Pre-Service Students Perception on their Skills and Access to the Use of ICT in Teaching and Learning of Science Subjects

Dr. Ronke Ogunmakin,
Department of Educational Foundation,
Faculty of Education,
National Open University of Nigeria,
14/16 Ahmadu Bello Way,
Victoria Island, Lagos,
e-mail: tanrong@yahoo.com

Abstract
This study investigated the ways through which pre-service science and mathematics teachers at College of Education; Ondo could acquire competencies for integrating technology, pedagogy and content in Teaching. Specifically the study investigated the pre-service teachers' ICT integration competencies; practices that could be effective in enhancing pre-service science and mathematics teachers' competency in integrating technology, pedagogy and content; as well as the impact of those practices in the development of pre-service teachers' technological pedagogical content knowledge. An action research approach was employed in the study, employing the pre and post-intervention assessment of pre-service teachers' perception on technology, pedagogy and content. Planed interventions were carried out during the study, to enable pre-service teachers to identify areas of weaknesses in their technology integration competencies, and propose alternative approaches for addressing the identified weaknesses. from Students' questionnaire, analysis of knowledge change after the intervention, showed a significant difference between pre-intervention and post intervention pre-service Teachers' Pedagogical and Content Knowledge (TPACK). It is therefore concluded that, the adoption of hands-on activities that uses technology and involve teachers in planning of what to teach, how to teach and with what technology to teach, and provision of an opportunity to share this plan with colleagues, can make a significant change in the development of TPACK among pre-service teachers

Key words*:* Pre-Service, Perception, Skill, Access, ICT, Teaching, Learning

Introduction

The idea of integrated knowledge of teachers is not new in teacher education. Discussion about the interplay of different components of knowledge to enhance teaching competencies started as far back as1980s. One of the pioneers of the integrated knowledge for teachers was Shulman (1986) who focused on the importance of treating pedagogy and content knowledge as basic requirement for teacher training. Since the presentation of the idea of pedagogical content knowledge (PCK) as a basis for teachers to deliver the required learning outcomes, there existed quietness until the early 1990s when the idea of technology started to be introduced in schools. Marcinkiewicz, (1993), in his paper, "factors influencing computer use in the classroom", described how easily or difficult could computer technology

be integrated in teaching (cf. Voogt, 1993). Also International Society for Technology in Education (ISTE) (1998) developed the so called National Educational technology Standards for teachers and students. In 2000, Roblyer reviewed those standards and provided a description on how best technology can be integrated in teaching to offer pleasing learning outcomes. Most of the studies done from 1990s to 2000 had more focus on the overall use of technology in education. These studies put less attention on the relationship between technology and the previously identified competencies for teachers on pedagogical content knowledge.

In 2005, two publications were made on the integration of pedagogy, content and technology. Niess (2005) tried to make a link between pedagogical content knowledge based on Shulmans idea, and technological knowledge, and described how the three components can interact to form the teachers' pedagogical and content knowledge (TPACK). Mishra & Koehler (2005) also came up with the idea of TPACK as a core of good teaching with technology being as well built on the idea of Shulman. However the difference between the concepts put forward by Mishra &Koeler and that proposed by Niess, is that while Mishra & Koehler consider technology as everything that can support learning (pencil, chalkboard, analogy and digital equipment), Niess discussed technology in reference to analogy and digital equipment alone. In addition, Mishra & Koehler (2005) discussed technology integration in the general education while Niess (2005) focused on a specific subject (Mathematics). But both had a common idea of developing teachers' knowledge on technology, pedagogy and content as important attributes for effective teaching with technology. It is Mishra & Koehler (2006, 2009) who extended TPCK to TPACK and added the context as one of the important components in thinking of the integration between technology, pedagogy and content (cf.Harris, Mishra & Koehler, 2009). The context may refer to grade level of the students, schools or a class in which the technology is used. According to Koehler & Mishra (2009), teachers need to know what and how they apply technology in the unique contexts within their classrooms. A teacher is urged to also develop an ability to flexibly navigate the spaces defined by the three elements; content, pedagogy, and technology and the complex interactions among these elements in specific contexts (cf. Koehler & Mishra, 2009; Voogt, Tilya& van den Akker, 2009). Thus, technology integration programs should focus on the development of teachers' knowledge of integrating technology, pedagogy and content.

