2014

Impact of Technology Interventions on Student Achievement in Rural Nigerian Schools

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2014

Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Education

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Abstract

Increasing technology intervention in rural schools is still a herculean task, especially with the lack of adequate infrastructures and limited resources. The purpose of this quantitative, causal comparative study was to determine the impact of technology interventions on student achievement in rural Nigerian schools. The study explored the differences in student achievement in mathematics and English between technology and nontechnology schools and established a relationship between teachers' level of technology implementation and student achievement. The convenience sample comprised 2,369 examination scores in mathematics and English of Senior Secondary Level 2 (SS2) students and purposive sampling of 34 teachers who participated in an online survey. Data were analyzed using multivariate analysis of variance (MANOVA), the level of technology implementation (LoTi) framework, and Pearson's correlation coefficient test. The results showed significant differences in student achievement between technology and nontechnology schools. However, the LoTi framework results indicated a low level of technology implementation in classroom instruction and no significant relationship between teachers' technology integration and student performance. Thus, the mere presence of technology seems to have more impact on student grades than the ways in which teachers use it. This study is resource material for stakeholders in education to ascertain the technology that worked best, teachers' professional development, and other infrastructures, prior to the deployment of technology interventions. The results could be useful for increasing teachers' technology integration and improving student performance, thereby leading to positive social change.

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Dedication

To the glory of my heavenly father who made a way where there is no way by providing all necessary resources in terms of finance, strength, wisdom, and above all, grace to excel in this doctoral study. To my husband and lovely children for their unflinching support, love, and encouragement that made my dream a reality.

Acknowledgments

With God, all things are possible. When human strength fails, His succor upholds me. I am most thankful to all my facilitators at the Walden University who helped shaped my doctoral journey. Dr. Wade Smith, Dr. MaryFriend Shepard, and others, too numerous to mention: You are simply the best. My dissertation committee members Dr. Gerald Giraud and Dr. Paula Dawidowicz: Your immense contributions to the success of this dissertation cannot be quantified. The professional experiences you shared in channeling this process is of exceptional value, and I am very grateful. As always, I am indebted to my wonderful chair of the committee, facilitator, editor, and mentor, Dr. Carol Watson. Your words of encouragement, support, care, and understanding of my challenges made me forge ahead rather than looking back. The first Skype chat we had made the difference and built my confidence in writing the dissertation. Words cannot express my heartfelt gratitude. Nkoyo, you introduced Walden to me and never relented in your efforts to monitor my progress as the month goes by. Patrick, your ever-listening ears to my plights in this doctoral journey were a source of encouragement. To both of you, accept my sincere gratitude. Finally, to my husband, Taiwo, Kenny, Tomisin, and Abiola, the sleepless nights, late dinner, no breakfast, and no social activities are now over. Thanks for providing me with your unwavering support throughout this doctoral journey. I love you all.

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Chapter 1: Introduction to the Study

The emergence of technology has made the world into a global village and has transformed teaching and learning processes. Technology integration into classroom instruction has gained much ground in both developed and developing countries. The concept of technology integration is now viewed as a fundamental part of successful teaching and has gained the interest of many researchers who investigated and explored effective ways of integrating technology into the school curriculum (Anderson & Maninger, 2007; Wood & Ashfield, 2008). Almekhlafi and Almeqdadi (2010) identified one overarching goal of technology integration: a school's ability to have a global learning environment with effective and appropriate use of technology in the classroom (p. 165). However, the high cost of acquiring technology is still a major challenge in many developing countries, and its adoption is not expanding as quickly as expected.

Many schools still have constraints on the effective use of technology in the classroom (Lim, Zhao, Tondeur, Chai, & Tsai, 2013). A digital divide exists between urban, semiurban, and rural schools as a result of varied challenges the rural communities experience (Akanbi & Akanbi, 2012). Through a series of technology interventions for rural communities, many rural schools now have access to technology, but the usage is minimal due to other enormous challenges, such as lack of basic supportive infrastructures. Levin and Wadmany (2008) noted that educators are yet to effectively integrate educational technologies into K-12 classrooms. Identifying the barriers and challenges in rural schools may assist in providing holistic technology interventions that would be highly effective in the learning environment.

The purpose of this study was to determine the impact of technology interventions on student achievement in rural schools with a focus on a rural community in the developing country of Nigeria. Researchers have carried out many studies to determine factors affecting technology adoption, use of technology in the classroom, teachers' attitudes toward technology usage, and impact of technology on student achievement (Inan & Lowther, 2010; Levin & Wadmany, 2008; Lim et al., 2013; Straub, 2009; Thieman, 2008). With the keen interest in technology usage to enhance teaching and learning process, especially with the deployment of low-cost technology solutions, researchers have yet to determine the impact of technology interventions on students' achievement amidst the other challenges faced by rural schools in developing countries. The quantity of technology does not impact students academically, but effective teaching practices in conjunction with quality technology usage can improve student achievement (Lei, 2010). The design of this study was to help define the outcomes of integrating technology into classroom instruction and determine if the deployed technology solutions meet the needs of learners and educators.

Background

In 1988, the Nigerian government enacted a policy on computer education, recognizing the role and integration of information and communication technology (ICT) in education (Adomi & Kpanghan, 2010). As a follow-up to this policy, computer systems were deployed to some schools. To harness and support the government initiative, many private and public organizations, through their corporate social initiatives, deployed various technology interventions into schools across the country.

However, the low level of basic infrastructures in some schools did not allow the interventions to manifest as expected. Technology integration in the classroom is not reliant upon technology tools or interventions but upon how technology can have a meaningful impact on student achievement.

Despite improved access to technology in schools, little research exists on the level of usage in rural schools, especially in developing countries. The ability of teachers to integrate technology activities to meet students' needs is important, not just having teachers teach only technology skills (Gorder, 2008). However, many teachers find the change process of innovation daunting and laborious. Considering their current teaching schedules, integrating technology into class instruction can be a herculean task (Cifuentes, Maxwell, & Bulu, 2011; Joshi, Pan, Murakami, & Narayanan, 2010; Wachira & Keengwe, 2011). Studies have shown teachers' enthusiasm and positive experiences with using technology but additionally point out the many barriers to effectiveness (Almekhlafi & Almeqdadi, 2010; Levin & Wadmany, 2008; Wachira & Keengwe, 2011; Winzeried, Dalgrano, & Tinkler, 2011; Zhao, 2007).

Past related research has focused on urban schools in developed countries (Joshi et al., 2010; Wachira & Keengwe, 2011), thus creating a gap in generalizing these identified factors across localities. Although Cakir, Delialioglu, Dennis, and Duffy (2009) argued that, given adequate technology facilities, the locality of a school does not affect the impact of technology on student achievement, few studies have explored how teachers in rural schools integrate technology compared to their contemporaries in urban schools (Marwan & Sweeney, 2010). One might have to consider the peculiarities of the rural environment, as well as varied and unique challenges faced by rural schools, and that technology interventions that have been successful in urban schools might be a failure in rural schools.

Most of the literature reviewed suggested varied factors that contribute to the success of technology integration. However, there was no clear study that ascertained if the factors were the same, irrespective of the locale. The need exists for examining the impact of technology interventions on student achievement in developing countries' rural communities and establishing differences in student achievement in a technology-enabled and nontechnology-enabled school within the same community. This study was designed to ascertain the technology interventions that have met the needs of teachers and had an impact on student achievement, thereby making them competitive with their counterparts in urban areas. In addition, it established how the teachers in this study ascribed meaning to technology differently than in prior research studies as a result of the peculiarities of their schools.

Problem Statement

Nigeria, being a developing country, faces the challenges of access to technology-rich education. The Federal Ministry of Education (FME), Universal Service Provision Fund (USPF) and several private organizations have assisted many schools by providing various technology solutions, such as supplying personal computers, setting up computer laboratories and other facilities inclusive of Internet connection, as well as interactive whiteboards (IWBs) and projectors (SchoolNet, 2005; USPF, 2010). However, there have been no means in place to ascertain the impact of technologies on student achievement, especially in rural schools in Nigeria that also faced the lack of electricity, adequate funding, and basic infrastructures, among other challenges.

Many research studies on technology integration into classroom instruction have shown that there can be a significant, positive impact on student achievement (Cakir et al., 2009; Inan & Lowther, 2010; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). However, most of the research studies did not focus on rural schools, especially in developing countries. There is a need to move beyond assessment of participants' perceptions and focus on actual student achievement in technology integration efforts (Smolin & Lawless, 2011). A rigorous evaluation that can provide information with which to make decisions and guide the deployment of various interventions is important. This research fills a gap by providing information on the impact of the various educational technology interventions on student achievement in rural Nigerian schools (Smolin & Lawless, 2011; Tamim et al., 2011).

Purpose Statement

The intent of this quantitative study was to determine the impact of the technology interventions that were deployed to rural schools on student achievement in Nigeria. It helped determine if the holistic technology solutions met teachers' needs as well as had a meaningful impact on learners. In this study, the test was based on whether or not the use of technology, the independent variable, had an impact on English and mathematics examination scores, the dependent variables. Further tests were based on teachers' level of technology usage as related to student achievement to determine the relationship between the level of technology implementation, the independent variable, and student achievement in mathematics and English as the dependent variables.

Technology initiatives such as one-to-one laptops and IWBs, among other technology initiatives have had a positive impact on student achievement in mathematics and English (Hossain & Quinn, 2013; Suleman, Aslam, Habib, & Hussain, 2013; Thomson & Davis, 2013). This study could lead to a positive social change in rural schools by increasing the level of awareness of the potential impact of various technology initiatives on student academic achievement.

Research Questions and Hypotheses

The guiding research questions in this quantitative study follow:

1. Is there a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools?
2. What is the relationship between teachers' level of technology implementation and student achievement in mathematics and English?

The hypotheses follow:

H_a1: There is a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools.

H_a2: There is a relationship between teachers' level of technology implementation and student achievement in mathematics and English.

The findings from this study add to the knowledge base of effective use of technology by teachers, teachers' perceptions on technology integration, as well as the impact of technology usage on student achievement in rural learning environments in a developing country. The study also determined the technology interventions that have worked best in rural schools.

The hypotheses were created to determine the impact of the technology intervention in a technology-enabled school on student achievement, with a comparison to a nontechnology-enabled school within the same community. End-of-session examination scores for SS2 in English and mathematics were used to answer Research Question 1. The end-of-session examination was a cumulative score comprised of three term scores. The term score was also cumulative, which comprised the final term score and three continual assessment scores. The null hypothesis states that when the mean score of the two groups is the same, there is no difference in achievement. The alternative hypothesis is the existence of a significant difference in the mean score of the two groups, showing a difference. The study further examined the relationship between the level of technology implementation reported by teachers and student examination scores in mathematics and English as reported in the selected schools. A widely used survey instrument, Level of Technology Implementation (LoTi), was used to obtain teachers' level of technology implementation (LoTi Connection, 2011).

Conceptual Framework

The basis of this study was a framework that is referred to as the level of technology implementation (Moersch, 1995). The foundation of this work was based on the concerns based adoption model, which asserts that people experience change in the process of learning, and there must be adequate support throughout the change process to ensure that the learning process is deeply rooted (Hall & Loucks, 1979). This framework was grounded in the work of Dwyer, Ringstaff, and Haymore (1994) in Apple Classrooms of Tomorrow (ACOT), after a 13-year research effort that revealed a substantial increase in student achievement through the use of technology in the classrooms alongside innovative ways to design curriculum, instruction, and assessment. The framework entails a set of measures that reflect the level of progress in the competency of teaching with technology (Moersch, 2001). The survey items were subjected to an intensive developmental and review process. According to Moersch (1997), the framework uses a scale based on six levels, comprised of Nonuse (Level 0); Awareness (Level 1); Exploration (Level 2); Infusion (Level 3); Mechanical (Level 4a) and Routine Integration (Level 4b); Expansion (Level 5); and Refinement (Level 6). (Details of the framework and how teachers' level of technology implementation is determined will be discussed in Chapter 2.)

This framework has been aligned to several state and national standards, such as the Texas STaR Chart, Florida STaR Chart, ISTE's NETS, and TSSA (Learning Quest, 2004). Several studies have used the framework to evaluate teachers' level of technology integration into classroom instruction and the extent of impact on student achievement (Alfaro, 2008; Al-Zaidiyeen, Leong Lai, & Fong Soon, 2010; Malcolm-Bell, 2010; Truett, 2006). For this study, the LoTi framework is the lens through which one might determine how the teachers' usage level of the various technology interventions impacts student learning potential.

Nature of Study

This study employed a causal comparative design in a quantitative approach. The approach involved collecting and analyzing quantitative data in two consecutive phases within one study. The analyses from the two phases are related to one another (Ivankova, Creswell, & Stick, 2006). A quantitative study is a means for testing objective theories by examining the relationship among variables; in this case, eight schools within the same rural community, grouped into technology-enabled and nontechnology-enabled schools. The sample data were estimated at 2,000 students and 50 teachers across the eight participating schools. For descriptive statistical and comparative analysis, the first phase employed the end-of-session examination scores of students in SS2 in English and mathematics. The independent variables were the type of schools in terms of technology availability while student achievement in English and mathematics were the dependent variables. The data were used to explore whether there was a significant difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools.

The second phase of data collection was based on the teachers' level of technology implementation, through a survey instrument designed by LoTi Connection (2011). The instrument was administered to mathematics and English teachers to determine the teacher's level of technology usage. The outcome was related to student achievement in a statistical analysis for existence of a relationship. The main analysis determined whether the use of technology had an impact on student achievement and was carried out using a multivariate analysis of variance (MANOVA). The *t* test showed the mean difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools. The *F* value (Wilks's lambda) was based on a comparison of the error variance/covariance matrix. The covariance helped determine the significance of the correlation between the teachers' level of technology implementation and student achievement.

Definitions

Rural school: A rural school is a setting in an underserved community with low-income earners and inadequate infrastructures to support and sustain an effective technology-enabled learning environment. In this study, the reference was a senior secondary school involving learners between the ages of 14 to 18, or Grades 10 through 12. It could also be termed as "a school in a community whose population is less than 25,000 people" (Cullen, Frey, Hinshaw, & Warren, 2004). However, the population size in a rural community is dependent on the state or country population. In Nigeria, the National Population Commission (NPC) recorded that the least populated rural community was about 31,641 people, while the rural community for this study had an average of 150,000 people (NPC, 2010).

Technology interventions: Technology interventions are the varied technology solutions that are deployed to schools for technology integration into classroom instruction. For this study, the interventions were comprised of computer laboratories, IWBs in the classroom, and the provision of one-to-one laptops, including hardware and education software tools (SchoolNet, 2005; USPF, 2010).

Technology integration: Many researchers have defined technology integration in their studies. Bauer and Kenton (2005) defined technology integration as reliance on computer technology for regular lesson delivery (p. 522). For the purpose of this study, technology integration refers to the reliance on various information and communication technologies for effective teaching and learning processes. Learners use technology to construct new knowledge and enhance their learning process, and teachers integrate technology into their teaching process for effective lesson delivery.

Nontechnology-enabled schools: For the purpose of this study, nontechnology-enabled schools were schools that did not have large-scale technology interventions to accommodate technology use by students. However, the schools might have had one or two computers for administrative purposes.

Technology-enabled schools: For the purpose of this study, technology-enabled schools were schools with technology interventions. The interventions or technology solutions deployed could be a computer laboratory, IWBs, or one-to-one learning environments through funding from government or private organizations (SchoolNet, 2005; USPF, 2010). The schools had received some professional development on the use of technology in the classroom (SchoolNet, 2005).

Level of Technology Implementation (LoTi): The survey instrument is based on technology usage, with 37 items that examine the level of teaching innovation, personal computer use (PCU), and current instructional practices (CIP). The survey design was to address the need of teachers in attaining a higher level of thinking and technology use in the classroom (LoTi Connection, 2011). It measures teachers' reported level of technology integration into classroom instruction by ranking the levels from 0 to 6. 0 – Nonuse, 1 – Awareness, 2 – Exploration, 3 – Infusion, 4a – Integration: Mechanical, 4b – Integration: Routine, 5 – Expansion, and 6 – Refinement (LoTi Connection, 2011).

Assumptions

Only mathematics and English teachers were involved in the survey. It was assumed that the selected teachers would have had some technology training based on the technology interventions available in the school. Another presumption was that the teachers in the study were a good representation of the population and that those teachers in the technology-enabled schools were integrating technology into their classroom instruction at some level. Additionally, it was assumed that rural schools in developing countries are different from rural schools in a developed country, such as the United States. Finally, the expectation was that all participants would provide honest responses to the survey items. Participants were informed of the right to withdraw at any time as participation in the study was voluntary.

Scope and Delimitations

The scope of this study covered senior secondary schools in a rural community in Nigeria in order to determine the impact of technology interventions on student achievement. The study involved teachers from technology-enabled and nontechnology-enabled schools within the same community. Based on the Federal Capital Territory Electronic Management and Information System (FCTEMIS) data, there are eight senior secondary schools within the community with a sample population of about 8,400 students and 540 teachers (FCTEMIS, 2012). A delimitation of this study was the varied technology interventions in the selected schools. The delimitation was not evaluated with respect to the teachers' level of technology implementation.

Limitations

The target population for this study was restricted to schools within the same community, and the implication was that participants for the study originated from the selected schools. This is a limitation, as the findings cannot be generalized. The large variability among rural communities in Nigeria might not permit the findings to be applicable beyond the immediate community, except for communities with similar demographics or characteristics. The study was also limited to SS2 students because the students in SS3 are in their final year of high school. The final examination is administered at the national level, and the results might not be accessible. The participating teachers were limited to mathematics and English teachers for SS2 students.

Significance of Study

The study helped determine the needs of learners and outcomes of integrating technology into classroom instruction, thereby keeping both educators and learners competitive, irrespective of their locale. Educators and learners remain enthusiastic about technology integration in the classroom and about opportunities to enhance their teaching and learning processes amidst challenges faced in their various schools.

This study serves as resource material for developing countries that have yet to deploy technology solutions to schools in rural areas and can lead to a paradigm shift for rural schools in developing countries that have been neglected or deprived of access to technology-rich education. Essentially, the findings provided information on what worked best, the status of technology interventions in selected schools, teachers' level of technology implementation, and students' level of achievement as a result of technology interventions (or lack thereof), thereby leading to positive social change in these rural communities.

Summary

Technology interventions in schools have become pervasive. However, they are still underutilized in many rural schools, especially in developing countries. The need to understand teachers' level of technology implementation and integration into classroom instruction can help determine the impact on student achievement. This study helped to ascertain if students are getting the full benefits of a technology-enabled learning environment, or if there are even any differences in student achievement.

This chapter addressed the problems associated with technology interventions in rural schools, with the aim to explore the impact of technology interventions on student achievement. The research questions and hypotheses guiding the study were introduced, with a discussion on the nature and significance of the study. Terms were clearly defined. This study may serve as a model for rural communities with the same demographic characteristics in Nigeria and other developing countries to get a valid view of what technology is a best-fit, as well as determine teachers' level of usage and proficiency and their impact on learners' performance on exams.

It also serves as resource material for developing countries that have yet to deploy technology solutions to schools in rural areas and could lead to a paradigm shift for rural schools in developing countries that have been neglected or deprived of access to technology-rich education. Essentially, the findings provide information on what worked best, the status of technology interventions in selected schools, and student level of achievement as a result of technology interventions or lack thereof, thereby leading to positive social change in these rural communities.

