to seriously tackle the problems hindering the smooth integration of ICT in the education system. Essential gadgets and utilities that make up the ICT infrastructure such as internet access, computers, and electricity should be carefully integrated to ensure effective teaching, learning and research so that students especially can have access to volumes of educational resources digitally.

The study further recommends that any model for

digital learning adoption and implementation in senior high schools be built around factors such as IT integration in teaching and learning, perceived risk of using ICT, normative believe of using ICT, perceived use of using ICT, usefulness of using ICT, digital infrastructures. Future studies on digital learning should consider comparative analysis of readiness of digital learning in rural and urban schools and what account for the differences, if any for policy direction. Also, future studies should consider how culture of students and teachers play a role in digital learning in schools in Ghana.

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