There is a growing body of research Niess, Ronau,., Shafer, Driskell, Harper, Johnston, Browning, Özgün-Koca, & Kersaint, (2009), which indicates that, technologies, including graphing, and some computer based mathematics learning programs can enhance students' conceptual and procedural knowledge of mathematics (Özgün-Koca, Meagher & Edwards, 2010; Webb, 2008). When teachers decide whether and how to use technology in their teaching, they need to consider the science or mathematics content that they will teach, the technology that they will use, and the pedagogical methods that they will employ" (Ozgun-Koca et al, 2010). This requires teachers to reflect on the critical relationships between content, technology and pedagogy (Koehler & Mishra, 2009; Niess et al, 2009).

However, the ability of teachers to establish the relationship between content, pedagogy and technology, depends largely on the way they were taught to integrate technology in teaching. (Doering, Hughes & Huffman, 2003).). In the late 1980s and early 1990s, an examination of teachers' science and mathematics PCK, revealed an overarching conception that teachers' beliefs about how to teach science and mathematics generally were aligned with how they learned science and mathematics (Beyerbach 2001; Niess et al 2009). Teachers who learned to solve science and mathematics problems through the use of graphing calculators, spreadsheets and some learning software were among the few who embraced the use of those tools in teaching science and mathematics (Niess,et al 2009).

Niess et al 2009, see the low uptake of technology by teachers as being mostly associated with the poor knowledge of science and mathematics, instructional strategies and representations of a particular science or mathematical topics supported by digital technologies to demonstration, verification, and drill and practice (cf. Koehler & Mishra, 2009; Webb, 2008). Also their knowledge of students 'understandings, thinking, and learning in mathematics held to the importance of mastery of skills with paper and pencil prior to using modern digital technologies was found to hinder the uptake of technology by teachers (Kastberg & Leatham, 2005, cited in Niess et al, 2009). In their study, Niess et al 2009 found that, access to technology without necessary knowledge of related science and mathematics curriculum materials did not encourage teachers to incorporate the technology in their classroom instruction. Thus, a reason why Mishra & Koehler (2009) insist on the need for teachers to know, not only the subject matter they teach but also the manner in which the subject matter can be changed by the application of technology. Thus, the need for science and mathematics teachers to participate in the training that cultivate the knowledge of various technologies as they are used in teaching and learning settings, and conversely, knowing how science and mathematics teaching might change as the result of using particular technologies seem to be inevitable.

The present-day students are essentially in a different situation from previous generations, with the large majority of students having ICT skills that are of a different type from their teachers' (and parents'), often better and wider; even the time spent using a computer efficiently supports the improvement of ICT skills. It is obvious that for the younger generation using ICT is easy and ordinary, characterizing a life-style consisting of the functions of both working and learning, as well as functions of leisure time, like social media, gaming or uploading and listening to music, Perderson (2006). There is a cultural gap between students and teachers in terms of the digital world, and, as mentioned in Pedersen (2006), very few teachers know what is going on in the digital world of a 13-year-old student. This differentiation and students' ICT competence are challenges for teachers because the digital skills are nowadays basic skills, such as reading and writing. Student's computer skills were captured by rating themselves using a four-tier scale from None-Expert. Most Physics students had no ICT skills from their previous schools. This is an indicator that students in secondary school have little knowledge of computers in their lower classes.