Chapter 2 explores related literature on the subject of the research study, the literature search strategy, and theoretical foundation. Chapter 3 details the methodology that was used to conduct the study. Chapter 4 presents findings from the quantitative approach and the concluding chapter, Chapter 5, summarizes the study, the data, and the importance of the findings, with further implications and recommendations.

Chapter 2: Literature Review

Introduction

The review of literature for this study was segmented into three areas: interventions, technology integration, and access to technology in rural schools. In the first, interventions, I discuss schools and holistic solutions that have had an impact on learners. The interventions were in the form of hardware support such as IWBs, desktop computers, and one-to-one laptops as well as software support. Technology interventions that have been deployed to schools through government and nongovernment initiatives in Nigeria will also be discussed. The second area is a review of technology integration into classroom instruction and its effective usage, as well as the impact on student achievement. The third aspect of the review is rural schools’ access to technology.

Literature Search Strategy

Databases in the Walden University library used for literature gathering included ERIC, Google Scholar, and Education Research Complete. The Thoreau search tool was used to find articles within multiple databases to ascertain the level of relevance of articles selected for review. The key search terms were *rural schools and technology, teacher and technology integration,* and *technology and student achievement*. The scope of literature review included peer-reviewed, scholarly articles published within the last 5 years. However, a few articles older than this were used to further buttress some of the points related to the study. Few recent dissertations were used as a result of inadequate resources on technology integration in developing countries’ rural schools.

Theoretical Foundation

The success of technology interventions provided for schools might largely be dependent on their effective usage by teachers. A reliable outcome on student learning potential and achievement can be measured through teachers’ level of technology implementation. There are several frameworks that have been developed to measure technology integration in the classroom. However, the basis for this study is the LoTi framework (LoTi Connection, 2011). Moersch developed this framework based on the concerns based adoption model, which asserts that people experience change in the process of learning, and there must be adequate support throughout the change process to ensure that the learning process is deeply rooted (Hall & Loucks, 1979). The framework has experienced several reviews from its inception until now, which further enhances its power. Since its inception in 1994, “The LoTi Framework has been used as a statewide technology use survey, a district school improvement model, and a classroom walkthrough tool impacting thousands of schools nationally” (Loti Connection, 2011).

The framework is used to articulate stages of technology implementation in the classroom. Perspectives on technology integration differ, and researchers have used various terminologies and concepts. However, the focus is on technology integration into classroom instruction. According to Joshi et al. (2010), who conducted a study on technology integration into classroom instruction for young children to determine teachers’ perceptions, 65% of U.S. teachers said it inspired the children, while only 8.5% of the Japanese teachers agreed to this same concept. It is unclear if this broad gap in opinions was a result of the locale or teachers' perceptions of the meaning of technology integration. Berkely-Jones (2012) examined teacher levels of technology implementation self-ratings and student Texas Assessment of Knowledge and Skills (TAKS) scores, finding no difference between teachers' LoTi scores and student mean scores on ELA and math TAKS. Alfaro (2008) established a relationship between teacher LoTi scores and student scores in language arts, but found no difference in math and social studies. However, Truett (2006) found that students' math scores were influenced by teachers' LoTi scores. Thus, LoTi scores have helped educators and schools to track the effective usage of technology integration into classroom instruction and to meet the needs of 21st century learners.

Literature Review Related to Key Variables

Technology Interventions

Many countries have tried, through various technology interventions, to provide technology-rich learning environments by equipping the schools with the latest technology. The technology interventions come in various forms, including IWBs, one-to-one laptop computing, and computer laboratories, among others. In recent years, the use of technology to enhance teaching and learning processes had increased tremendously, even in developing countries. However, the effective usage of technology interventions is highly dependent on several factors such as teachers' attitude, beliefs, and perceptions; school adoption rate; pedagogical aspects; students' perception and acceptance; and sustainability (Berry, 2011; Gurevich & Gorev, 2012; Lai, 2010; Levin & Wadmany, 2008).

Effects of IWBs. There has been a growing interest in the use of IWBs in classrooms. European countries such as Spain, England, and Turkey have invested in IWBs (Holmes, 2009; Türel, 2010). As of the 2010 statistics of usage, England ranked highest with 73% penetration rate, followed by Denmark (50%), the United States (35%), and Asia, with as low as 2% (McIntyre-Brown, 2011). Several related studies on IWBs focused on teachers' perceptions, professional development, and training workshops (Jones & Vincent, 2010; Lai, 2010; Turel & Johnston, 2012) while others were on students' perceptions (Yanez & Coyle, 2011) and the use of IWBs in the classroom (Yelas & Engles, 2010). Most studies have shown that IWBs strengthened student motivation and active engagement in learning as a result of the interactive features (Marzano, 2009; Schmid, 2008).

Learners and teachers have widely perceived IWBs as a positive technology tool in the classroom learning environment, and several studies have shown empirical evidence for the positive correlation between IWBs and student motivation. However, only limited studies are available on the relationship between IWBs and learner achievement (Digregorio & Sobel-Lojeski, 2010; Gurevich & Gorev, 2012). Thus, in spite of the numerous studies in recent years on IWBs, in the classroom, their direct impact on learners' achievement has been sparsely measured.

Digregorio and Sobel-Lojeski (2010) also carried out a literature review of the effects of IWBs on student performance and learning. The review consisted of several common themes, such as the effects of IWBs on motivation, interaction, pedagogy, perception, achievement, and learning. However, the researchers found that these effects were based on contextual factors such as teacher training and confidence, technical support, lesson planning, and activities and school culture. The review included studies that suggested the positive effects of IWBs on teaching and learning. However, the evidence was subjective, and could not be generalized. Data collection instruments such as focus groups, interviews, and surveys were employed in most studies (as cited in Digregorio & Sobel-Lojeski, 2010). There was a need to gather more quantitative data or a larger sample of data.

Furthermore, contextual factors that might affect student outcomes in relation to IWB classroom usage were not considered in most studies (Digregorio & Sobel-Lojeski, 2010). Contextual factors are vital in explaining the direct and indirect relationships between student learning and performance and IWB usage (Schuck & Kearney, 2007). In another study, Glover, Miller, Averis, and Door (2007) found teachers used IWBs to reinforce current instructional teaching practices, but the impact of IWBs would be greater if there were a pedagogic change from didactic to interactive teaching. A progression of interactive pedagogy might lead to long-term motivational and achievement gains (Glover et al., 2007). The effect of IWBs being integrated into the classroom is dependent on the contextual factors. In this purview, the researchers suggested a framework that will focus on context and outcomes of IWBs. Environmental factors, student outcomes, and IWBs usage are considered in the framework. Interaction level and pedagogy influence perception, motivation, learning, and achievement (Glover et al., 2007). The findings of effects of IWBs on perception showed that learners' and teachers' perceptions on the use of IWBs were positive. Learners liked the ability to manipulate objects, as well as the tactile elements, versatility, multimedia, and fun that IWBs provided (Lai, 2010; Yanez & Coyle, 2011). Whiteboard manufacturers, policy makers, and academics claimed that interactivity increased engagement, enjoyment, and motivation, thereby improving achievement (Hall & Higgins, 2005).

With respect to motivation, using IWBs was motivational because of the visual and conceptual appeal of information (Glover et al., 2007); learners interacted with it and overcame behavior issues as a result of sequencing and pacing of the learning process. It promoted learner interest and more sustained attention and concentration. Learners suggested multimedia aspects held their attention and increased engagement and motivation, while teachers stated that increased motivation was short-lived, and the overall quality of teaching was important to IWBs' successful implementation (Yanez & Coyle, 2011). Solvie (2007) suggested that increasing students' attention would also increase achievement. The interaction revealed IWBs had less impact when teachers did not use a novel approach to pedagogy. Interaction was vital to learning, teaching and sustained interest, which involved supported didactic, interactive, and enhanced interactivity. Teachers should ensure mediating the software and IWB to promote interactions and interactivity according to Solvie (2007). IWB was used to promote learning using technology to support a variety of learning styles (Jones & Vincent, 2010). Therefore, the research suggested learning was dependent on how technology was used in the classroom and perceptions of both teachers and learners.

An IWB alone cannot enhance learning; rather, it reinforced learning and altered the way learning takes place. Yet there was insufficient evidence on the impact on achievement. The findings revealed that IWB might not transform pedagogy when not used interactively. The interaction involved the linking of technology and pedagogy while enhanced interactivity involved technology integration, pedagogy, and learning styles. The fluency of teachers with regard to usage can change approaches to pedagogy, thereby leading to change in teaching practice (Glover et al., 2007; Solvie, 2007). Effective pedagogical interactivity, with or without technology requires structured lesson planning, paced activities and a cognitive review (Digregorio & Sobel-Lojeski, 2010). Lastly, there was insufficient evidence of measured gains in learner achievement with whiteboard use, and where it does exist it had a negligible effect (Martin, 2007). However, if using IWB results in variety, challenge, and interactivity, then student achievement may be enhanced (Digregorio & Sobel-Lojeski, 2010).

Glover et al. (2007) and Holmes (2009) supported of the use of IWBs in the classroom and revealed disparate findings showing that learners rely on teachers' attitudes, the quality of teaching, and the level of IWB lesson activities. Additionally, they found that IWB as a technology tool alone does not guarantee impact on learner achievement. Higgins, Beauchamp, and Miller (2007), in a 2-year study, found no significant differences in test scores between IWB-schools and non-IWB schools. Also, a secondary whiteboard expansion project in London that teachers use IWBs in various ways reported no impact on learner performance in the first year of the project. Higgins et al. (2007) concluded that IWBs appeared to have a negligible effect on learner achievement. In another study, researchers showed positive gains in literacy, mathematics and science for children aged 7 through 11, as a result of the duration of being taught with an IWB. Learners with above-average prior achievement had gains compared to lack of impact on learners with low prior achievement (Lewin, Somekh, & Steadman, 2008). Other researchers found insufficient evidence to identify the actual impact of IWBs on learner achievement (Martin, 2007; Schuck & Kearney, 2007) and suggested that an increase in students' attention might increase achievement (Solvie, 2007).

One-to-one laptops initiatives. There has been a tremendous increase in the implementation of one-to-one computing initiatives in both developed and developing countries. The initiative was seen as a technology-rich educational reform providing teachers and students access to technology and laptop computers on an individual basis. Although this initiative was controversial, many countries still invest heavily in laptops or iPads. In 2002, the state of Maine provided iBook laptops to 34,000 students and teachers. In Michigan, more than 30,000 students were provided with laptop computers (Jing & Yong, 2008). A government agency in Nigeria, USPF provided over 1,000 government schools with classmate PCs between 2007 and 2010 (USPF, 2010). However, empirical evidence on the impact of the one-to-one initiatives on student achievement was limited. Literature in this section will focus on studies related to the impact on educational outcomes.

Shapley, Sheehan, Maloney, and Caranikas-Walker (2010) examined the association between implementation of one-to-one computing and student achievement measured by higher test scores. Shapley et al. analyzed the students' reading and mathematics TAKS scores. The two subjects are tested each year, and the pretests were used as control. Implementing student technology access and use was a positive predictor of students’ TAKS reading and mathematics scores. Students’ home use of laptops was a stronger predictor of TAKS reading and mathematics scores.

These findings can be related to Bebell and Kay’s (2010) study on teaching and learning practices. Students and teachers were provided with laptops, appropriate technology resources, and wireless learning environments. In their longitudinal study, the authors examined five schools running the one-to-one initiative and found that implementation and outcome differed across schools and over the duration of the study. The one-to-one initiative had a positive impact on teacher classroom practices, student academic achievement, engagement, and research skills when compared to non-one-to-one schools. ELA state assessment scores for Grade 7 students in the second year of the initiative improved significantly compared to non-one-to-one students.

Similarly, Jing and Yong (2008) studied how students’ use of laptops affected learning, communication, exploration, and expression. Students’ learning experiences and technology proficiency were enriched, as revealed in interviews with teachers and students. Student Grade Point Average (GPA) increased in the academic year of the study; however, the relationship between student GPA and laptop use was not established.

Furthermore, Suhr, Hernandez, Grimes, and Warschauer (2010) found that one-to-one computer use students had higher achievement on ELA tests related to writing strategies and literary response and analysis than the non-one-to-one computer students. Suhr et al. conducted a 2-year study comparing ELA test scores for students who participated in the one-to-one initiative in the fourth grade to a similar group of students in a normal classroom setting within the same school district. The one-to-one students outperformed the control group. Similarly, in Mooresville, NC, test scores in the district increased with overall proficiency growing from 73% to 86% within 3 years (Mellon, 2011).

However, some school districts have found that one-to-one computing has not lived up its expectations. Interestingly, Boston College researchers found that the impact of one-to-one computing was largely dependent on classroom teachers (Norris & Soloway, 2010). A comparative analysis of the literature review in this section showed that the use of laptops by teachers and students can have a positive impact on student academic achievement taking adequate cognizance of teacher practices and proficiency (Mellon, 2011; Shapley et al., 2010; Suhr et al., 2010).

Technology Interventions in Nigeria

Many nations across the world have enacted national information and communication technology policies, which serve as a framework for integration of ICT into all facets of society. Nigeria, among other African countries, is not an exception. At the 32nd ministerial council meeting of the National Council on Education in 1987, the federal government decided to introduce computer education into the nation’s secondary school system. This led to the formulation of Nigeria National Computer Policy in 1988 with the objectives to bring about a computer literate society in Nigeria by the mid-1990s and enable present school children to appreciate and use the computer in various aspects of life and in future employment (Jegede & Owolabi, 2003). This policy did not penetrate the education system as expected, and a new national policy on ICT in education has been developed by the FME (2012). While the lack of an adequate policy did not stop the government or other stakeholders from deploying various technology solutions to schools, the ICT penetration is still low.

One of the government agencies, the Education Trust Fund (ETF), funded the ETF DigiNet project. The project was designed to address the severe digital infrastructure problem in Nigerian schools. Over the years, the project provided schools, irrespective of their locale, with 21 desktop systems, a server, VSAT-based Internet, and an alternate power supply in terms of solar or generator. The project transcended the provision of equipment, by providing adequate teacher training, technical support and a professional learning community (SchoolNet, 2003). Similarly, a private organization, MTN as part of their corporate social initiatives, tagged their technology intervention “MTN Schoolsconnect,” and it was deployed to many schools across the country (SchoolNet, 2005).

As the one-to-one initiatives became popular across the world, another government agency, USPF deployed 100 Intel Classmate PCs per school, to facilitate technology usage in several schools. From 2007 to 2010, USPF provided this technology intervention in over 1,000 government schools. To reach out to the underserved community, the National Information Technology Development Agency (NITDA) deployed technology interventions to help rural communities. The rural information technology centers serve established communities, while the mobile Internet units serve rural schools (NITDA, 2010). This was further enhanced by i-connect mobile unit project, which also served schools that do not have access to technology (Begho, 2012).

Despite such interventions, the percentage of both private and public schools that have benefitted was still very low compared with the number of schools in the country. One major challenge was the lack of adequate evaluation of the various interventions in order to determine the best fit amidst other challenges such as poor funding, sustainability, inadequate infrastructures, and constant power outages.

Technology interventions in many schools across the world have attracted huge financial investments. In addition to government funding, several nongovernmental organizations have now also intervened through corporate social initiatives. Despite the effective technology integration, there have been challenges in deploying holistic solutions. Periodic evaluation of the technology interventions was a large task, especially in rural communities. Studies focusing on technology interventions that worked best in many rural communities are still limited.

Technology Integration

Attaining a high level of achievement has been attributed to many factors inclusive of a technology-enabled learning environment. The rapid evolution of varied technology tools has created a need for users to keep abreast of the emerging technologies. However, the success of the technology-based environment has many challenges, both at the teacher and school level. This section will review literature on the impact of technology on students’ achievement and the effectiveness of technology usage in the classroom to enhance teaching and learning process.

Effective use of technology in the classroom. Research (Cakir et al., 2009; Groff & Mouza, 2008; Inan & Lowther, 2010; Thieman, 2008) has supported teaching and learning with technology across the curriculum in order to transform the learning environments. But integrating technology into classroom instruction goes beyond teaching basic computer skills; it must happen across the curriculum and include the major components of learning such as active engagement of students, teamwork, collaboration, evaluation of impact, and connection to real-life situations. The use of technology tool is not a one-time event but must be consistent, transparent, and support curricular goals.

Researchers have developed frameworks for technology integration in their studies (Annetta, Murray, Laird, Bohr, & Park, 2008; Groff & Mouza, 2008). In their study on investigating student attitudes toward a synchronous online graduate course in a multiuser virtual environment (MUVE), Annetta et al. (2008) shared their findings on the effective use of technology. The MUVE environment was designed to evoke in the user a sense of virtual "presence," that is, a sensation the participant has of being in another place while visiting a virtual environment. Surveys and observations carried out with a sample class centered on student products, instructor-student interaction, plans to implement course features, and perceived difficulties in implementation. The students benefitted from using the MUVE by moving from a state of virtually no knowledge to one in which they acquired skills in virtual environments and were able to create a functional and engaging learning activity. In addition, the students gained a wide range of comfort and proficiency with the use of technology.

Creating an effective learning environment with technology is still a challenge, and there is a struggle to find consistent success with technology-based instruction. Groff and Mouza (2008) indicated that amongst the barriers of effective use of technology is the lack of access to technological resources. The teachers' lack of technology–based skills, along with their attitudes and beliefs, was not favorable to a technology-based learning environment. Groff and Mouza (2008) developed a coherent framework titled "Individualized Inventory for Integrating Instructional Innovations" (i5), which can provide practical assistance to teachers as they navigate the process of technology integration. They found that i5 helped teachers identify and address potential challenges associated with the implementation of technology-based projects in the classroom, thereby increasing the likelihood of achieving success in technology integration. Although most researchers believed that technology can change the teaching process, making it more flexible, engaging, and challenging for students, little actual evidence exists to support these claims.

In past years teacher education programs have been criticized for not training preservice teachers how to integrate technology into their classroom instruction. Thieman (2008) analyzed how K-12 preservice teachers used technology as a tool for student learning, given technology standards for teachers and students from the International Society for Technology in Education (ISTE, 2007) and considered how those experiences relate to 21st-century citizenship skills. The key findings indicated that 85% of preservice teachers integrated technology skills and knowledge in instructional practice with their K-12 students. About half of the sample works suggested that students benefit with the use of technology in the classroom especially in the areas of creativity, innovation, communication, collaboration, research, and information fluency. Thieman (2008) believed there was little evidence that K-12 students used technology to support critical thinking, problem solving, and decision making. However, the author suggested a follow-up study to evaluate the extent to which teachers and their students are meeting current expectations for digital citizenship skills through the use of various technology tools.

Other studies (Annetta et al., 2008; Inan & Lowther, 2010; Levin & Wadmany, 2008) explored factors affecting the use of technology. In their 2010 study on factors affecting technology integration in K-12 classrooms, Inan and Lowther (2010) established that barriers such as teachers' demographic characteristics hindered the successful use of technology. However, teachers' computer proficiency, beliefs, and readiness positively influenced the use of technology in the classroom. Other factors such as the school factors also positively influenced teachers' belief and readiness. In essence, teachers' beliefs and readiness may mediate the indirect effects of school and teacher level factors on the use of technology by the teacher in the classroom.

Levin and Wadmany (2008) explored teacher views on factors affecting their use of information and communication technologies (ICT) in the classroom and how those views reflect changes in teachers' beliefs and actual classroom practice. The findings revealed the positive influence on teachers' use of technology. Levin and Wadmany (2008) believed it was important to understand teachers' view, experience and educational practices when technology was introduced into their classroom. Teachers' practices and belief may determine to which extent technology will be integrated into their classroom practice.