At present, researchers (cf. LeBaron, McDonough& Robinson, 2009; Kirschner, Wubbels& Brekelmans, 2008; Mcdougall, 2008) are questioning the efficacy of teacher preparation for successful use of technology in schools and classrooms. LeBaron (2009) believe that the quality of teaching with technology depends in some significance measures on the way teachers were taught to work with technology. There are still some challenges on how teachers are trained to integrate technology with pedagogy and content. Studies by Pope, Hare, & Howard (2002) and Selinger (2001) cited in Angeli (2005) found that pre-service teacher education does not adequately prepare future teachers to teach with technology. In most teachers training colleges the concept of TPACK is still new, thus pre-service teachers are still learning technology, pedagogy and content as independent subjects; not as integrated knowledge.

This study was intended to investigate ways through which pre-service science and mathematics teachers can acquire ICT competencies to enable them integrate technology, pedagogy and content in their teaching. Its first objective was to assess the pre-service teachers' competencies in ICT and its integration with content and pedagogy. Findings revealed that pre-service teachers were less competent in technology use and its integration with content and pedagogy. This incompetency was found to be caused by the limited use of technology in learning and accessibility to technological tools. Ezeife, A. N. (2003) reported that teacher training institutions have limited supply of technological tools, which makes it difficult for pre-service teachers to practice the use of technology in their learning. It was also reported that pre-service teachers had no opportunity to learn technology integration approaches from their instructors. Borko (2004) reported that college instructors are not integrating technology in the classroom because they are as well incompetent in using technology to facilitate teaching. Thus, the pre-service teachers' incompetency in technology integration was partly caused by the way they were taught by their teachers while on training. This led to a limited technological knowledge, technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge, among pre-service teachers.

An analysis of practices that can enhance pre-service science and mathematics teachers' competency in integrating technology with pedagogy and content, revealed that the more pre-service teachers were engaged in hands on activities that reflects the real teaching environment, the more they learned about technology integration in teaching. Pre-service teachers' participation in the process of designing and presenting a lesson in the classroom in a similar way as the real teaching is done, has been found to enhance competency in various aspects of technology integration and develop confidence of using technology in teaching (Collis & Moonen 2001)

Purpose of the Study

The overall purpose of this study was to investigate students' perception on their skills, and use of computer related technology by teachers of science subjects who were

recent college graduates. The main foci of the research were: descriptions of teacher pre-service experiences, teacher computer proficiency, frequency of computer use, interest in using computer-related technology, and learning outcomes

Research Questions

This study sought to address the following questions.

l. How do Pre-service teachers rate their own proficiency in using various computer-related technologies?

2. How do Pre-service teachers have access to various computer-related technologies?

3. What are the perceptions of Pre-service teachers on how the use of computer-related technologies enhances the teaching of science subjects?

Methodology

The study adopted survey research design, the study population covers sixty (60) respondents comprising of staff and students in Physics, Chemistry and Mathematics Department at Adeyemi College of Education. The study population from which the sample was drawn for the study consists of three departments using judgmental sampling method and questionnaires were administered. The total number of staff in the three departments is 458. However, 60 science students were randomly selected from the three departments. A research instrument titled: Pre Service students use of ICT in Teaching and Learning of Science Subjects in Secondary Schools was constructed to provide relevant information on the present state of ICT facilities in secondary schools. The instrument has two sections comprising personal information and question sections. It is made up of Questions with responses arranged in accordance with the four points Likert scale.The items on the questionnaire were subjected to scrutiny using experts in educational measurement and evaluation/test items to ensure validity. Their expertise advice and suggestions were carefully incorporated in the final copy of the questionnaire that was later trial tested. The instrument was further subjected to a further critiquing at a training of experts on ICT held at NIEPA ICT department and necessary corrections were made before the field work. The reliability of the research instrument was determined using test re-test method for a pilot study in two secondary schools from the twelve sampled schools. The instrument was administered to 10 permanent science teachers and 10 neutral students twice at interval of two weeks. This is done to eliminate bias that may arise from pre information. The coefficient of reliability of 0.85 was obtained which was considered high enough for reliability.