Palak and Walls (2009) studied teachers' beliefs and technology practice rationale because of the ongoing contradictions in findings between teachers' beliefs and technology usage. The fundamental goal was to determine if teachers who often integrate technologies, and work at technology-rich schools, change their beliefs and consequently their instructional practices toward a student-centered paradigm. The methodology involved mixed-methods design using multiple variables and sampling techniques in selecting technology. Teachers from 28 Benedum collaborative professional development schools participated. The findings in the quantitative analysis revealed no shift in teacher practice. In the qualitative phase the results of both methods were integrated. The results showed that teachers' positive attitudes toward technology did not necessarily have the same influence on student instructional strategies. Palak and Walls (2009) stated that the focus of technology integration should be on student-centered pedagogy and future professional development may need to model a theory of change toward a student-centered paradigm. The findings further corroborated results from prior research that indicate teacher technology use in a technology-rich environment did not transform teaching into more student-centered practice (Judson, 2006).

Hammond, Reynolds, and Ingram (2011) explored the nature and scope of student teachers' use of ICT, the factors that led them to use ICT, and the constraints on usage. The study employed a mixed-methods design involving a survey with a sample population of 340 teachers and a semistructured interview with a sample of 21 teachers. Personnel, access, and other environmental factors were identified as factors that affect the use of ICT while factors that influenced the use of ICT were mentoring, training, and support. The findings revealed that innovative student teachers used ICT in a greater range of contexts and made more effort to overcome barriers, such as access. ICT use was seen as emerging from a mix of factors: chiefly student teachers' access to ICT; their feeling of "self-efficacy" when using ICT; and their belief that ICT had a positive impact on learning, and can help promote behavioral and effective engagement.

Almekhlafi and Almeqdadi (2010) investigated teachers' perceptions of their technology integration competencies, barriers obstructing such integration, and incentives to increase it, in addition to other related issues. The authors sought to determine how teachers perceived their competencies with technology integration; how teachers perceived obstacles and incentives related to successful classroom technology integration; and how teachers perceived their students' classroom usage of technology. Using a mixed-methods approach with focus group interviews and questionnaires as data collection instruments, the sample population included 40 female and 60 male teachers from two schools. Findings showed that both male and female teachers at UAE Model Schools had high self-perception of their abilities and competencies to integrate technology successfully in their teaching. In addition, teachers integrated technology in their classes to varying degrees and with different levels of effectiveness, in spite of the barriers that hindered such integration. Essentially, teachers at both schools integrated technology in their classroom activities, and used various technologies to promote students' learning, though male and female teachers differed in some cases on methods of integration.

Cifuentes, Maxwell, and Bulu (2011) focused on technology integration through professional learning community (PLC) in order to support technology integration in three rural school districts, and the contributions of various program strategies toward teacher growth. The fundamental question was how effective technology integration was encouraged in classroom teaching and learning through a shared learning community comprised of teachers, faculty, and administrators. A longitudinal study that evolved over the 2-year span employed concurrent mixed-methods approach. Quantitative methods were used to determine the increase in technology adoption as perceived by the participating teachers, and qualitative case study methods were used to describe the process and impacts of the learning community. There was an indirect positive effect on student achievement and an improvement in teachers' stages of technology adoption. Additionally, teachers' practice of technology integration enhanced student learning. However, effective technology integration might be encouraged in classrooms through the strategies applied in shared learning community (Cifuentes et al., 2011).

The impact of technology on students' achievement. Gracia and Rose (2007), Martin et al. (2010), and Cakir et al. (2009) focused on a technology-based program in their research as a tool to determine the level of impact of technology. Garcia and Rose examined the influence of technocentric collaboration on preservice teachers' attitudes about technology's role in powerful learning and teaching. The authors focused more on program evaluation than research with the introduction of a technology tool WebSTAR to enhance teaching and learning. The design of a WebSTAR was based on three areas of focus: how teachers viewed use of technology, their concerns and needs, the notion of collaboration and community as it relates to teaching and learning, and accepted instructional strategies that make use of information and communication technologies (ICT).

Using a mixed-method approach, Garcia and Rose (2007) found computer technology created opportunities for collaborative learning. Also, web pages can organize and direct student activities, and participation in the WebSTAR modified students' perceptions concerning the difference between using technology for teaching, and students using technology for learning. Furthermore, the positive impact of technology outweighed the negative impact. Students valued the experiences provided by the WebSTAR and indicated that they would have welcomed the opportunity for even more interaction with other classes both virtually and face-to-face. This outcome showed that the impact of technology was dependent on students' achievement.

Martin et al. (2010) stated that professional development (PD) fidelity can have an impact on teachers understanding of the core program concepts (Buckenmeyer, 2008; Martin et al., 2010). Teachers who experience higher quality PD in the less comprehensive program spend more time with instructional specialists on planning of the lessons, reflective practice, and problem solving rather than on technology assisted or modeling instruction. Categorically, it can be said that Martin et al. (2010) did not show the level of impact of technology. However, they found that use of PD added value to students and teachers achievements.

Cakir et al. (2009) examined the impact of student and school factors on student achievement in a technology-enhanced learning environment. They showed that individual student factors, which must be adequately cared for in a traditional learning environment, are also vital in a blended learning environment supported with technology. Students with higher academic performance and good use of computer knowledge excel above the students with low academic performance and little use of computer knowledge. Students' enthusiasm and motivation to use technology had a positive impact on their achievement. However, the combination of centralized materials and local face-to-face teaching could provide a strategy for reducing the achievement gap between these two groups of students.

In contrast, Tamim et al. (2011) and Solvie and Kloek (2007) addressed the impact of technology in the classroom from another perspective. Tamim et al. (2011) summarized 40 years of investigation addressing the effect of computer technology use in educational contexts. The extracted effect sizes showed that the use of technology in the experimental group had a significant effect size compared to the control group with no technology. The two substantive moderator variables (subject matter and type of technology) suggested that support instruction had a negligible but a higher average effect size compared to that of direct instruction. Furthermore, the average effect size of K-12 applications of computer technology was higher than computer applications introduced in post-secondary classrooms, showing a positive impact on their classroom practice.

Preparing preservice teachers to be good teachers within the confines of the university classroom is ideal. However, problems have emerged with regard to making conceptually difficult content easier to grasp, understandable, and retainable. This led to a proposed solution of the use of technology and the positive impact on the teaching and learning process of preservice teachers. Solvie and Kloek (2007) used technology tools to engage students with multiple learning styles in a constructivist-learning environment Solvie and Kloek (2007) sought to gauge the effectiveness of technology used to address multiple learning styles by using substantial experience, abstract conceptualization, active experiments, and reflective observation. Students with the most rigid learning styles performed lower on examinations while students who had strengths in more than one learning style performed better. To determine the impact of technology, selecting technology tools to match the characteristics of the four learning styles employed by students in construction of knowledge is crucial. The impact would be seen when teachers and learners agreed on the use and evaluation of technology tools in their constructivist classroom (Solvie & Kloek, 2007). In addition, Cakir et al. (2009) found that irrespective of the geographic locale of the school, the use of technology does not change the impact on students' achievement.

Lowther, Inan, Strahl, and Ross (2008) examined Tennessee EdTEch Launch (TnETL), a statewide technology program impact on student achievement, teachers' skills and attitudes toward technology integration, students' skills in using technology as a tool, and use of research practices. The study in a quasi-experimental approach involved 26 schools, 12,420 students and 927 teachers. The data collection instruments included direct classroom observation, focus groups, student performance assessments, student achievement analysis, and surveys. Findings revealed that program teachers had significantly higher confidence to integrate technology and in using technology for learning. Program students used computers as tools, worked in centers, and engaged in project-based learning.

Neill and Mathews (2009) investigated the influence of two computer-assisted instructional programs on math and language arts academic achievement. They employed two groups comprised of academic at-risk middle school students and not at-risk. They investigated how technological interventions usage improved student achievement in mathematics and language arts for an identified group of at-risk students. The findings indicated only a marginal gap in academic achievement between the at-risk students receiving computer-assisted learning interventions compared to those students engaged in the traditional instructional strategies. However, there was a considerable increase in the number of students who met or exceeded the state-mandated growth targets after the first year of technology intervention.

Alege and Afolabi (2011) surveyed teachers' use of computer/internet in secondary schools in southwestern Nigeria, to investigate teachers' literacy profiles, attitudes towards computers, integration of ICT, and the hindrances in integrating ICT into their teaching process. A total of 562 teachers, 58% female and 42% male, were randomly selected from both private and public schools. The research questions were based on teachers' information, computer literacy, attitudes, integration into the classroom, and barriers. The findings revealed that 87% of the participants, irrespective of gender or educational qualifications, do not use computers in teaching. The barriers were lack of expertise in use of ICT, inadequate infrastructures, technophobia, and lack of incentives and support among others.

In Adewole, Akinwale and Omokanye (2008) study on consulting ICT teacher model for teaching secondary school curriculum, a questionnaire determining the level of the ICT usage in Nigerian secondary schools was administered to 120 teachers comprising of 75 males and 45 females. Participants had access to computers aside the use of Internet and email facilities and the access frequency was 15 hours per week. However, lack of technical support and teacher's expertise hindered teachers' readiness and confidence on ICT usage (Adewole, Akinwale, & Omokanye, 2008). These findings corroborate several other findings that there was a need for teacher training and professional development for effective technology usage (Cakir et al., 2009; Cifuentes et al., 2011; Levin & Wadmany, 2008).

In the various research studies on effective technology integration into classroom instruction, diverse research methods and designs were explored, and their findings were interrelated. Some findings revealed that there is a positive impact of technology usage on student academic achievement (Cakir et al., 2009; Cifuentes et al., 2011; Lowther et al., 2008; Martin et al., 2010; Neill & Mathews, 2009). The use of varied technologies in the classroom improved student learning (Almekhlafi & Almeqdadi, 2010; Hammond et al., 2011; Solvie & Kloek, 2007). However, for more effectiveness, technology integration should focus on student-centered pedagogy (Judson, 2006; Palak & Walls, 2009). Other studies focusing on teachers' perspectives stated that teachers' use of technology and adoption, beliefs and practices have enhanced teaching and learning process (Cifuentes et al., 2011; Levin & Wadmany, 2008; Martin et al., 2010; Tamim et al., 2011; Wright & Wilson, 2011). Studies are still limited to evaluate the technology integration process that is best-fit in rural schools.

Rural Schools Access to Technology

Technology emergence is now a critical component of education. Rural schools are accustomed to several challenges inclusive of access to quality education, but with the emergence of technology, most schools are systematically overcoming the challenges. However, the provision of technology-enabled learning environments is still faced with other barriers such as effective implementation of technology interventions, lack of adequate infrastructure, adequate internet access, funding and shortage of tech-savvy teachers (Gordon, 2010). In Nigeria, the government agency, NITDA, deployed two technology interventions to help rural communities. The rural information technology centers serve established communities while the mobile internet units serve rural schools. However, the challenges of sustainability in terms of adequate funding and internet broadband made the projects ineffective (NITDA, 2010). Many rural schools across the world still lack technology in the classroom.

In the Kodiak, AK, school district, using distance learning technology was the strategy employed to mitigate some of the challenges (Gordon, 2010). The district delivers math instruction using video teleconferencing, Elluminate, and Moodle, with the support of IWBs, projectors, and cameras, among others. In contrast to the district’s past results, introducing new a form of specialized instruction resulted in successful math students (Gordon, 2010).

Mitchell, Hunter, and Mockler (2010), in their study on connecting classrooms in rural communities, focused on the use of video conference and interactive whiteboard technology. The e-program initiative involved five schools in rural New South Wales, Australia, to extend the range of curriculum options available for students. The findings showed improved teachers practices and commitment to work with the technologies. The pedagogy of the e-program met the goal of extending curriculum options for students beyond their immediate environment and the ability of regional/rural schools to develop complementary programs for students. Mitchell et al. (2010) found that the engagement potential with these technologies was high among students in different school sites relating it to other studies on the use of IWBs.

In another study relating to technology integration and its impact on rural elementary schools, Howley, Wood, and Hough (2011) compared results of a survey completed by 500 rural and nonrural teachers. The findings revealed rural teachers had more positive attitudes toward technology integration than did the nonrural teachers. Attitudes, teachers' preparation for technology usage, and availability of technology were significantly related to technology integration; school locale and socioeconomic status had no relationship. In addition, engaging students with technology applications is dependent on teachers' access to instructional technology and preparedness (Howley, Wood, & Hough, 2011).

In Jordan, 650 rural secondary school teachers were randomly selected as participants in a study designed to investigate the level of ICT use for educational purposes (Al-Zaidiyeen, Leong Lai, & Fong Soon, 2010). Using a quantitative approach, the authors focused on the level of ICT use and teachers' attitudes toward ICT usage in the classroom. Survey results revealed that teachers had a low level of ICT use for educational purposes but held positive attitudes towards the use of ICT with a significant correlation between teachers' level of ICT use and their attitudes (Al-Zaidiyeen et al., 2010). In an effort to document how teachers perceive ICT, Panigrahi (2011) compared teachers' perceptions of ICT use in relation to gender, level of qualification, and age as well as between urban and rural teachers. The findings revealed no significant difference between urban and rural teachers' perceptions of use of ICT or in relation to gender, and age. In essence, effective technology usage was not dependent on locale as this was corroborated by Cakir et al. (2009).

In a mixed-methods study to explore the beliefs, attitudes, concerns, barriers, perceptions, and teaching practices of rural K-12 teachers, Lewis (2010), stated that the findings revealed the need for professional development and technical support for teachers. The professional development was to encourage the involvement of teachers in the effective use of technology to enhance the student learning. Furthermore, Jaber's (1997) study on factors that influence teachers' use of technology revealed that access to computers influenced the usage, but lack of internet access and obsolete equipment had a negative influence on teachers' actual usage, and there was a need for professional development. In a study on the effectiveness of technology professional development for teachers, Rives (2012) harnessed the essence of professional development on teachers' effective usage of technology in the classroom.

Malcolm-Bell (2010) explored the status of technology integration in primary and secondary high schools in a rural parish in Jamaica using concurrent nested mixed methods. The data collection instruments were survey and interviews in which the survey data was analyzed with the LoTi questionnaire administered to 231 participants selected from five primary and five secondary schools. The interviews were analyzed for emerging themes through an open-coding approach. The findings showed a low level of technology integration in instruction and learning in the schools, which corroborated the findings by Al-Zaidiyeen et al. (2010). Further, computer use focused on the content areas that required project-based learning and instructional software. However, barriers such as inadequate professional development and access to computers in the classroom required urgent attention to ensure appropriate technology infusion in the curriculum (Malcolm-Bell, 2010; Rives, 2012).

Essentially, in rural schools, the impact of technology integration into classroom instruction relies heavily on teachers’ practices, attitudes, level of preparedness, school technology acceptance, professional development, adequate technology resources and sustainability among others (Berry, 2011; Cakir et al., 2009; Howley et al., 2011; Lewis, 2010; Mitchell et al., 2010; Rives, 2012). Amidst the various challenges in rural schools, which differ from one community to another, the provision of a holistic technology solution that would meet the needs of both teachers and students was important. School remoteness, race, and socioeconomic status were not the most important factors, as studies have shown that these dynamics have no relationship to technology integration

(Cakir et al., 2009; Howley et al., 2011). However, the technology solutions in rural communities require adequate evaluation for effectiveness.

Summary

The literature review in this chapter focused on technology interventions, technology integration, and rural schools' access to technology. Research has taken place in both developed and developing countries, and technology interventions have diverse impacts on teaching and learning processes. There has been great improvement in infusing technology into the curriculum, but more aspects need to be explored for effectiveness. The literature provided evidence on the high-level use of IWBs across the world, but with no clear evidence of its effect on learners' achievement. Many factors emanated from technology integration process in which literature clearly identified personal, organizational, and environmental factors. Effective technology integration and usage are highly dependent on teachers' beliefs, attitudes, practices, training, professional development, technical support, adequate funding, and appropriate resources among others.

The main focus of the present study was rural schools. Rural schools' access to technology tends to be marginalized, but there is still a low penetration in many rural communities across the world. Research studies are limited on impact of technology on student achievement in rural schools, especially in developing countries. This study adds to the knowledge base of impact of technology integration on student achievement in rural schools amidst other challenges faced in rural communities. It also corroborated findings in previous researches with no significant difference in student achievement, irrespective of locale. The essential aspect is adequate provision of appropriate technology resources.

The research methodology is discussed in Chapter 3, with a detailed description of the data collection and analysis procedures used in this quantitative approach.

Chapter 3: Research Method

Introduction

The purpose of this quantitative study was to determine the impact of the technology intervention that was deployed to rural schools on student achievement in Nigeria. It helped determine if the holistic technology solutions met teachers' needs, as well as had a meaningful impact on learners. This chapter provides sections on the research design and rationale, methodology, and threats to validity. The methodology section is subdivided into population, sampling and sampling procedures, procedures for participation, recruitment and data collection, instrumentation, and operationalization of constructs. Ethical procedure is discussed as a subsection under threats to validity.

Research Design and Rationale

This quantitative study involved a nonexperimental design. The causal comparative research employed independent and dependent variables. Johnson and Christensen (2004) stated that in causal-comparative research, the study focuses on the relationship between one or more categorical independent variables and one or more quantitative variables. The research questions follow:

1. Is there a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools?
2. What is the relationship between teachers' level of technology implementation and student achievement in mathematics and English?

This study was designed to determine the difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools, as well as establish the relationship, if any, between teachers' level of technology implementation and student achievement in mathematics and English. The independent variable was the level of technology at schools. The dependent variables were the student examination scores in mathematics and English. This design had a lower constraint because it did not involve isolating the effects of a modifiable independent variable on the dependent variable (Johnson, 2001). The variables could not be manipulated, and the time and resource constraint was lower because archived data on student examination scores in mathematics and English were used. In cross-sectional research, data collection from participants is at a single point in time or in a relatively short period (Johnson, 2001). However, the teachers' survey was difficult to collate at once. It involved extensive travel to ensure that the selected teachers in the various participating schools submitted the survey questionnaire within a specified timeline.

Causal-comparative studies are used to determine the existence of relationships between independent and dependent variables after the occurrence of the events (Brewer & Kuhn, 2010). The rationale for this nonexperimental comparative was that it helped determine differences and relationships between variables and related one variable to another with no attempt to determine causation. Because the basis of this study was to determine the impact of technology interventions on student academic achievement, other types of experimental design were not appropriate. Several studies have used causal-comparative design because of the advantages in terms of access to the large volume of data, large sample populations, and data collected from a large population in an economical manner, thereby adding to the knowledge base of the design (Bernardo, 2013; Brewer & Kuhn, 2008; Johnson, 2001; Page, 2013).

Methodology

Population

The target population involved teachers from eight public senior secondary schools in a rural community of about 150,000 residents in Nigeria (NPC, 2010). The socioeconomic status of the inhabitants in this community tended to be low. There was a mixed ethnicity as many non-Indigenes have settled in the community as a result of moving the capital of Nigeria to Abuja. Most Indigenes are peasant farmers. The schools for this study were currently senior secondary schools (SS1 – SS3, an equivalent of Grade 10 – 12). The government established most of the schools more than 20 years ago. The education system is subdivided into three levels comprised of the primary and junior secondary schools, the senior secondary schools, and the tertiary level schools. The schools in focus were senior secondary schools, which engage students between ages 14 and 18. At the time of this study, the community had eight senior secondary schools with some being technology-enabled and some not. The total population of the schools was about 8,400 students and 540 teachers (FCTEMIS, 2012). In this study, only SS2 students' examination scores were used. The estimated number of students was about 2,400 while the English and mathematics teachers' population was 40. This sample population was valuable to the field because of the availability of both technology-enabled and nontechnology-enabled rural schools in a developing country, which was the focus of the research study.