The researcher personally visited the selected secondary schools in company of trained research assistants during data collection to observe pre service teachers on teaching practice. Regular teachers were also interacted with during these visits. This was done in order to make it possible to complete all aspects of ICT usage in schools' analysis format and Observation Inventories personally by the researcher and the research assistants as well as to ensure that the instruments get to the right persons at the right time. This method is preferred because the study involves first hand observation of ICT resources available in pre Service

Teacher Training. Apart from this, personal visitation by the researcher will make it possible to get more accurate data than collecting information by other means. In addition, this method will facilitate the high rates of return of questionnaires. In all, about 60 questionnaires were distributed while 60 were returned. The percentage returned is 100%

Data Analysis

The analysis of data collection for this study involves the use of both descriptive and inferential statistics. Descriptive analysis of data was carried out using simple percentages, while hypothesis formulated were tested using t-test analysis. All the hypotheses would be tested at 0.05 level of significance. Gender distribution is as follows: 24 females representing 40 % of the respondents and 36 males representing 60%. This analysis indicates that the science students in Ondo West, are mostly dominated by male which underscores field, just as most scientific and technical disciplines, is predominated by male.

Research Question 1. How do Pre-service teachers rate their own proficiency in using various computer-related technologies?

Table 1. Frequency count on pre-service teachers' level of proficiency in the use of various computer-related technologies

Skills	None	Freq	Basic	Freq	Average	Freq	Expert	Freq
Word processing	1	1.8	15	26.3	27	47.4	14	24.6
Spreadsheets	18	32.1	10	17.9	23	41.1	5	8.9
Databases	8	14.5	18	32.7	24	43.6	5	9.1
Presentation tools	10	18.5	11	20.4	27	50.0	6	11.1
Internet	9	15.3	9	15.3	21	35.6	20	33.9
Basic Maintenance	5	8.9	15	26.8	23	41.1	13	23.2
Use of Desktop	13	23.2	12	21.4	19	33.9	12	21.4

Table 1, shows the responses of the students on basic ICT skills, 24.6%, 33.9% and 23.2% of the students claimed to have expert skills in word processing, Internet and basic computer maintenance without relying on the teacher or computer specialists. The table also revealed that, they had no skills in spreadsheets, databases, presentations tool and publishing software such as, MS-publisher, Corel draw and adobe page maker. In contrary, there is an even distribution of students across the categories ranging from no skills to those claiming expertise on the use of internet. This analysis implies that the present-day students are essentially in a different situation from previous generations, with the large majority of students having ICT skills that are of a different type from their teachers' (and parents'), often better and wider; even the time spent using a computer efficiently supports the improvement of ICT skills. It is obvious that for the younger generation using ICT is easy and ordinary, characterizing a life-style consisting of the functions of both working and learning, as well as functions of leisure time, like social media, gaming or uploading and

listening to music, this in turn will help in inculcating the use of ICT Pedagogies in teaching and learning of science subjects in Ondo West.

Research Question 2. How do Pre-service Teachers have access to various computer-related technologies

Table 2: Frequency count and percentage ofPre-service Teachers access to various computer-related technologies.

Place of access	Frequency	Total frequency	Percentage
Computer laboratory	Never	20	33.3
	Sometimes	23	38.3
	Always	13	21.7
	Not Sure	4	6.7
Classroom	Never	29	51.8
	Sometimes	8	14.3
	Always	17	30.4
	Not Sure	2	3.6
Cyber Centre	Never	29	52.7
	Sometimes	17	30.9
	Always	4	7.3
	Not Sure	5	9.1
Library	Never	21	38.2
	Sometimes	15	27.3
	Always	17	30.9
	Not Sure	2	3.6
Staffroom	Never	21	38.2
	Sometimes	15	27.3
	Always	17	30.9
	Not Sure	2	3.6
Home	Never	20	36.4
	Sometimes	21	38.2
	Always	14	25.5
	Not Sure	0	0

Table 2, shows student's frequency of access to computers in school and outside school. This was important in identifying the student's capabilities in the use of computers in teaching and learning of sciences. Student's access to computers was based on a four –tier nominal scale ranging from never to not sure. only 30.4% of students indicated that they have access to school computers in their class room always, 14.3% sometimes and 51.8% have never accessed computer. The students always had access to computer were from the schools that have computers in the computer laboratories and have timetables. Moreover, these students were determined that they were taking computer as a subject therefore they had more time in the computer laboratory than others. Students who had access to computers at cyber center were only 7.3% and those who had never had access to computers were 52.7%. This shows

that, apart from the school students have limited access to computers elsewhere. There were very few students who had access to computers at home and cyber. It is clear that only a small percentage of students that have no access to computers.

Research Question 3. What is the perceptions of Pre-service teachers on how the use of the computer-related technologies can enhance the teaching of science subjects

Table 3. Mean and Standard Deviation on Students views on how ICT enhances teaching and learning of Sciences

Benefits of ICT	Mean	SD
ICT enhances learning of science	3.11	0.94
ICT helps to meet various needs of the Science	2.95	0.99
ICT helps in research and Problem solving	3.15	0.94
ICT use ICT makes the lesson enjoyable	3.25	0.84

Table 3, shows that all the benefits of ICT in teaching and learning of sciences highlighted on a four scale rating scale were far above the mean average of 2.5. In general, most of the students agreed that use of ICTs makes them more effective in their learning, i.e. ICT enhances effective learning by making them more organized and meeting various needs of syllabus and make it enjoyable to them. Therefore, it appears that students' perceptions toward ICTs in learning science oriented courses are encouraging, where most of them showed positive perception on computer use in teaching and instruction. It is believed that the students can see the value of the ICTs in enhancing teaching and learning, and they are positive towards further integration of technologies into classroom instruction. The students pointed out that a successful science teaching requires the use of laboratory work during which they are able to link theoretical understanding and a practical activity. Thus, the students and their teachers as well have the opportunity to evaluate and identify possible misconceptions or enhanced conceptual understanding.

Discussion of the Findings

The overall focus of the study was on how pre-service science and mathematics teachers can acquire competencies for integrating technology pedagogy and content in their teaching. . Findings from the study revealed a limited technological knowledge among pre-service teachers also limited knowledge of integrating technology, pedagogy and content, thus poor technological pedagogical content knowledge (TPACK) as they go about their training. Although pre-service teachers had the basic ICT knowledge, they could not integrate this knowledge with content and pedagogical knowledge. The observed incompetency of pre-service teachers in technology and its integration with pedagogy and content is attributed to ill-structure and components of the ICT and methodological courses offered to pre-service teachers at the college. It is also attributed to Instructors' incompetency in integrating technology in teaching which causes pre-service teacher to miss the model (an example of a technology integrated learning), as well as the shortage of technological tools.

Furthermore, ICT courses offered at the college doesn't provide an opportunity for pre-service teachers to experience the integration of technology, pedagogy and content. The college offers courses on methodology for teaching different disciplines (physics, chemistry, mathematics etc) also a course on ICT in science and mathematics education. The two courses are taught separately, there is no opportunity for a learner to experience the combination of ICT, science or mathematics and pedagogy. Absence of the opportunity to experience the integration of technology, pedagogy and content, leads to inability of the pre-service teachers to practice the integration in teaching. According to UNESCO (2008b) pre-service teachers' learning of technology integration in teaching should take into account the curriculum goals (subject matter), pedagogy and ICT. But, pre-service teachers at DUCE miss the opportunity to learn and practice the integration of technology pedagogy and content also they miss the model for their technologyintegration because even their instructors are not integrating these components in the classroom.