Sampling and Sampling Procedures

The sampling strategy for this study was convenience sampling. Convenience sampling is a nonprobability sampling method in which sampled population is based on "convenient" sources of data for researchers and does not involve known nonzero probabilities (Lavkaras, 2008). The eight available schools were divided into two groups comprised of technology-enabled and nontechnology-enabled, as defined in this study. As the target population was SS2 students’ examination scores and teachers teaching English and mathematics, convenience sampling was the most appropriate.

The sampling procedure involved the school authority releasing the archived data for all SS2 students in English and mathematics after I sought adequate permission from the education agency. The number of students’ scores was dependent on the population of SS2 graders in the participating schools at the time of the study, an approximation of 2,400 students. The criterion for teachers’ selection was predominantly teachers that are teaching English and mathematics in SS2, focusing on the students whose data were used. The teachers’ selection was purposeful sampling, and each participant signed an informed consent letter prior to the survey. It was expected that all 40 teachers would participate. However, only 34 teachers responded, which still provided a confidence level of 95% with a confidence interval of 5 using Creative Research Systems (2012) sample size calculator.

Procedures for Recruitment, Participation, and Data Collection

Permission was sought from the Walden University Institutional Review Board (IRB) to commence collection of data. I sent a letter to the authority in charge of senior secondary schools requesting the use of the schools within the specified rural community for the research study. Upon receipt of permission from the IRB and the authority in charge of schools inclusive of the principal in each participating school, students' examination scores were collected from each of the schools in this study. I assigned a number to each set of records on a school-level basis for ease of analysis. The school also provided information about the teachers. Teachers teaching English and mathematics in the participating schools were selected to participate in an online survey on technology implementation. The selected teachers were informed of the research study through face-to-face contact, text messages, and e-mails. Thereafter, teachers' consent was sought for participation (Appendix A). The estimated number of teachers was 40. However, there was variation at the time of study. As a result of unsteady electricity and Internet access, and in order to maximize the timeline for data collection, Internet-enabled laptops were taken to the schools to enable teachers complete the online survey. The online survey involved the use of the LoTi questionnaire (LoTi Connection, 2011).

Instrumentation and Operationalization of Constructs

Examination scores. This quantitative study involved the use of examination scores. Examinations are systems designed to assess learners' knowledge, ability, and intelligence (Teddlie & Tashakkori, 2009). Examination scores provided the quantitative data to be collected and involved the end-of-session cumulative scores for SS2 graders with a focus on mathematics and English language. These two subjects are offered at all grade levels in the school system. The end-of-session examination score comprised three terms scores. Each end-of-term score was also cumulative as it was the average of the term examination plus three continuous term assessments. Continuous assessment is a test, project, or assignment administered to students over the course of the term and represents 30% of the total obtainable score for the term. The mathematics and English scores were the dependent variables while the independent variables were the technology-enabled and nontechnology-enabled schools. The examination score is graded according to the specification of the education board as shown in Table 1.

Table 1

Scores Scale

Scores	**Grade**
75 and above	A1
70 – 74	B2
65 – 69	B3
60 – 64	C4
55 – 59	C5
50 – 54	C6
45 – 49	D7
44 – 40	E8
Below 40	F9

Level of Technology Implementation (LoTi) questionnaire. The LoTi questionnaire was used to collect data from teachers through an online survey. Moersch developed the LoTi questionnaire in 1994 to measure the extent of technology integration in schools. The questions focus on how teachers integrate technology in the learning process and proficiency levels of usage in different settings. Permission was sought from the LoTi Connection prior to usage (LoTi Connection, 2014). (See Appendix F) According to Moersch (1995), as a teacher progresses from one level to the next, the instructional method shifts from teacher-centered to student-centered.

The following are the levels of the LoTi framework (Moersch, 1995):

1. Level 0 (Nonuse). Teacher perception of lack of access to technology or time management issues thwarts technology integration.
2. Level 1 (Awareness). Technology not integrated into teacher’s classroom instruction, a step away from normal classroom proceedings.
3. Level 2 (Exploration). Technology-based tools serve as an appendage to instructional programs, and use as a learning and teaching enhancement resource.
4. Level 3 (Infusion). Technology-based tools augment instructional activities, experiments and support higher order thinking skills.
5. Level 4a (Integration-Mechanical). Technology used to solve authentic problems and provides a rich context to give student a better understanding of concept and themes.
6. Level 4b (Integration-Routine). Technology is a tool that teachers can readily use to create integrated instructional units with little intervention from outside resources.

7. Level 5 (Expansion). Technology usage beyond the walls of the classroom to enable collaboration and partnering with other sectors, such as businesses and research institutions.
8. Level 6 (Refinement) Technology as a seamless tool for both teachers and students to solve authentic problems; create new products and access information.

The data provided a detailed overview of the technology integration process and how it was infused into the school curriculum. The reliability and validity of LoTi is very high, and it is widely used to create data in various schools in the United States and across many countries. It has been used in many research studies (Fields, 2005; Malcolm-Bell, 2010; Ray, 2008; Stubbs, 2008; Summak & Samancioglu, 2011) to measure teachers' level of technology implementation. The reliability coefficient of LoTi questionnaire was .94. The survey has 37 items apart from demographic questions and uses a Likert-type scale with eight responses ranging from 0 to 7 for each question. Table 2 shows the Likert scale narratives.

Table 2

Level of Technology Implementation Likert Scale

Scale	Narrative
0	Not applicable
1 and 2	Not true of me now
3, 4 and 5	Somehow true of me now
6 and 7	Very true of me now

Operationalization. The key independent variables were the type of schools comprised of technology-enabled and nontechnology-enabled schools, and teachers' technology implementation, comprised of six levels as determined by the LoTi framework. The technology-enabled school is defined as a school with access to technology, which could be a computer laboratory, use of IWBs or one-to-one laptops among others. The nontechnology school is a school without access to standard technology but that might have just one computer for administrative purposes. The level of technology implementation is measured using the scale in Table 2. The dependent variables were student achievement in mathematics and English. The sessional examination score is a cumulative score and the two subjects used in this study are mandatory or core subjects for all students. The end-of-session score was disaggregated using the scale in Table 1.

Data analysis. The data analysis in this study was two-fold. The SPSS software package was used for the analysis of mathematics and English language examination scores of SS2 graders from the participating schools, which were categorized into technology-enabled and nontechnology-enabled schools. The teachers' level of technology implementation was analyzed within the LoTi framework. However, further statistical analysis was employed to establish the relationship between the teachers' level of technology usage and student achievement in mathematics and English. The goal was to establish any significant difference in scores, based on the use of technology. The overarching question was to determine the impact of technology interventions on student achievement. The guiding research questions follow:

1. Is there a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools?
2. What is the relationship between teachers' level of technology implementation and student achievement in mathematics and English?

The hypotheses follow:

H_a1: There is a difference in student achievement in mathematics and English between and technology-enabled and nontechnology-enabled schools.

H_a2: There is a relationship between teachers' level of technology implementation and student achievement in mathematics and English.

A MANOVA was employed. MANOVA is used to determine whether multiple levels of independent variables on their own or in combination with one another have an effect on the dependent variables. MANOVA requires that the dependent variables meet parametric requirements. Students' scores in mathematics and English language were the two dependent variables. The difference in student achievement based on the type of schools was also determined. The *t* test showed the mean difference. The *F* value (Wilks's lambda) was based on a comparison of the error variance/covariance matrix. The covariance helped determine the correlation between the two measures when performing the significant test. MANOVA was used to test the difference between student achievement in mathematics in technology-enabled and nontechnology-enabled schools, as well as in English in both type of schools. The validity was the extent to which inferences can be accurately made based on the students' scores in both learning environments.

The assumption was that there were linear relationships among the dependent variables, mathematics and English achievement. The homogeneity of variance was that the variance of the scores in one school would be equal to the variance of scores in the second school. Levene's test of homogeneity of the variance was used to test equality of variance as it tolerates violations of normality and examines whether the amount of variance is equally represented within the independent variable groups. To avoid limitation of this statistical analysis, outliers were tested prior to performing MANOVA. If an unequal sample size exists in the schools, SPSS was used to adjust the unequal sample sizes based on the student population for the grade level. Furthermore, the level of usage was determined by the survey on teachers' technology implementation using the online LoTi framework software. Thereafter, to determine the relationship between teachers' level of technology implementation and student achievement, the results specifying the different levels alongside the student achievement were analyzed using SPSS.

Threats to Validity

It is expedient to utilize procedures to ensure the validity of the data and findings (Creswell & Plano-Clark, 2011). Validity serves the purpose of checking on data quality and ascertaining if what is being measured is what is intended to be measured (Frankfort-Nachmias & Nachmias, 2008). There is a need as a researcher to design studies to reduce the threats to internal validity and external validity. According to Creswell and Plano-

Clark (2011), internal validity is the extent to which a researcher can conclude the existence of cause-and-effect relationships among variables. External validity is the extent to which a conclusion can be derived that the results apply to a large population. In this study, the threats to external validity included the location of schools selected for the research. The schools are within the same rural community although characteristics differ, and the findings might be applicable only to school with similar characteristics. The findings cannot be generalized based on a rural community and might be less applicable to an urban community. However, to reduce these threats, the specificity of variables was based on similar technology-enabled learning environments. Threats to internal validity were minimal, as the testing involved a large sample of student scores. The same school curriculum was used irrespective of the learning environment of the participating schools. However, teaching or instructional methods in various schools might have differed.

Ethical Procedures

Prior to data collection, approval was sought to conduct the study from the Walden University Institutional Review Board, the institution governing the schools, and the principals of the participating schools. Upon approval to carry out the study in selected schools, students' scores in mathematics and English were collected based on schools' records. To protect the rights of participants, the data gathered were kept confidential so there would be no link to any student, and codes were used to capture data on an individual school basis. The data were stored on researcher's laptop with a password protection to avoid any form of infiltration by an unknown person. Upon successful completion of this study, the data will be deleted from the researcher's laptop. Participation by teachers in the survey was voluntary and maintained the inclusion criteria of mathematics and English teachers who taught the students whose scores were used in the study. Informed consent was sought from the participants once identified based on school records. I had no personal interest in the participating schools, and as such the bias in data collection was reduced. A recharge card valued at 500 naira (about $3 U.S.) was given as an incentive to participants who completed the survey. The incentive was at the cost and discretion of the researcher.

Summary

The causal comparative research design used in this study allowed the collection of a large amount of data commensurate to the study. The outcome of the first phase of the study using the students' examination scores helped form the basis of the second phase using the LoTi online survey, by providing adequate information on the status of student achievement as it relates to technology usage. The examination scores determined the level of student academic achievement, while the survey provided information on teachers' level of technology implementation.

A descriptive statistical analysis was used to identify the differences in the mean, the equality of variance, and correlation between the independent variables and dependent variables. The outcome of this analysis helped establish the specified hypotheses. Adequate consideration was given to ethical procedures by protecting the rights of participants, especially in the archived data of student scores. The bias in this study was minimal, as I had no relationship with the participating schools.

In the next chapter, the data collection process will be discussed, and using the various data analysis techniques specified earlier, the findings are presented.

Chapter 4: Results

Introduction

This study explored the varied technology interventions that were deployed in eight rural schools in Nigeria and determined the impact of the technology interventions on student achievement using mathematics and English scores. I had tailored the research questions to achieve the purpose of this study, which was to establish the difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools and to establish a relationship that might exist between teachers' level of technology implementation and student achievement in mathematics and English. The hypotheses were designed to examine a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools, as well as the existence of a relationship between teachers' level of technology implementation and student achievement in mathematics and English. Chapter 4 includes discussion of the data collection process, the results of the data analysis, and the summary of the findings to the research questions.

Data Collection

The data collection process was conducted in two phases over a 6-week period. The first phase spanned 3 weeks and included the collection of SS2 student examination scores in English and mathematics from the participating schools. The second phase spanned a 3-week period and involved SS2 mathematics and English teachers' participation in an online survey. The survey instrument (Digital-Age survey for teachers) was developed by Moersch (1995) to collect data for measuring the level of technology implementation. The recruitment process was slow because of the criterion sampling. In some of the participating schools, the response rate of the selected participants was high, as teachers showed a high level of enthusiasm to participate in an online survey. The biggest challenge faced during data collection was lack of electricity in most of the schools. After the first week, I traveled to the affected schools with laptops and Internet modems to enable teachers to complete the online survey. This challenge affected the response rate because some of the teachers were teaching or otherwise unavailable during the visit. Invariably, the process became cumbersome as participating schools had to be visited multiple times. However, 95% of the selected participants were able to contribute to the study.

The eight schools in the rural community were categorized into technology-enabled and nontechnology-enabled as earlier defined. The socioeconomic status in this community was low because most Indigenes are farmers, while others and non-indigenes are government workers and petty traders who can be classified as average income earners. Although most of the students resided within the community and immediate environs, School F differed, as it was a special school for gifted students and accepted students from across the country. The demography of each school relating to technology is described as follows:

School A: The estimated student population at the time of study was 1,300. The number of SS2 students was 385. The school lacked a computer laboratory but had two computer systems used for administrative purpose only. School A was classified as a nontechnology-enabled school. The SS2 classes were tutored by four English teachers and four mathematics teachers. One English teacher withdrew from the survey, and one mathematics teacher did not complete the survey.

School B: The student population was above 1,000 with 325 students in SS2. The school had two computers, used mainly for administrative purposes. Three mathematics teachers and two English teachers participated in the study. School B was classified as a nontechnology-enabled school. Among the five teachers, only two had working e-mail addresses while others had to create an e-mail address in order to participate in the study.

School C: The school had a large population of about 2,000. The number of SS2 students divided into 12 classes was 565. Three mathematics teachers and three English teachers tutored the students, but only five teachers participated in the survey. The school was well equipped with different technology laboratories. The school had two computer laboratories, each comprising 10 systems, though four systems were nonfunctional. One of the computer laboratories was donated by a private organization while the government provided the second laboratory. Also, the government provided 70 classmates PCs for one-to-one learning while a private organization donated a multimedia laboratory with digital satellite technology. School C was classified as a technology-enabled school. Out of the five teachers that participated, only one had a phobia for technology.

School D: This girls’ school had a population of 500 students. The SS2 students were numbered 204. The school had 100 classmate PCs for one-to-one learning and two computers for administrative purpose. The school had three mathematics teachers and two English teachers handling SS2. Only the mathematics teachers participated. The school was technology-enabled.

School E: The school had two computer systems for administrative purposes and a nonfunctional computer laboratory. As at the time of data gathering, the laboratory was being renovated. The school's student population was about 1,800. The SS2 students were approximately 417. The number of SS2 students' scores used in the study was 190 because the school did not have comprehensive data. Only students with examination scores were considered. School E was classified as a nontechnology-enabled school.

School F: A special school with a population of 500 students. The SS2 students were numbered 111. The school was highly equipped with varied technology interventions, which included two computer laboratories with 20 computer systems, one multimedia laboratory, and 100 classmate PCs for one-to-one learning. The school had only one English teacher, who withdrew from the survey after signing the consent form, and two mathematics teachers who participated in the survey. The school was technology-enabled.

School G: The student population was estimated at 1,000. The number of SS2 students was 192. Two mathematics teachers and two English teachers tutored the SS2 students. Both English teachers and one mathematics teacher participated in the survey. The school had a computer laboratory with Internet facilities, but most of the systems were nonfunctional. The school was technology-enabled.

School H: The population was about 1,500 students. The SS2 students were 432. The school was equipped with a computer lab with 10 systems and Internet facilities. Four mathematics teachers and three English teachers participated in the study.

In this study, 2,369 students’ mathematics and English scores were collated and analyzed using MANOVA in the SPSS package to generate findings for Research Question 1. The total number of teachers who participated in the online survey was 34. Table 3 displays the summary of the participants’ years of teaching experience. The LoTi profile and bivariate correlation was used to analyze and generate results for Research Question 2.

Table 3

Years of Teaching Experience of Participants (N = 34)

Years of experience	Number of participants	Percent
Less than 5 years	3	9%
Five to 9 years	10	29%
Ten to 20 years	16	47%
More than 20 years	5	15%

Results of the Study

Research Question 1

The first research question determined the difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools. Five schools were categorized as technology schools and three schools as nontechnology schools. Table 4 lists the schools by category and the actual data used for analysis after removing outliers.

Table 4

Categorization of Schools and Numbers of SS2 students

School code	Technology code	Number of students	Exact data used
A	Nontechnology	385	385
B	Nontechnology	320	317
C	Technology	554	554
D	Technology	202	202
E	Nontechnology	190	189
F	Technology	111	84
G	Technology	192	192
H	Technology	415	415

The student population varied on school basis, as well as the technology interventions implemented in the technology-enabled schools. The students' mathematics and English scores were obtained for SS2 students of the 2013 school year from the schools. The total number of students' scores from technology schools was 1,474 while the number was 895 from nontechnology schools. For the analysis, the total number of students' scores gathered was 2,369. A multivariate analysis was used to establish if any significant differences in student achievement in mathematics and English scores between technology-enabled and nontechnology-enabled schools.

A normality test established that the dependent variables exhibited a fairly normal distribution except for few outliers. There were 2,338 cases with valid data, and the criteria for identifying an outlier were -3.0 for lower bound and 3.0 for upper bound. The outliers were removed, and a further inspection of the histograms and normal Q-Q plots showed that the English and mathematics scores were fairly distributed for both technology and nontechnology schools. The skewness and kurtosis of English and mathematics scores did not exceed the rule of thumb criteria of 1.0. For technology schools, Figure 1 shows the English scores with a skewness of -.401*(SE* = .064) and a kurtosis of .239*(SE* = .129), while Figure 2 shows the mathematics scores with a skewness of .005 (*SE* = .064) and a kurtosis of .175 (SE = .129). For nontechnology schools, Figure 3 depicts the English scores with a skewness of -.258*(SE* = .082) and a kurtosis of -.825 *(SE* = .164), while in Figure 4, mathematics scores show a skewness of .634 *(SE* = .082) and a kurtosis of -.097 *(SE* = .164). The result was based on exact data as shown in Table 4.

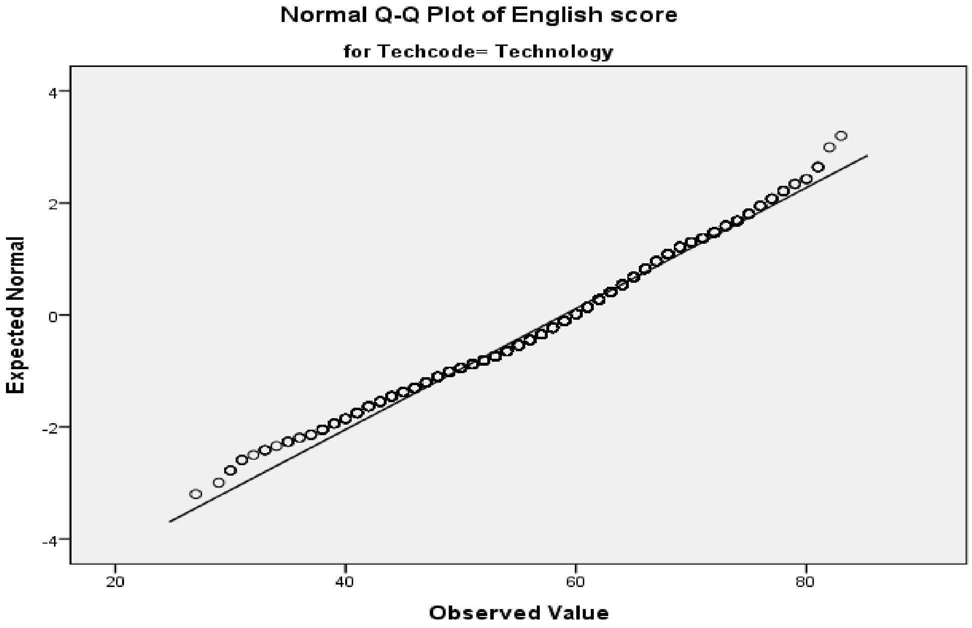

Figure 1. Q-plots showing the distribution of English score for technology schools.

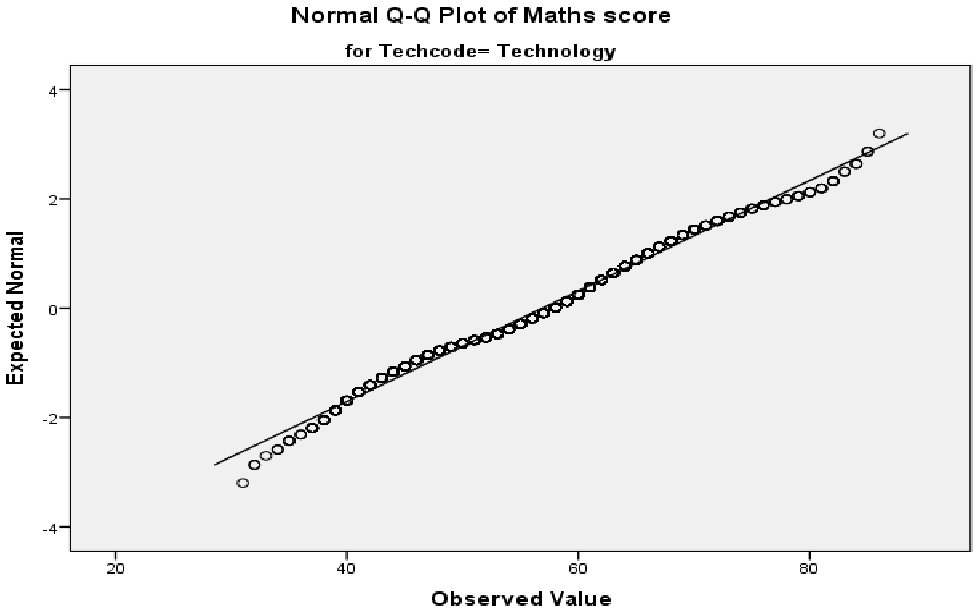

Figure 2. Q-Plots showing the distribution of mathematics scores for technology schools.

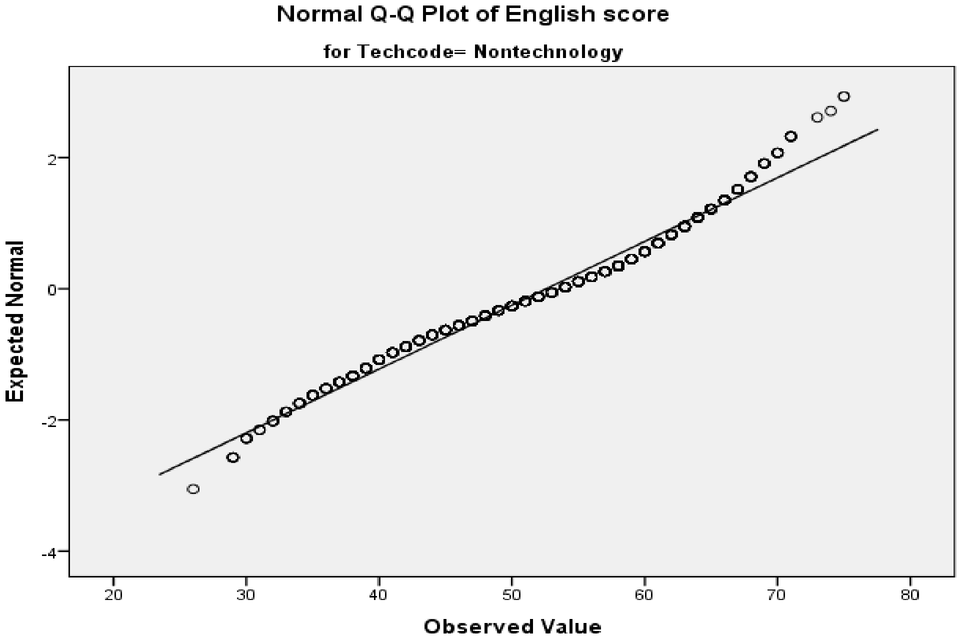

Figure 3. Q-Plots showing the distribution of English score for nontechnology schools.

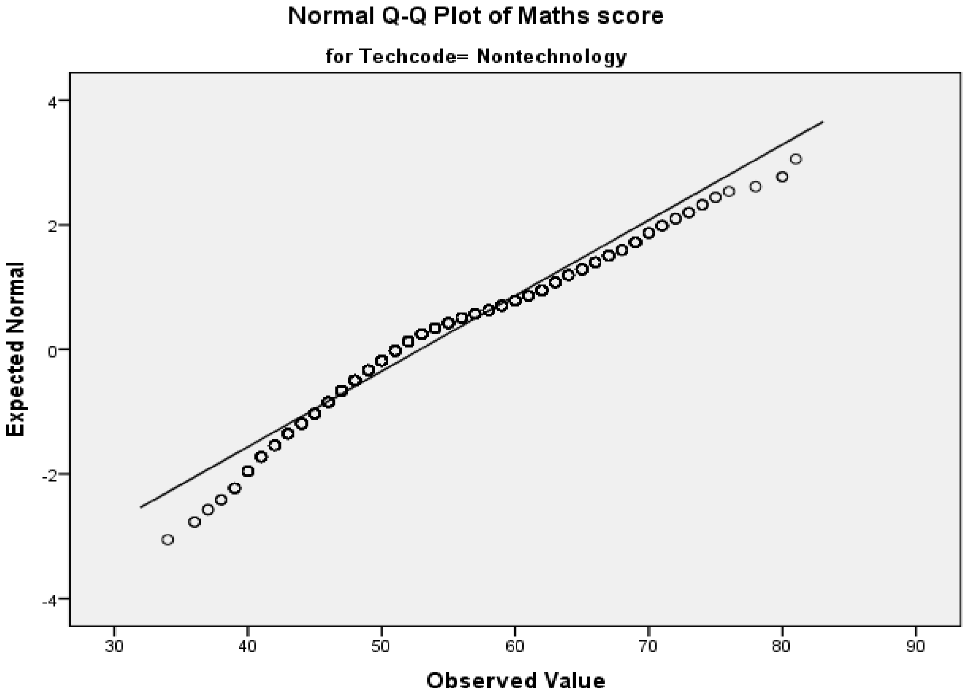

Figure 4. Q-Plots showing the distribution of mathematics scores for nontechnology schools.

The descriptive statistics showing the means and standard deviation on the dependent variables are presented in Table 5. The dependent variables were the students' mathematics and English scores for 2013 school session. The independent variables were the technology code and the school code. The mean score for English in technology schools was 58.93 and in nontechnology schools was 52.59 showing a difference of 6.34. The mean score for mathematics in technology schools was 56.87 and in nontechnology schools was 52.89 revealing a difference of 3.98. The analysis revealed that students' performance in English was better than students' performance in mathematics, though, in nontechnology schools, there was only slight difference in the mean score of both dependent variables.

Table 5

Means and Standard Deviations on the Dependent Variables for the Schools

School code	English scores		Mathematics scores		
	M	*SD*	*M*	*SD*	*n*
Technology					
C	60.85	4.37	60.31	4.84	554
D	66.96	5.22	63.38	5.62	202
F	73.05	5.41	72.75	9.50	84
G	50.01	8.48	53.23	8.86	192
H	53.74	8.99	47.60	7.75	415
Submean	59.26	9.50	56.87	9.88	1447
Nontechnology					
A	60.62	5.68	56.44	8.08	385
B	44.67	8.47	52.09	7.23	317
E	49.50	8.41	47.01	6.25	190
Submean	52.59	10.28	52.89	8.24	891
Grand mean	56.59	10.14	55.36	9.49	2338

A one-way MANOVA was conducted to determine the impact of technology interventions in schools on two dependent variables, mathematics and English scores. The analysis revealed a significant multivariate difference for the various schools categorized into technology-enabled and nontechnology-enabled schools, Wilks's λ = .376, $F(12, 4658) = 244.79$, $p < .01$, $\eta2 = .39$. The multivariate $\eta2 = .39$ indicates 39% of multivariate variance of the dependent variables is associated with the school code factor. The power to detect difference was 1.0, which is strong. The hypothesis that there is a significant difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools was confirmed.

The covariance among the dependent variables was evaluated using the Box's test. The homogeneity test of covariance matrices was significant $F(21, 2486003) = 28.16$, $p < .01$, revealing that there are differences in the matrices. The Box's test was highly sensitive and the significance might be as a result of unequal large sample sizes in the groups, thereby rejecting the null hypothesis. A Levene's test was used to verify the equality of variance on the dependent variables (English and mathematics scores). The result was significant ($p < .01$); there is no equality of variance, and the differences in both English and mathematics scores in the two groups are statistically significant. Considering the significance of the overall test, and for consistency with the MANOVA results, the univariate differences were examined. Using the Scheffe's method, the analysis on the English scores was significant, $F(6, 2330) = 359.39$, $p < .001$, $\eta 2 = .481$, power = 1.0, and it also was significant for mathematics scores, $F(6, 2330) = 289.24$, $p < .001$, $\eta 2 = .427$, power = 1.0.

A further test was run on pairwise comparison of school differences using the two dependent variables. The results showed a significant difference among the schools, with the exclusion of some schools in each dependent variable (See Table 6). For English scores, School A (nontechnology) and School C (technology), and school E (nontechnology) and School G (technology) exhibited no significant difference with $p > .05$. For mathematics scores, School B (nontechnology) and School G (technology) had $p = .871$, and school H (technology) and School E (nontechnology) had $p = 1.0$, exhibiting no significant difference. Table 6 displays the description of the significant pairwise school differences on English and mathematics scores using Scheffe's test.

Table 6

Pairwise Comparisons for the Dependent Variables on School Basis

DV	SC (I)	SC (J)	*p*	95% CI	
				LL	UL
English	A	B	.000	13.97	17.95
		C	1.000	-1.98	1.51
		D	.000	-8.62	-4.06
		E	.000	8.95	13.60
		F	.000	-16.21	-10.55
		G	.000	8.29	12.93
		H	.000	5.02	8.74
	E	A	.000	-13.60	-8.95
		B	.000	2.28	7.09
		C	.000	-13.72	-9.30
		D	.000	-20.27	-14.96
		F	.000	-27.80	-21.52
		G	.997	-3.35	2.02
		H	.000	-6.70	-2.10
Mathematics	B	A	.000	-6.46	-2.31
		C	.000	-10.18	-6.32
		D	.000	-13.79	-8.86
		E	.000	2.51	7.55
		F	.000	-28.19	-22.13
		G	.874	-3.69	1.33
		H	.000	2.42	6.50
	E	A	.000	-11.85	-6.98
		B	.000	-7.55	-2.51
		C	.000	-15.59	-10.97
		D	.000	-19.13	-13.58
		F	.000	-33.47	-26.91
		G	.000	-9.02	-3.40
		H	.998	-2.97	1.84

Note. DV = dependent variables; SC = school code for comparison; CI = confidence interval; LL = lower limit; UL = upper limit; computed at $p < .05$.

Research Question 2

The second research question established the relationship between teachers' level of technology implementation and student achievement in mathematics and English. The teacher's level of technology implementation was determined using the results of the online LoTi Digital-Age survey analyzed by LoTi profile. The survey instrument encompasses levels of teaching innovation, personal computer use, and current instructional practices (LoTi, 2014). These three components are pivotal to technology integration into classroom instructions. The survey focused on teacher perceptions, behaviors, and instructional practices, which jointly have an impact on student achievement through the use of the varied digital tools and resources (LoTi, 2014). The digital-age survey questionnaire was used to determine the level of technology implementation for the participants (see Appendix A).

The levels of teaching innovation profile approximated the degree to which participants supported or implemented the principles of digital-age teaching and learning in a classroom setting. The degrees on the LoTi Framework (See Appendix B) range was from Level 0 (Nonuse) to Level 6 (Refinement). Table 7 displays the level of teaching innovation by participants in all the schools. A graphical representation showed that a high percentage of the participants do not use technology (see Figure 5).

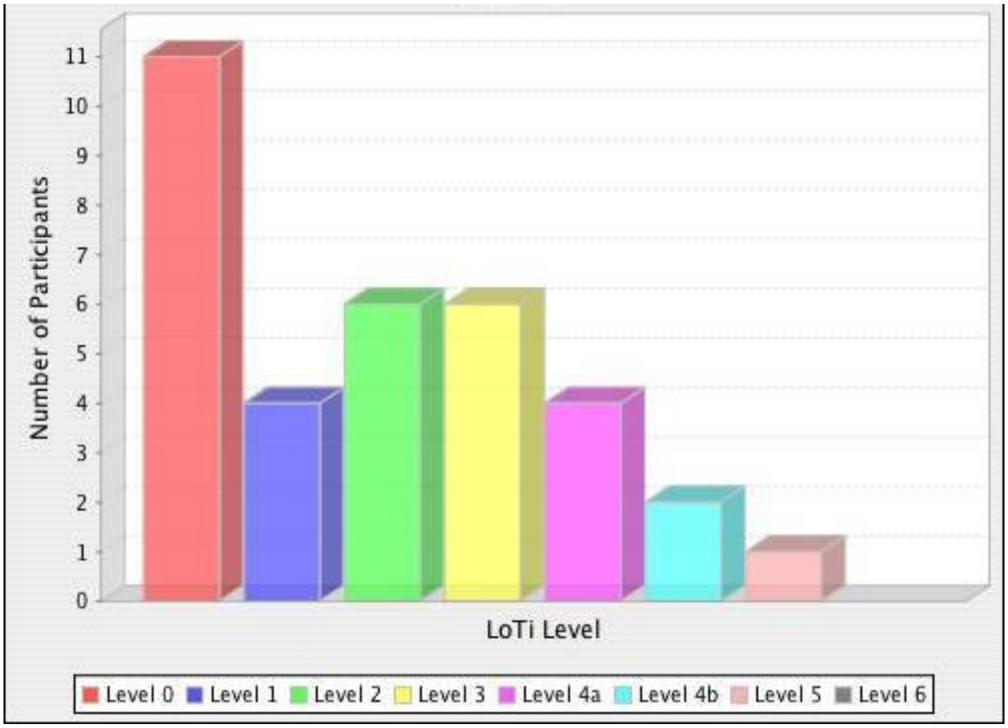

Figure 5. Bar graph showing the level of teaching innovation (LoTi) ranking for all participants.

The results revealed that most of the participants did not meet the target technology level of LoTi 4b or higher. Only school C had 20% participation at Level 5, while School G, School A, and School B had 50%, 17%, and 20%, respectively, at Level 4b.

Table 7

Level of Teaching Innovation Results

LoTi Level	Technology schools					Nontechnology schools		
	C	D	F	G	H	A	B	E
0	60%	67%			29%		20%	75%
1			50%		14%	17%	20%	
2					29%	33%	20%	25%
3	20%	33%	50%			33%	20%	
4a				50%	29%			
4b				50%		17%	20%	
5	20%							
6								

Note. From "Level of teaching innovation results for the various schools," by LoTi Connection, 2014. Copyright 2014 by LoTi Connection. Adapted with permission. The percentage is the number of participants at each level on school basis.

The Current Instructional Practices (CIP) profile showed the consistency of participants' implementation of instructional practices with learner- centered curriculum and project-based learning experiences (LoTi, 2014). The CIP intensity levels varied from 0 to 7, with 0 representing no classroom setting and 7 representing the alignment of instructional practices exclusively with a learner-based approach to teaching and learning processes (See Appendix C). A graphical representation of the intensity levels of the participants is displayed in Figure 6.

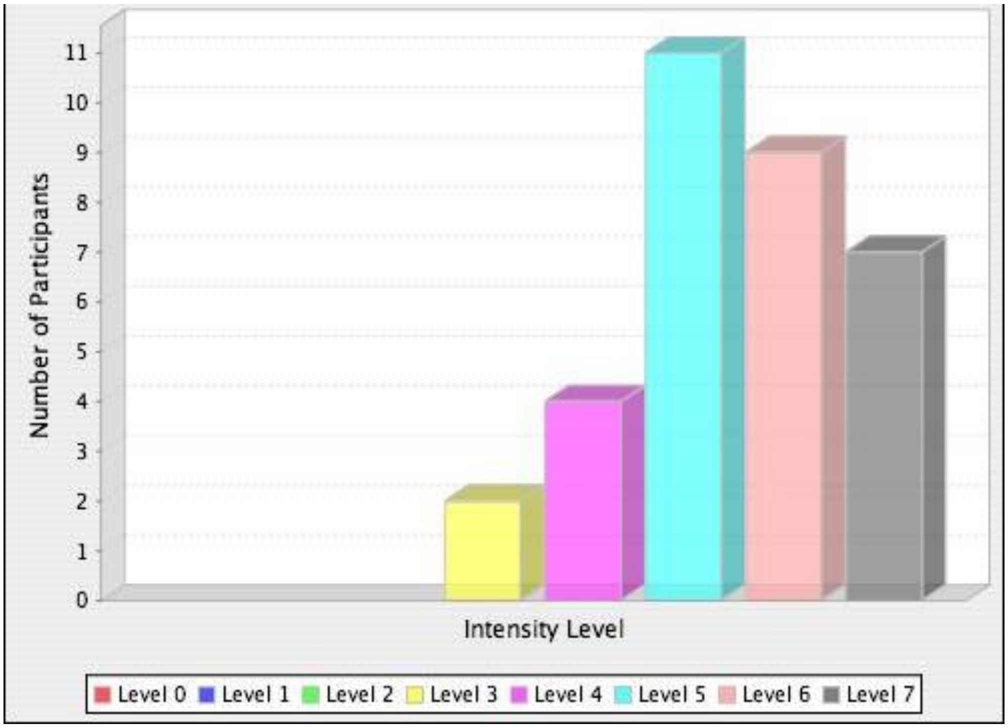

Figure 6. Bar graph showing the level to which each participant in the various schools was implementing technology in the classroom.

In Table 8, no participant was found on the intensity level below 3. Most of the participants had in various ways aligned instructional practices to a reasonable extent with a subject-matter based approach to learning. However, the participants from school G indicated a learner-centered approach in their instructional practices.

The Personal Computer Use (PCU) profile entailed participants' comfort level with digital tools and resources to enhance student learning and effective use in the learning environment, in the classroom, and at home (LoTi Connection, 2014). The PCU intensity levels varied from 0 to 7, with 0 representing no skill and 7 representing high proficiency in the use of computers. Figure 7 is a graphical representation of the personal computer use of the participants.