Many studies (cf. Beyerbach et al, 2001; LeBaron et al, 2009) report that the quality of teaching with technology depends significantly on the way teachers were taught with technology. The impact of what they learned from the college depends on the extent to which pre-service teachers themselves learn with technology (LeBaron et al, 2009; UNESCO, 2008a). Since pre-service teachers had a very limited opportunity to learn with technology and their instructors were not a replica to them in teaching with technology; it was obvious that they could not teach with technology, as it was observed during the microteaching session .Given the fact that, pre-service teachers had limited opportunity to develop their technological competencies, this study introduced different learning activities which were intended at developing pre-service teachers' competencies in integrating technology, pedagogy and content and thus developing TPACK.

This study has established that, the process of planning a lesson, presenting to colleagues, getting critiques from colleagues and re-planning again in a cyclic way is effective in enhancing pre-service teachers' competency. The findings of this study agree with those of Somekh, (2008) who found that this study, based on a survey of recent graduates of Iowa State University who are teachers in Iowa, examined teachers' computer use and attitude toward computers, as well as their pre-service experiences.

The respondents' computer use and their attitude toward computer-related technology were very similar as well as many national surveys. They were somewhat interested in using technology, but they rate their proficiency low. Although the teachers indicated that computer-related technologies are important to secondary education, they reported they used computers infrequently. In regards to teacher pre-service programs, most of the teachers believed the computer-specific course was important, with many suggesting such a course should be required. In addition, when asked to rate their teacher pre-service preparation for using computer-related technologies in schools

Another evolutionary change will be the use of multimedia training techniques to deliver higher volumes of training and also to improve pedagogic efficiency in line with the suggestions of Dominique & Fereirra, (2008). The driving force for this will be the

increasingly rapid technology-based training will experience the fastest technology change and globalization.

Nigeria, like other developing countries have become aware of the invaluable role of ICT in fostering all round development especially in the Education industry. Despite the awareness, the nation has not been able to make significant progress in improving education through this medium evidenced by different research studies. The benefit of ICT usage and its application to teaching and learning is evident but ICT infusion into education in Nigerian Higher institutions is rather low. Studies by Ferrini-Mundy & Breaux (2008), attributed the slow pace of ICT infusion to several challenges posed in the integration of ICT into education. The challenges enumerated includes:

- Limited ICT infrastructure and facilities
- Frequent electricity interruption
- Low internet connectivity
- Limited access to ICT facilities
- Limited ICT skills among teachers
- Lack of content developers
- Lack of Technical Support Specialists
- Lack of specific educational policy and planning
- Non-integration into school curriculum
- Low levels of government funding

Conclusion

It has been common practice for years to view the use of learning resources as an essential part of teaching and learning processes .The entrance of Information and Communication Technologies into the consumer market is bringing about new opportunities for utilizing the highly interactive and mobile digital resources in education. These technologies introduced into higher education system are however bound to face some challenges and expectations. There is therefore the need for proper planning, research and evaluation and capacity development for academics in higher education in Nigeria for them to take full advantage of the benefits of utilizing ICT in the teaching learning process .It is therefore the responsibility of academic planners in our higher educational institutions as well as the National Universities Commission to invest in the latest Education and Communication technologies to enhance the teaching learning process and through this Nigerian Vision 2020 could be achieved.

Recommendations:

1. Pre-service teachers should be adequately trained to attain proficiency in using various computer-related technologies
2. University administrators should provide ICT infrastructural facilities to ensure that pre-service teachers have access to various computer-related technologies

3. Lecturers in charge of pre-service teachers should expose them to the use of the computer-related technologies in order to enhance their teaching of science subjects
4. A review of the National Policy on IT needs to be reviewed to include specific guidelines on Education.
5. The Federal government needs to increase the budgetary allocations for ICT in teacher training institutions. Teacher training institutions should train Pre service Teachers to be computer literate and to acquire mastery on how ICT can be infused into learning.
6. University administrators should provide ICT infrastructural facilities to ensure that both lecturers and students have access to and adequate equipment to work with.
7. Research should be conducted nationally on the status of ICTs in Universities to assess the progress periodically.

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