Table 8

Level of Current Instructional Practices Results

CIP Level	**Technology schools**					**Nontechnology schools**		
	C	D	F	G	H	A	B	E
0								
1								
2								
3	20%							25%
4	20%							75%
5	20%		50%		43%	50%	60%	
6	20%	66%	50%		43%	33%	20%	
7	20%	33%		100%	14%	17%	20%	

Note. From “Level of current instructional practices results for the various schools,” by LoTi Connection, 2014. Copyright 2014 by LoTi Connection. Adapted with permission. The percent is the number of participants at each level on school basis.

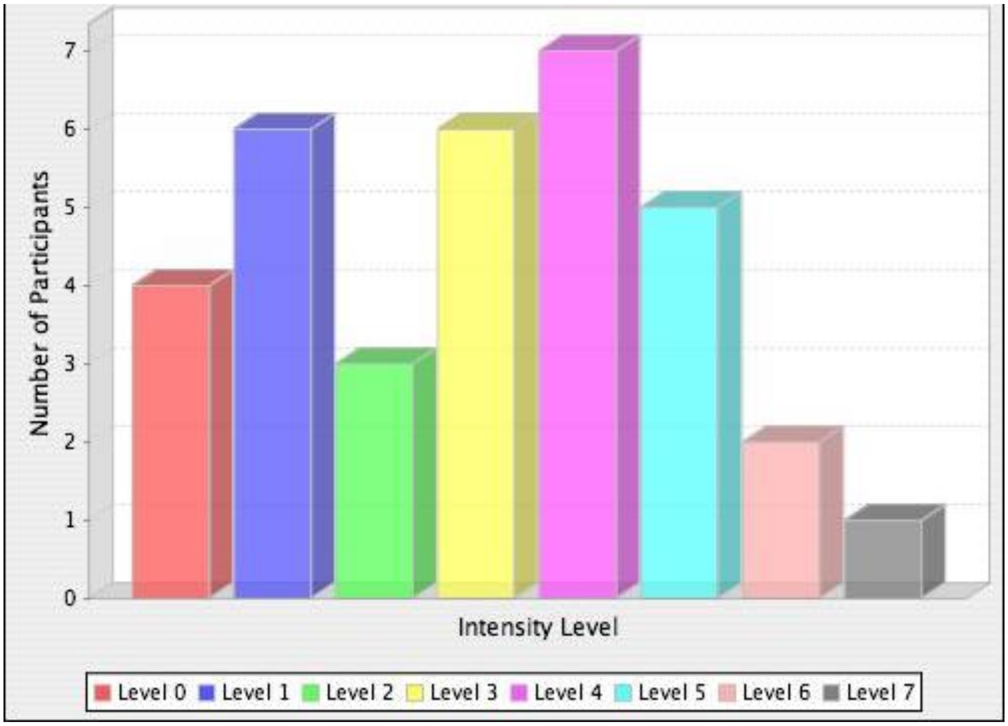

Figure 7. Bar graph showing the level to which each participant in the various schools was implementing technology in the classroom.

Table 9 showed an analysis of participants' level of proficiency of the various schools. No participant had intensity level 7 in all the schools. However, most of the participants were still at low level of intensity, while some participants had no computer skills.

Table 9

Levels of Personal Computer Use Results

PCU Level	Technology schools					Nontechnology schools		
	C	D	F	G	H	A	B	E
0	20%					33%	20%	
1	20%				14%	17%	20%	25%
2	20%				14%			25%
3	40%	66%				17%	20%	
4		33%	50%	50%	14%		40%	50%
5					44%	33%		
6			50%	50%	14%			
7								

Note. Based on “Level of personal computer usage results for the various schools,” by LoTi Connection, 2014. Copyright 2014 by LoTi Connection.

A summary of the data for all the schools is displayed in Table 10. The degree to which each teacher supported or implemented technology in a classroom setting is approximated by the LoTi profile. The degree on the levels of teaching innovation (LoTi) framework ranges from Level 0 (Nonuse) to Level 6 (Refinement), the description of each level is shown in Appendix B. The PCU (see Appendix C) and CIP (see Appendix D) intensity levels were determined based on the following scale: Level 0 – Level 2 (Not true of me now), Level 3 – Level 5 (Somewhat true of me now), and Level 6 – Level 7 (Very true of me now).

On average, the analysis of the responses of all participants for LoTi was L2 (Exploration) with a median score of 18%. Level 2 indicated that the emphasis was more on content understanding with support for mastery learning and direct instruction. However, student learning is at the lower levels of cognitive processing. The mode score was 32% of the participants at Level 0 (Nonuse). The PCU profile addressed participants' level of fluency with digital tools and resources to enhance student learning. The average intensity level for all the participants was Level 3. Level 3 indicates that participants exhibited adequate fluency with digital tools and resources usage for student learning. The mode score was 21% with an intensity Level 4, indicating movement from adequate fluency to high fluency of digital tools usage. The CIP median and mode score had intensity Level 5; thus, the CIP profile showed participants' instructional practices support for learner-centered and research-based approaches. Level 5 indicated that the participants' instructional practices were on learning activities and teaching strategies based on learners' questions in the classroom.

Table 10

Summary of Digital-Age Survey for Teachers

School Code	*n*	LoTi	PCU	CIP
School category		*Technology*		
C	5	Level 0	Level 2	Level 5
D	3	Level 0	Level 3	Level 6
F	2	Level 1	Level 4	Level 5
G	2	Level 4a	Level 4	Level 7
H	7	Level 2	Level 5	Level 6
		Nontechnology		
A	6	Level 2	Level 1	Level 5
B	5	Level 2	Level 3	Level 5
E	4	Level 0	Level 1	Level 4
Overall	34	Level 2	Level 3	Level 5

Note. Based on "LoTi data summary for digital-age survey for teachers showing various levels of LoTi, PCU and CIP results for Each School" by LoTi Connection, 2014.

The LoTi digital-age priorities were based on the balance between instruction, assessment, and digital tools usage to improve the teaching and learning processes in the 21st century learning environment. The summary was centered on five priorities as described in Appendix E with details of each level priority. The priorities are: 1 - Visionary Leadership; 2 - Digital-Age Learning Culture; 3 - Student Learning and Creativity; 4 - Systemic Improvement; and 5 - Digital Citizenship, and these priorities aid participants to determine the area of improvement in professional development. The priority areas are aligned to the ISTE National Educational Technology for Teachers. The overall data summary of participants on school basis is shown in Table 11.

The results from Table 11 revealed that student learning and creativity had the highest-level need for professional development, while digital-age learning experiences and assessments had the lowest-level need for professional development. The low priority implies a score between 0 and 33%; mid priority is between 34% and 66%, and high priority is between 67% and 100%. The assessment of student learning and creativity was generated from the scores of the digital-age questionnaire for questions Q1, 4, 5, 8, 10, 14, 21, 22, 36, 38, 40, and 47 (see Appendix A), while, for digital-age learning experiences, the assessment was generated from the scores of Q6, 20, 32, 41 and 50.

After the teacher's level of technology implementation had been determined using LoTi software, a Pearson's correlation coefficient test to establish a relationship between teachers' level of technology implementation and student achievement in mathematics and English was conducted. The Pearson's correlation coefficient on the dependent variables varied for the three aspects (LoTi, CIP, and PCU) of technology implementation. The Pearson's correlation coefficient for English mean scores versus LoTi was not significant ($r = -.417$, $p > .05$). The implication is that no correlation exists between student achievement in English and teachers' level of teaching innovation. The correlation coefficient between mathematics and LoTi ($r = -.272$, $n = 8$, $p > .05$) also showed no significance. The correlation coefficient between English and CIP ($r = .082$, $n = 8$, $p > .05$), as well as mathematics and CIP ($r = .153$, $p > .05$), showed no significance. Thus, there was no correlation between student achievement in mathematics and English and teachers' current instructional practices. For the correlation between English and PCU ($r = -.019$, $n = 8$, $p > .05$) and mathematics and PCU ($r = -.017$, $n = 8$, $p > .05$), the coefficient implies nonsignificance. The hypothesis that there is a relationship between teachers' level of technology implementation and student achievement in English and mathematics is rejected.

Table 11

LoTi Digital-Age Professional Development Priority Results

School Code	*n*	#1	#2	#3	#4	#5
School category		*Technology*				
C	5	High	Mid	High	Low	High
D	3	Mid	Low	High	Mid	High
F	2	Mid	Low	High	Mid	Mid
G	2	Low	Low	Mid	High	Mid
H	7	Mid	Low	High	Mid	Mid
		Nontechnology				
A	6	High	Low	Mid	Mid	High
B	5	Mid	Low	Mid	Mid	Mid
E	4	High	Mid	High	Low	High
Overall	34	Mid	Low	High	Mid	Mid

Note. Based on “LoTi data summary for digital-age survey for teachers showing various levels of LoTi, PCU and CIP results for Each School” by LoTi Connection, 2014. Copyright 2014 by LoTi Connection. #1 - visionary leadership, #2 – digital-age learning culture; #3 – student learning and creativity, #4 – Systemic improvement and #5 – digital citizenship.

Table 12 showed the analysis of the Pearson's correlation coefficient. The coefficient values for LoTi and PCU are negative tending towards a very weak relationship. Categorically, teachers' level of technology implementation does not affect the student achievement in English and mathematics.

Table 12

Correlation between the Dependent Variables and LoTi Subscales

	Pearson's *r*		*P* value	
	English	Mathematics	English	Mathematics
LoTi	-.417	-.272	.304	.515
CIP	.082	.153	.848	.717
PCU	-.019	-.017	.965	.968

Summary

Chapter 4 provided a detailed description of school demographics, data collection and analysis, results, and summary of the study on the impact of technology interventions on student achievement in English and mathematics in rural schools. The schools were categorized into technology-enabled and nontechnology-enabled schools. The data were analyzed using the SPSS package and LoTi profiler software. The results revealed significant differences in student achievement in English and mathematics and technology-enabled and nontechnology-enabled schools. The teachers' level of technology implementation was determined based on three aspects: level of teaching innovation, current instructional practices, and personal computer use. The results showed a low level of teaching innovation using digital tools and resources, alignment of instructional practices at a minimal level with subject-matter based approaches, and high comfort with personal computers use to enhance student learning. Results of further analysis on the relationship of teachers' level of technology implementation and student achievement revealed no correlation.

A discussion of these results and recommendations for future research and practice appear in Chapter 5.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this causal comparative study was to determine the impact of the technology interventions that were deployed to rural schools in Nigeria on student achievement in English and mathematics. This study was designed to determine if the deployed solutions met teachers' needs with the ability to integrate technology into classroom instruction and the impact of technology usage on learners' achievement. The findings revealed that the mean score of students for mathematics and English in technology-enabled schools was higher than nontechnology-enabled schools. Further, using the LoTi profile, teachers' level of technology implementation in the classroom was at low or nonuse levels for both technology-enabled and nontechnology-enabled schools, and there was no correlation between teachers' level of technology implementation and student performance. In the remaining part of this chapter I discuss the findings, limitations of the study, recommendations for further research, implications for social change, and conclusions.

Interpretation of the Findings

The technology interventions in the participating schools were mostly one-to-one laptops, computer laboratories, and multimedia centers, except one school with a nonfunctional IWB. On this premise, the interpretation of this study's findings will focus on one-to-one laptops initiatives, the description of technology integration in the classroom, and the impact on student achievement based on the peer-reviewed literature in Chapter 2. The study examined the SS2 students' scores in mathematics and English from all participating schools. The MANOVA was used to determine the varying significant differences in mathematics and English between technology and nontechnology schools. The findings showed a higher mean score for technology schools and a lower mean score for nontechnology schools. The data set used help answer Research Question 1: Is there a difference in student achievement in mathematics and English between technology-enabled and nontechnology-enabled schools?

The results showed a significant difference in student performance in the different learning environments. The students in technology schools performed better than the students in nontechnology schools. These findings can be related to Shapley et al. (2010), who demonstrated that technology access and use were positive predictors of students' TAKS reading and mathematics scores. Also, other researchers revealed that the one-to-one initiatives had an impact on student academic achievement and proficiency (Bebell & Kay, 2010; Jing & Yong, 2008). Further, Neill and Mathews (2009) revealed that technology interventions improved student achievement in mathematics and language arts. Suhr et al. (2010) showed that students in technology schools performed better than students in nontechnology schools. Several studies have confirmed that the use of technology had a positive impact on student achievement (Bebell & Kay, 2010; Neill & Mathews, 2009; Shapley et al., 2010; Suhr et al., 2010). A few studies noted that the impact of technology on student achievement might be dependent on teachers' usage and students' motivation and enthusiasm (Mellon, 2011; Norris & Soloway, 2010). The implication is that there might be other contextual factors that led to improved student performance.

Furthermore, this study examined the relationship between teachers’ level of technology implementation and student achievement to determine the impact of technology use in the classroom on student performance. The findings of teachers’ level of technology implementation using LoTi framework revealed the levels of technology implementation based on LoTi, CIP, and PCU. The results indicated that the teachers have access to computers for instructional use, but most of the teachers were clustered in Levels 0 to 2. These are low levels of the LoTi framework (see appendices), which focuses on teacher's use of productivity tools, student use of tutorial programs, and “project-based” learning opportunities at the low-order thinking levels of knowledge or comprehension (LoTi Connection, 2014). Malcolm-Bell (2012) corroborated the result that technology integration is at low levels in instruction and learning in the schools in Jamaica. Other studies revealed that the low level of implementation might be a result of other factors affecting teachers’ use of technology (Solvie & Kloek, 2007; Tamim et al., 2011).

A further analysis of these results was a comparative test of the LoTi scores and the student performance mean score. The correlation test revealed no relationship between teachers’ level of technology implementation and student achievement. Based on other research, the nonexistence of a relationship might be a result of teachers’ use of technology and adoption, beliefs, and practices (Cifuentes et al., 2011; Levin & Wadmany, 2008; Martin et al., 2010; Tamim et al., 2011; Wright & Wilson, 2011).

In this study, the result of Research Question 2 was dependent on the result of Research Question 1. Therefore, the findings did not suggest that the technology interventions had a direct positive impact on student achievement when teachers' level of usage was at a low level. The implication is that other factors might have led to better student performance. Supporting the existence of other factors is the univariate analysis carried out for Research Question 1, which showed the mean score of a nontechnology school to be higher than the mean score of two of the technology schools. Invariably, other factors might accentuate the difference in performance between the schools.

Limitations of the Study

One of the limitations of this study was the restriction that participants were exclusively SS2 teachers. The number of teachers in most of the schools was very low compared with the students' population. Most of the schools were understaffed, thereby leading to low participation in the online survey. Another unforeseen limitation was teachers' poor ability to access and use technology. Some of the teachers lacked a functional e-mail address, a prerequisite to accessing the online survey. The LoTi organization does not offer a paper-and-pencil survey; thus, some of the participants were not technologically able to participate. The difficulty with technology use affected the timeline, but providing telephonic and online support for the participants mitigated the problem.

A follow-up telephone conversation with the teachers revealed that the survey process was cumbersome. Some teachers had a technology phobia or a negative attitude toward technology. There was a time factor because of the end-of-school term examination and marking, and there was a lack of electricity (and therefore Internet) during school hours. One particular school had only one English teacher, who chose not to participate in the study. Though the effect on the overall results might not be significant, a simple test on school-by-school basis would not generate any result for such a school. The varied school population, which was unknown at the time of the study design, might have affected the findings.

Recommendations

The major recommendation that came out of this study is that it be used as a guide in developing countries with similar demographics. This study focused on two hypotheses, and the results showed a significant difference in student achievement between technology and nontechnology schools. However, there were discrepancies among some of the schools in which the mean score of students in nontechnology school was better than the mean score of students in technology school. There is a need to discover the factors that cause such differences. The hypothesis that there was a relationship between teachers' level of technology implementation and student achievement revealed no relationship. Further research involving a mixed-methods approach and direct interview with teachers might give more insights into how technology is used in the classroom.

The overall results showed that the level of technology implementation of teachers both in technology and nontechnology schools was very low. An implication for further research is to ascertain the hindrances of effective use of technology. Several studies (Alege & Afolabi, 2011; Anderson & Maninger, 2007; Groff & Mouza, 2008; Inan & Lowther, 2010) have examined factors affecting the effective use of technology in the classroom. However, the varied infrastructure and technology tools available in most developing countries might reveal new findings for those in developing countries. The locations of the schools are within the same rural community, but the demographic characteristics of the schools varied in terms of the student population, the teacher population, and facilities. Therefore, categorization of schools within the same population range might be used for further study.

Other researchers have identified similar needs for further study in their various research works. According to McKinley (2014), further study need to be conducted to determine if more specific demographics and attitude toward technology affect technology implementation. Malcolm-Bell (2012) suggested a further study to ascertain the findings by replicating the study in similar demographics. Berkeley-Jones (2012) expressed a study to determine the effect of teachers' professional development on student performance in relation to the level of technology implementation.

Implications

The impact of social change in any society reflects the ability of the citizens to acclimatize with the evolving technological trends in their daily lives. This study has provided avenues to determine the technology interventions that might work best in a rural community. The findings of the varied differences in student achievement between technology and nontechnology-enabled schools gave an accurate description of what is obtainable in most of the schools, irrespective of their locale or availability of technology. It also showed the level of teachers' technology implementation in the varied learning environments.

The study contributed to the potential for social change by providing teachers the evidential data to integrate technology into classroom instruction. Teachers can increase the level of innovative teaching, instructional practices, and computer use by moving from a lower level of technology implementation and thinking skills to a higher level of technology implementation. Social change in the schools and classrooms is forthcoming in rural communities as teachers see the need to seamlessly infuse technology at a higher level in order to fulfill the 21st-century learner-centered approach.

Furthermore, the results of the study will guide the stakeholders, especially the Ministry of Education and its affiliate bodies, and other private organizations that have invested and equipped the schools with technology interventions, on what worked best and the status of usage. The study has added to the knowledge base and literature on the technology interventions deployed in rural schools in a developing country. Also, the study will help stakeholders to collaborate and consider other factors that will facilitate the best use of technology in the schools prior to deployment. It is anticipated that the study will be an avenue for change by providing a basis for other researchers to conduct further studies on technology integration in rural communities taking cognizance of other contextual factors.

The study may be resource material for other developing countries with similar demographics to consider various factors prior to deploying technology solutions to schools in rural areas. The results may provide rural schools that have experienced deprivation of access to technology-rich education the opportunity to receive interventions from stakeholders.

The foundation of this theoretical/conceptual framework used in the study (LoTi framework) is based on the principles of the constructivist approach to learning that fosters high levels of student achievement in a student-centered learning environment. Based on the results of this study, the learner-centered approach is still at a low level. Schools should encourage teachers to adopt the learner-centered strategies and use the LoTi framework as a tool for the alignment of instructional practices for teaching and learning. Most of the participants in the study claimed that they had access to digital tools, but the results showed a low level of usage. The suggestion is that schools should incorporate the use of LoTi framework for professional development in order to align teachers with constructivist instructional and teaching practices.

There was no statistical significant relationship between teachers' level of technology implementation and student achievement in mathematics and English. The observation was that the nontechnology school A students with teachers' level of technology implementation at exploration level (Level 2) outperformed technology School G students with teachers' level of technology implementation at integration level (Level 4a). Various factors may account for this inconsistency. Qualitative data in terms of interviews and classroom observations to determine the actual technology use in the classroom and the self-reported use as filled in the online LoTi survey instrument may require consideration.

The following recommendations for the schools and teachers are based upon the results of this study:

- Provide staff development tailored toward definite strategies and techniques for the integration of higher-order thinking skills and engaged learning using available technology interventions resources. Participants' level of teaching innovation will move to a higher level.
- Make available staff development that increases participants' confidence and competence with designing LoTi higher levels learning experiences using a constructivist, learner-based approach to curriculum formation. The staff development will help to move teachers to LoTi Level 4a and 4b (target technology), and improve the views of teachers at LoTi 4a regarding their ability to support or promote authentic, problem-solving learning opportunities.
- Review professional development programs where they exist, and where not. Each school should develop professional development programs that would help teachers achieve more of the attributes of a student-centered curriculum.
- Help schools and the government and private sectors collaborate to develop a technology plan. Identification of adequate infrastructure and specific resources to support technology integration should be considered prior to the deployment of any form of technology interventions.
- Give priority to a constant public power supply and alternate power supply, such as inverters, over generators. Some schools were apparently unable to fuel their generators because of the cost implication.

- Create new approaches to professional development to enable teachers make better connections between technology use and student realistic problem-solving in the classroom.

Conclusion

Emerging technologies are tools to enhance teaching and learning processes. Nigeria, as a developing country, still lacks technology-rich education and adequate expertise to implement technology in a learning environment. The government and private sector organizations, in an attempt to bridge the digital gap, have invested and equipped some rural schools with technology facilities. The result, however, has not evidentially reflected on student academic achievement. The central focus of this study was to determine the impact of technology interventions that were deployed to rural schools in Nigeria on student achievement. The findings revealed significant differences in student achievement in mathematics and English between technology and nontechnology schools, as well as no correlation between teachers' level of technology implementation and student achievement. The nature of the results is important information for all stakeholders, as it shows that the improper implementation and nonuse of technology have not added significant value to student learning. The funding partners should explore other factors that might accentuate ineffective use of the technology facilities in rural communities, put in place measures that would guide the technology interventions process, and devise strategies to mitigate barriers to technology integration. The schools are responsible for sustainable technology plan and provision of adequate professional development for staff in order to have a technology-rich learning environment. The onus is for teachers to use technological tools effectually and efficiently for instructional practices that would invariably affect and add value to student academic performance. It is hoped that this research will motivate all stakeholders to consider some of the recommendations, and to encourage student-centered learning approach for the transformation of classroom practices, thereby leading to a positive social change in our society.

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Appendix A: Digital-Age Survey for Teachers Questionnaire

Scoring rubric: 0 – Never; 1 - At least once a year; 2 - At least once a semester; 3 - At least once a month; 4 - A few times a month; 5 - At least once a week; 6 - A few times a week; 7 - At least once a day

Q1: My students use digital tools and/or enriched resources in my classroom to engage in learning activities that require them to analyze information, think creatively, make predictions, and/or draw conclusions.

Q4: My students use digital tools to create web-based or multimedia presentations (e.g., Prezi, PowerPoint) that showcase information gathered on topics that I assign in class.

Q5: My students participate in web-based projects that emphasize complex thinking strategies (e.g., problem-solving, decision-making, experimental inquiry) aligned to the content standards.

Q6: I provide multiple and varied formative and summative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways.

Q8: My students use digital tools and/or enriched resources to explore multiple solutions to teacher-directed problems that require creative and innovative thinking.

Q10: My students identify important real world issues (e.g., environmental pollution, elections, health awareness), then use collaborative digital tools and enriched resources within and beyond the school building (e.g., partnerships with business professionals, community action groups) to solve them.

Q12: I promote, monitor, and model the ethical use of digital information and technology in my classroom (e.g., appropriate citing of resources, respecting copyright permissions).

Q13: I use digital tools to communicate and collaborate with students, parents, and peers.

Q14: My students propose innovative ways to use our school's advanced digital tools (e.g., 1:1 mobile devices, digital media authoring tools, probeware with GPS systems) and enriched resources (e.g. ready access to outside experts) to address challenges/issues affecting their local and global communities.

Q15: I model and facilitate the effective use of current and emerging digital tools to support teaching and learning in my classroom.

Q16: I use digital tools to enhance my lectures or presentations (e.g., multimedia presentations) so that students can better understand the content that I teach.

Q17: I alone use the digital tools due to the amount of content that I have to cover in my classroom by the end of each marking period.

Q18: I use a variety of digital tools that support the evolving nature of my grade level content and elevate student success and innovation in my class- room.

Q19: My students are well versed in current and emerging technologies and readily self-select the most appropriate tool or resource to aid them in completing any given task.

Q20: I employ learner-centered strategies (e.g., communities of inquiry, learning contracts) to address the diverse needs of all students using develop- mentally-appropriate digital tools or enriched resources.

Q21: My students participate in collaborative projects involving face-to-face and/or virtual environments with students of other cultures that address current problems, issues, and/or themes.

Q22: My students use digital tools and enriched resources for (1) collaboration with others beyond the classroom, (2) publishing, (3) communication, and (4) research to solve issues and problems of personal interest that ad- dress specific content standards.

Q23: I model for my students the safe and legal use of digital tools while I am delivering content and/or reinforcing their understanding of pertinent concepts.

Q25: My students model the "correct and careful" (e.g., ethical usage, proper digital etiquette, protecting their personal information) use of digital re- sources and are aware of the consequences regarding their misuse.

Q26: I participate in local and global learning communities to explore creative applications of technology to improve student learning.

Q27: My students use digital tools to solve "real-world" problems or issues of importance to them related to the content standards.

Q30: My students engage in standards-based instructional units and related learning experiences that emphasize innovative thinking, student use of digital tools, and applied learning to the real world.

Q31: I seek outside help with designing student-centered performance assessments using the available digital tools that involve students transferring what they have learned to a real world context.

Q32: My students' questions, interests, and readiness levels directly impact how I design learning activities that address the content standards. Q36: My students use the classroom digital tools to engage in relevant, challenging, self-directed learning experiences that address the content standards.

Q37: My students complete web-based projects that emphasize high level cognitive skills (e.g., analyzing, evaluating, creating). Q38: My students use digital tools or enriched resources to supplement their content understanding or to improve their basic math and literacy skills.

Q40: My students use digital tools or enriched resources for research purposes (e.g., data collection, questionnaires, Internet research) that require them to investigate a teacher-directed issue/problem, take a position, make decisions, and/or seek out a solution.

Q41: My students collaborate with me in setting both group and individual academic goals that provide opportunities for them to direct their own learning aligned to the content standards.

Q42: I promote global awareness in my classroom by providing students with digital opportunities to collaborate with others of various cultures.

Q43: My students apply their classroom content learning to real-world problems within the local or global community using the digital tools at our disposal.

Q45: My students use classroom digital tools (e.g., interactive whiteboard, digital student response system) or enriched resources (e.g., manipulatives, graphic organizers, dioramas) to supplement the curriculum and reinforce specific content standards.

Q46: My students use digital tools for higher-order thinking (e.g., analyzing, evaluating, creating) and personal inquiry related to problem-based learning experiences.

Q47: My students use all forms of the most advanced digital tools and re- sources to pursue collaborative problem-solving opportunities surrounding issues of personal and/or social importance.

Q48: I model and advocate for the use of assistive technologies that are available to meet the diverse demands of special needs students.

Q49: I promote the effective use of digital tools on my campus and within my professional community and actively develop the technology skills of others.

Q50: I consider how my students will apply what they have learned in class to the world they live when planning instruction and assessment strategies.

Appendix B: Level of Teaching Innovation Framework

LoTi Level of description

Level 1: Nonuse

At level 0 (Non-Use), the instructional focus ranges anywhere from traditional direct instruction approach to a collaborative student-centered learning environment. The use of research-based best practices may or may not be evident, but those practices do not involve the use of digital tools and resources. The use of digital tools and resources in the classroom is non-existent due to (1) competing priorities (e.g., high stakes testing, highly-structured and rigid curriculum programs), (2) lack of access, or (3) a perception that their use is inappropriate for the instructional setting or student readiness levels. The use of instructional materials is predominately text-based (e.g., student handouts, worksheets).

Level 1: Awareness

At level 1 (Awareness), the instructional focus emphasizes information dissemination to students (e.g., lectures, teacher-created multimedia presentations) and supports the lecture/discussion approach to teaching. Teacher questioning and/or student learning typically focuses on lower cognitive skill development (e.g., knowledge, comprehension). Digital tools and resources are either (1) used by the classroom teacher for classroom and/or curriculum management tasks (e.g., taking attendance, using grade book programs, accessing email, retrieving lesson plans from a curriculum management system or the Internet), (2) used by the classroom teacher to embellish or enhance teacher lectures or presentations (e.g., multimedia presentations), and/or (3) used by students (usually unrelated to classroom instructional priorities) as a reward for prior work completed in class.

Level 2: Exploration

At level 2 (Exploration), the instructional focus emphasizes content understanding and supports mastery learning and direct instruction. Teacher questioning and/or student learning focuses on lower levels of student cognitive processing (e.g., knowledge, comprehension). Digital tools and resources are used by students for extension activities, enrichment exercises, or information gathering assignments that generally reinforce lower cognitive skill development relating to the content under investigation. There is a pervasive use of student multimedia products, allowing students to present their content understanding in a digital format that may or may not reach beyond the classroom.

Level 3: Infusion

At level 3 (Infusion), the instructional focus emphasizes student higher order thinking (i.e., application, analysis, synthesis, evaluation) and engaged learning. Though specific learning activities may or may not be perceived as authentic by the student, instructional emphasis is, nonetheless, placed on higher levels of cognitive processing and in-depth treatment of the content using a variety of thinking skill strategies (e.g., problem-solving, decision-making, reflective thinking, experimentation, scientific inquiry). Teacher-centered strategies including the concept attainment, inductive thinking, and scientific inquiry models of teaching are the norm and guide the types of products generated by students. Digital tools and resources are used by students to carry out teacher-directed tasks that emphasize higher levels of student cognitive processing relating to the content under investigation.

Level 4a: Integration (Mechanical)

At level 4a (Integration: Mechanical) students are engaged in exploring real-world issues and solving authentic problems using digital tools and resources; however, the teacher may experience classroom management (e.g., disciplinary problems, internet delays) or school climate issues (lack of support from colleagues) that restrict full-scale integration. Heavy reliance is placed on prepackaged materials and/or outside resources (e.g., assistance from other colleagues), and/or interventions (e.g., professional development workshops) that aid the teacher in sustaining engaged student problem-solving. Emphasis is placed on applied learning and the constructivist problem-based models of teaching that require higher levels of student cognitive processing and in-depth examination of the content. Students' use of digital tools and resources is inherent and motivated by the drive to answer student-generated questions that dictate the content, process, and products embedded in the learning experience.

Level 4b: Integration (Routine)

At level 4b (Integration: Routine) students are fully engaged in exploring real-world issues and solving authentic problems using digital tools and resources. The teacher is within his/her comfort level with promoting an inquiry-based model of teaching that involves students applying their learning to the real world. Emphasis is placed on learner-centered strategies that promote personal goal setting and self-monitoring, student action, and issues resolution that require higher levels of student cognitive processing and in-depth examination of the content. Students' use of digital tools and resources is inherent and motivated by the drive to answer student-generated questions that dictate the content, process, and products embedded in the learning experience.

Level 5: Expansion

At level 5 (Expansion), collaborations extending beyond the classroom are employed for authentic student problem-solving and issues resolution. Emphasis is placed on learner-centered strategies that promote personal goal setting and self-monitoring, student action, and collaborations with other diverse groups (e.g., another school, different cultures, business establishments, governmental agencies). Students' use of digital tools and resources is inherent and motivated by the drive to answer student-generated questions that dictate the content, process, and products embedded in the learning experience. The complexity and sophistication of the digital resources and collaboration tools used in the learning environment are now commensurate with (1) the diversity, inventiveness, and spontaneity of the teacher's experiential-based approach to teaching and learning and (2) the students' level of complex thinking (e.g., analysis, synthesis, evaluation) and in-depth understanding of the content experienced in the classroom.

Level 6: Refinement

At level 6 (Refinement), collaborations extending beyond the classroom that promote authentic student problem-solving and issues resolution are the norm. The instructional curriculum is entirely learner-based. The content emerges based on the needs of the learner according to his/her interests, needs, and/or aspirations and is supported by unlimited access to the most current digital applications and infrastructure available.

At this level, there is no longer a division between instruction and digital tools and resources in the learning environment. The pervasive use of and access to advanced digital tools and resources provides a seamless medium for information queries, creative problem-solving, student reflection, and/or product development. Students have ready access to and a complete understanding of a vast array of collaboration tools and related resources to accomplish any particular task.

Appendix C: Personal Computer Use Framework

PCU Level Description

PCU Intensity Level 0

A PCU Intensity Level 0 indicates that the participant does not possess the inclination or skill level to use digital tools and resources for either personal or professional use. Participants at Intensity Level 0 exhibit a general disinterest toward emerging technologies relying more on traditional devices (e.g., use of overhead projectors, chalkboards, paper/pencil activities) than using digital resources for conveying information or classroom management tasks.

PCU Intensity Level 1

A PCU Intensity Level 1 indicates that the participant demonstrates little fluency with using digital tools and resources for student learning. Participants at Intensity Level 1 may have a general awareness of various digital tools and media including word processors, spreadsheets, or the internet, but generally are not using them. Participants at this level are generally unaware of copyright issues or current research on the impact of existing and emerging digital tools and resources on student learning.

PCU Intensity Level 2

A PCU Intensity Level 2 indicates that the participant demonstrates little to moderate fluency with using digital tools and resources for student learning. Participants at Intensity Level 2 may occasionally browse the internet, use email, or use a word processor program; yet, may not have the confidence or feel comfortable using existing and emerging digital tools beyond classroom management tasks (e.g., grade book, attendance program). Participants at this level are somewhat aware of copyright issues and maintain a cursory understanding of the impact of existing and emerging digital tools and resources on student learning.

PCU Intensity Level 3

A PCU Intensity Level 3 indicates that the participant demonstrates moderate fluency with using digital tools and resources for student learning. Participants at Intensity Level 3 may begin to become “regular” users of selected digital-age media and formats (e.g., internet, email, word processor, multimedia) to (1) communicate with students, parents, and peers and (2) model their use in the classroom in support of research and learning. Participants at this level are aware of copyright issues and maintain a moderate understanding of the impact of existing and emerging digital tools and resources on student learning.

PCU Intensity Level 4

A PCU Intensity Level 4 indicates that the participant demonstrates moderate to high fluency with using digital tools and resources for student learning. Participants at Intensity Level 4 commonly use a broader range of digital-age media and formats in support of their curriculum and instructional strategies. Participants at this level model the safe, legal, and ethical uses of digital information and technologies and participate in local discussion forums that advocate the positive impact of existing digital tools and resources on student success in the classroom.

PCU Intensity Level 5

A PCU Intensity Level 5 indicates that the participant demonstrates a high fluency level with using digital tools and resources for student learning. Participants at Intensity Level 5 are commonly able to use an expanded range of existing and emerging digital-age media and formats in support of their curriculum and instructional strategies. Participants at this level advocate the safe, legal, and ethical uses of digital information and technologies and participate in local and global learning that advocate the positive impact of existing digital tools and resources on student success in the classroom.

PCU Intensity Level 6

A PCU Intensity Level 6 indicates that the participant demonstrates high to extremely high fluency level with using digital tools and resources for student learning. Participants at Intensity Level 6 are sophisticated in the use of most, if not all, existing and emerging digital-age media and formats (e.g., multimedia, productivity, desktop publishing, web-based applications). They begin to take on a leadership role as advocates for technology infusion as well as the safe, legal, and ethical uses of digital resources in the schools. Participants at this level continually reflect on the latest research discussing the impact of digital tools on student success.

PCU Intensity Level 7

A PCU Intensity Level 7 indicates that the participant possesses an extremely high fluency level with using digital tools and resources for student learning. Participants at Intensity Level 7 are sophisticated in the use of any existing and emerging digital-age media and formats (e.g., multimedia, productivity, desktop publishing, web-based applications). Participants at this level set the vision for technology infusion based on the latest research and continually seek creative uses of digital tools and resources that impact learning. They actively participate in global learning communities that seek creative uses of digital tools and resources in the classroom

Appendix D: Current Instructional Practices Framework

CIP Level Description

CIP Intensity Level 0

A CIP Intensity Level 0 indicates that the participant is not involved in a formal classroom setting (e.g., pull-out program).

CIP Intensity Level 1

At a CIP Intensity Level 1, the participant's current instructional practices align exclusively with a subject-matter based approach to teaching and learning. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions, but no effort is made to use the results of the assessments to guide instruction. Student projects tend to be teacher-directed in terms of identifying project outcomes as well as requirements for project completion. No effort is made to differentiate instruction. The use of research-based best practices focuses on basic classroom routines (e.g., providing homework and practice, setting objectives and providing feedback, students summarizing and note taking, providing adequate wait time).

CIP Intensity Level 2

At a CIP Intensity Level 2, the participant supports instructional practices consistent with a subject-matter based approach to teaching and learning, but not at the same level of intensity or commitment as a CIP Intensity Level 1. Teaching strategies tend to lean toward lectures and/or teacher-led presentations. The use of curriculum materials aligned to specific content standards serves as the focus for student learning. Learning activities tend to be sequential and uniform for all students. Evaluation techniques focus on traditional measures such as essays, quizzes, short-answers, or true-false questions with the resulting data used to guide instruction. Student projects tend to be teacher-directed in terms of identifying project outcomes as well as requirements for project completion. No effort is made to differentiate instruction. The use of research-based best practices focuses on basic classroom routines (e.g., providing homework and practice, setting objectives and providing feedback, students summarizing and note taking, providing adequate wait time).

CIP Intensity Level 3

At a CIP Intensity Level 3, the participant supports instructional practices aligned somewhat with a subject-matter based approach to teaching and learning. An approach characterized by sequential and uniform learning activities for all students, teacher-directed presentations, and/or the use of traditional evaluation techniques. However, the participant may also support the use of student-directed projects that provide opportunities for students to determine the "look and feel" of a final product based on their modality strengths, learning styles, or interests. Evaluation techniques continue to focus on traditional measures with the resulting data serving as the basis for curriculum decision-making. The use of research-based best practices expands beyond basic classroom routines (e.g., providing opportunities for non-linguistic representation, offering advanced organizers).

CIP Intensity Level 4

At a CIP Intensity Level 4, the participant may feel comfortable supporting or implementing either a subject-matter or learning-based approach to instruction based on the content being addressed. In a subject-matter based approach, learning activities tend to be sequential, student projects tend to be uniform for all students, the use of lectures and/or teacher-directed presentations are the norm as well as traditional evaluation strategies.

In a learner-based approach, learning activities are diversified and based mostly on student questions, the teacher serves more as a co-learner or facilitator in the classroom, student projects are primarily student-directed, and the use of alternative assessment strategies including performance-based assessments, peer reviews, and student reflections are the norm. Although traditional learning activities and evaluation techniques are used, students are also encouraged to contribute to the assessment process when appropriate to the content being addressed. The amount of differentiation is moderate based on the readiness level, interests, and learning styles of the students. The use of research-based best practices expands beyond basic classroom routines (e.g., providing opportunities for non-linguistic representation, offering advanced organizers).

CIP Intensity Level 5

At a CIP Intensity Level 5, the participant's instructional practices tend to lean more toward a learner-based approach. The essential content embedded in the standards emerges based on students “need to know” as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Both students and teachers are involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed.

Although student-directed learning activities and evaluations are the norms, the use of teacher-directed activities (e.g., lectures, presentations, teacher-directed projects) may surface based on the nature of the content being addressed and at the desired level of student cognition. The amount of differentiation is substantial based on the readiness level, interests, and learning styles of the students. The use of research-based best practices delves deeper into complex classroom routines (e.g., students generating and testing hypotheses, implementing cooperative learning, students identifying similarities and differences).

CIP Intensity Level 6

The participant at a CIP Intensity Level 6 supports instructional practices consistent with a learner-based approach, but not at the same level of intensity or commitment as a CIP Intensity Level 7. The essential content embedded in the standards emerges based on students “need to know” as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed. The amount of differentiation is substantial based on the readiness level, interests, and learning styles of the students. The use of research-based best practices delves deeper into complex classroom routines (e.g., students generating and testing hypotheses, implementing cooperative learning, students identifying similarities and differences).

CIP Intensity Level 7

At a CIP Intensity Level 7, the participant's current instructional practices align exclusively with a learner-based approach to teaching and learning. The essential content embedded in the standards emerges based on students “need to know” as they attempt to research and solve issues of importance to them using critical thinking and problem-solving skills. The types of learning activities and teaching strategies used in the learning environment are diversified and driven by student questions. Students, teacher/facilitators, and occasionally parents are all involved in devising appropriate assessment instruments (e.g., performance-based, journals, peer reviews, self-reflections) by which student performance will be assessed. The amount of differentiation is seamless since students completely guide the pace and level of their learning. The use of research-based best practices delves deeper into complex classroom routines (e.g., students generating and testing hypotheses, implementing cooperative learning, students identifying similarities and differences).

Appendix E: Digital-Age Professional Development Priority Description

Visionary Leadership (#1): According to the National Education Technology Standards for Teachers (NETS-T) from ISTE, Visionary Leadership signifies a teacher's exhibition of the “knowledge, skills, and work processes representative of an innovative professional in a global and digital society.” Based on this priority area, a teacher is able to demonstrate fluency in a variety of technology systems, communicate relevant information and collaborate with others (e.g., students, parents, community members) using a variety of digital tools and resources, and employ current and emerging technologies for data analysis purposes in support of research and learning.

Digital-Age Learning Culture (#2): According to the National Education Technology Standards for Teachers (NETS-T) from ISTE, Digital-Age Learning Experiences and Assessments signify a teacher's ability to “design, develop, and evaluate authentic learning experiences and assessments incorporating contemporary tools and resources to maximize content learning....” Based on this priority area, a teacher is able to create and implement engaging and relevant learning experiences that incorporate a variety of digital tools and resources, promote learner-based investigations, and provide a myriad of formative and summative assessment schemes aligned to the content and technology standards to improve and adjust future learning experiences.

Excellence in Professional Practice (#3): According to the National Education Technology Standards for Teachers (NETS-T) from ISTE, Excellence in Professional

Practice signifies a teacher's ability to “use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.” Based on this priority area, a teacher is able to promote, support, and model creative and innovative thinking; engage students in real-world problem-solving and issues resolution; model collaborative learning communities; and support student reflection using a variety of collaborative tools and resources.

Systemic Improvement (#4): According to the National Education Technology Standards for Teachers (NETS-T) from ISTE, Systemic Improvement signifies a teacher's inclination to “continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources.” Based on this priority area, a teacher is able to participate in local and global learning communities, evaluate and reflect on current research and professional practice involving the use of digital tools and resources, and exercise leadership in promoting the technology skills of others as well as improvements to the teaching profession.

Digital Citizenship (#5): According to the National Education Technology Standards for Teachers (NETS-T) from ISTE, Digital Citizenship and Responsibility signifies a teacher's understanding of the “local and global societal issues and responsibilities in an evolving digital culture and (the ability to) exhibit legal and ethical behavior in their professional practice." Based on this priority area, a teacher is able to advocate, model, and teach safe, legal, and ethical use of digital information and technology; employ learner-centered strategies to address the diverse needs of all learners; promote and model digital etiquette; and promote Digital-Age communication and collaboration tools with diverse groups and cultures.

Appendix F: Permission to Use LoTi

LoTi Connection, Inc.
PO Box 130037 Carlsbad, CA 92013-0037
(V) 760-431-2232 (F) 760-946-7605
www.loticonnection.com

February 17th, 2014

Permission For Use of the LoTi Framework

To: Walden University
Dissertation Review Boards

Please accept this letter as notification that Aderonke Bello is hereby granted permission to utilize the LoTi Framework and corresponding Digital-Age Survey to collect data for her doctoral dissertation study. Aderonke is permitted to use the Digital-Age Survey and the LoTi Framework for purposes of the study only. In addition, Aderonke has permission to review all available LoTI Digital-Age results on the individuals taking place in his study.

The guidelines for using LoTi Connection copyrighted material as part of this dissertation study are as follows:

1. Permission to reprint the LoTi Framework is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
2. Permission to reprint selected results including graphs and tables in the Appendices of the study is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
3. Permission to reprint selected questions from the Digital-Age Survey in the Appendices of the study is granted provided that the content remains unchanged and that attribution is given to LoTi Connection.
4. LoTi Connection holds the right to restrict usage of any intellectual property if LoTi Connection finds that the content is being used in an inappropriate manner.

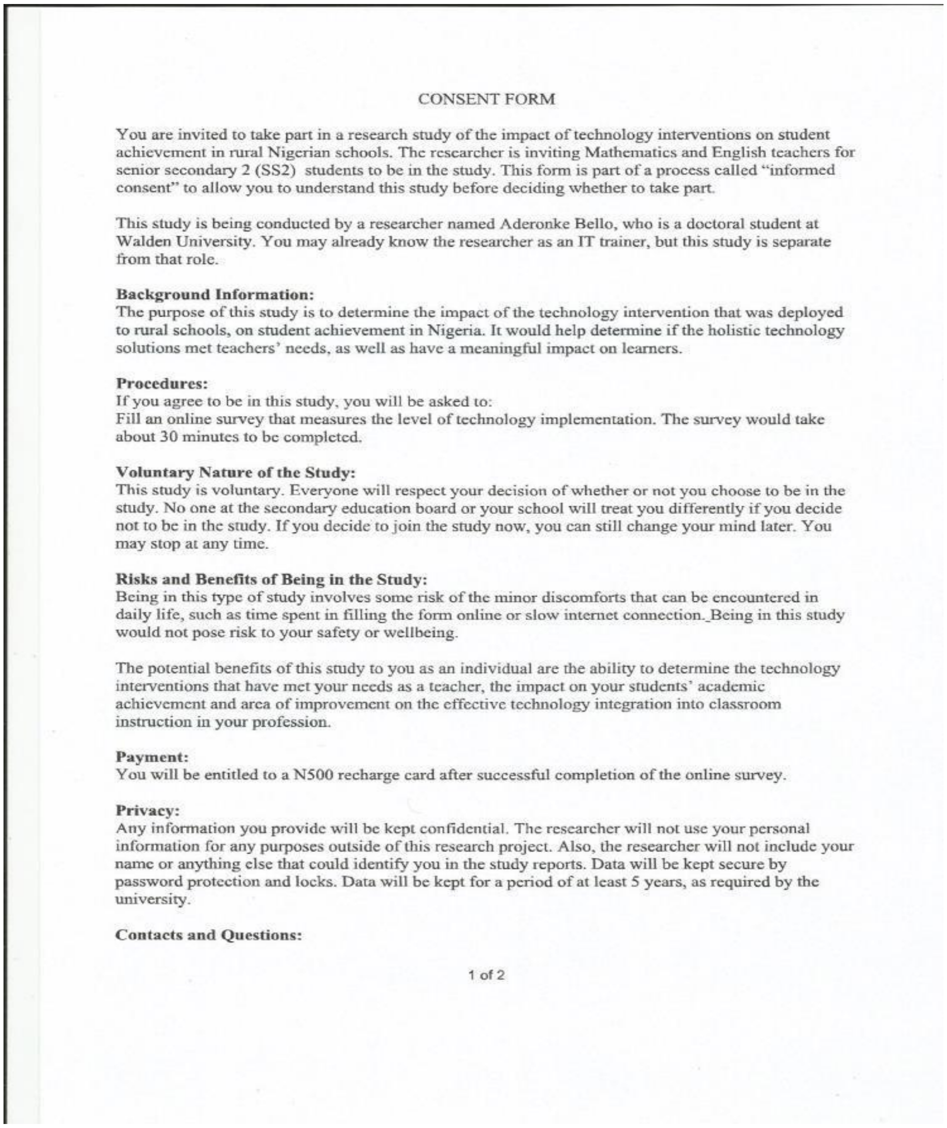
Sincerely,

Dennee Saunders

Dennee Saunders
Assistant Executive Director

Date 01/07/2014

Appendix G: Consent Form



CONSENT FORM

You are invited to take part in a research study of the impact of technology interventions on student achievement in rural Nigerian schools. The researcher is inviting Mathematics and English teachers for senior secondary 2 (SS2) students to be in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Aderonke Bello, who is a doctoral student at Walden University. You may already know the researcher as an IT trainer, but this study is separate from that role.

Background Information:
The purpose of this study is to determine the impact of the technology intervention that was deployed to rural schools, on student achievement in Nigeria. It would help determine if the holistic technology solutions met teachers' needs, as well as have a meaningful impact on learners.

Procedures:
If you agree to be in this study, you will be asked to:
Fill an online survey that measures the level of technology implementation. The survey would take about 30 minutes to be completed.

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at the secondary education board or your school will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as time spent in filling the form online or slow internet connection. Being in this study would not pose risk to your safety or wellbeing.

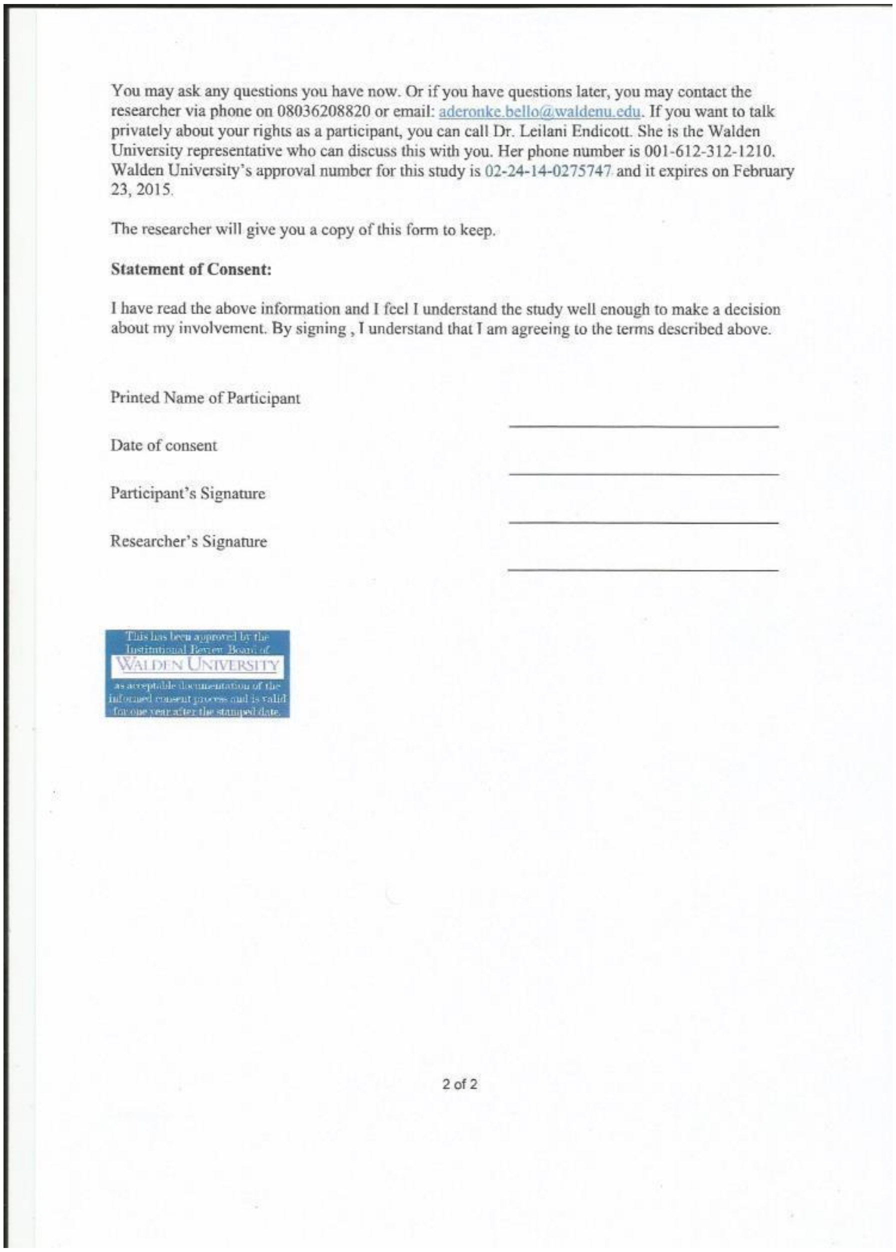
The potential benefits of this study to you as an individual are the ability to determine the technology interventions that have met your needs as a teacher, the impact on your students' academic achievement and area of improvement on the effective technology integration into classroom instruction in your profession.

Payment:
You will be entitled to a N500 recharge card after successful completion of the online survey.

Privacy:
Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by password protection and locks. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:

1 of 2



You may ask any questions you have now. Or if you have questions later, you may contact the researcher via phone on 08036208820 or email: aderonke.bello@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 001-612-312-1210. Walden University's approval number for this study is 02-24-14-0275747 and it expires on February 23, 2015.

The researcher will give you a copy of this form to keep.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By signing , I understand that I am agreeing to the terms described above.

Printed Name of Participant ______________________________

Date of consent ______________________________

Participant's Signature ______________________________

Researcher's Signature ______________________________

This has been approved by the Institutional Review Board of WALDEN UNIVERSITY as acceptable documentation of the informed consent process and is valid for one year after the stamped date.

Curriculum Vitae

INTRODUCTION

Mrs. Aderonke Bello has over 27 years of experience in both IT and Education sectors. She is the managing director of Innovative Technology Literacy Services Limited; an ICT in education consulting firm with a mission of reaching out to all learners irrespective of culture, ethnicity, race, and gender through technology integration into their everyday activities to earn a better living. Over the years, she has served in the following strategic positions: deputy national coordinator, SchoolNet Nigeria, project director for the Intel Teach Program, coordinator of Microsoft Partners in Learning program, coordinator of IEARN and Multichoice Resource Center programs among several others. She coordinated various teams that have set up over 250 computer laboratories in secondary schools across the nation. She has served in several committees at the national level on issues relating to ICT, which includes among others the development of the National ICT in Education policy for Nigeria. A seasoned and professional IT trainer has actively participated in training teachers on the integration of technology into classroom instruction. She coordinates and manages ICT related programs for schools. Her prowess for training of teachers was not limited to Nigeria; she has trained teachers in Ghana, Equatorial Guinea, Kenya, Gambia, Liberia, and Sierra Leone just to mention a few. She has acted in the capacity of a judge at several national and international competitions. She is on the board of some organizations as a director.

PERSONAL INFORMATION

Surname:	Bello
Other names:	Aderonke Abosede
Sex:	Female
Nationality:	Nigerian

EDUCATIONAL QUALIFICATIONS

INSTITUTIONS	YEAR	COURSE OF STUDY	DEGREE
Walden University Minneapolis, USA	2014	Educational Technology	Doctor of Philosophy
Abilene Christian University, Abilene, Texas, USA	2010	Curriculum and Instruction Technology	Master of Education
University of Lagos, Akoka, Lagos, Nigeria	1993	Computer Science	Master of Science
University of Lagos, Akoka, Lagos, Nigeria	1987	Computer Science	Bachelor of Science
Redeemed Christian	1999	Theology	Post Graduate

Bible College, Lagos Nigeria	Diploma

PROFESSIONAL QUALIFICATIONS AND CERTIFICATIONS

INSTITUTIONS/PROFESSIONAL BODIES	YEAR	PROGRAM DESCRIPTION
Harvard Graduate School of Education, Massachusetts, USA	2011	Systemic Change for Student Success
Abilene Christian University, Abilene, Texas, USA	2010	Conflict Resolution & Mediation
Harvard Graduate School of Education, Massachusetts, USA	2010	Universal Design Learning
IEARN Master Trainer	2004	Productivity tools and Collaborative Learning
Microsoft Certified Professional	2002	System Administration and Software Installation

EMPLOYMENT HISTORY

POSITION/ORGANIZATION/YEAR
Managing Director **Innovative Technology Literacy Services Limited, Abuja** **2012 - present**
Deputy National Coordinator **SchoolNet Nigeria, Abuja** **2004 - 2012**
Program Officer (Teacher Development) **SchoolNet Nigeria, Abuja** **2003 - 2004**
ICT Consultant **Federal Ministry of Information, Abuja** **2001 - 2002**
Executive Director **Roattabel Nigeria Limited** **1998 - 2003**
Software Development and Training Manager **Inlaks Computers Limited** **1995 - 1998**
Head of Software Unit **Inlaks Computers Limited** **1993 – 1995**

Senior Systems Analyst
Nigerian Ports Authority, Lagos
1993 - 1993
Principal Programmer
Royal Exchange Assurance, Lagos
1991 - 1993
Programmer
Royal Exchange Assurance, Lagos
1989 - 1991
Training Officer
Computer Links Limited
1988 - 1989
Graduate Assistant
Anambra State University of Technology (Now Enugu), Enugu State
1987 - 1988

LANGUAGES

English & Yoruba - fluent in reading, writing and speaking

AWARD/HONOR

Distinguished Citizenship Award	2009

PROFESSIONAL AFFILIATIONS/ASSOCIATIONS

Member	Association for Educational Communications and Technology, USA
Member	Computer Professionals of Nigeria, Nigeria
Member	International Education and Resource Network, USA
Fellow	Nigeria Computer Society, Nigeria
Member	Nigerian Women in Information Technology

WORKSHOPS/CONFERENCES ATTENDED

- Annual e-LEARNING Conference in African countries
- Annual ICT conferences (CPN, AECT and NCS among others)
- Several ICT-related workshops at a global level
- Organized the first ICT in education conference in Nigeria
- Annual Microsoft Worldwide Innovative Education Forum around the globe

SOME OF THE PROJECTS UNDERTAKEN

- Curriculum mapping for Computer Studies Education (College of Education)
- ICT Entrepreneurship training for technical schools
- Implementation of ICT training for Health workers
- Localization of Intel Teach Program training materials
- Localization of Multichoice Resource Center course materials

- Development of several training materials for teachers on use of ICT in Education
- Implementation of DigiNet laboratories in 89 schools
- Implementation of MTNschoolsconnect laboratories in 62 schools
- Implementation of Multichoice Resource Center laboratories in 300 schools
- Have handled over 100 training sessions in the last five years
- Organized several national award programs for teachers

EXTRA CURRICULA ACTIVITIES

- Vice-President, Nigerian Women in Information Technology
- Council member, Computer Professionals of Nigeria
- Chairperson, Board of Trustees, Technology Literacy Foundation
- Ex-officio, Nigeria Computer Society
- Region 10 Coordinator, Sunday school dept., Redeemed Christian Church of God
- Former Director, Linuxchix Africa, South Africa.

INTERESTS

- Social work
- Pastoral work/Counseling
- Game-based learning
- Travelling