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ASSESSMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY COMPETENCIES OF FINAL YEAR MATHEMATICS AND SCIENCE PRE-SERVICE TEACHERS IN TERTIARY INSTITUTIONS

TOINPERE MERCY FREDERICK-JONAH PhD.
Department of Science Education, Niger Delta University,
Wilberforce Island, Bayelsa State

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Abstract

The study assessed proficiency with modern information and communication technologies among final year pre-service mathematics and science teachers in tertiary institutions in Bayelsa State. It focused on the social and ethical use of ICT. The research employed a descriptive survey methodology and a simple random sampling method was used to select 168 student teachers. The study was guided by four research questions. A 4-point Likert-type scale twenty-two-item self-developed questionnaire named "Assessment of Social and Ethical ICT Competencies of Pre-Service Mathematics and Science Teachers Questionnaire" (ASEICPMSTQ) was utilized for data collection. It had a reliability value of 0.82 using Cronbach Alpha. Mean and standard deviation was used to answer the research questions, with a criterion mean of 2.5. The study found among others that the final year student-teachers social and ethical ICT competencies were moderately high. The study recommended among others that education programs should be designed in such a way that it builds the teachers' ICT competency in all four domains.

Introduction

A wide variety of technical techniques and resources derived from science that are utilized in the development, storage, and administration of information is known as ICT (Information and Communication Technology). ICT in education relates to the direct use of ICT in teaching and learning activities (Voogt & Tondeur, 2015).

It is possible to employ a range of gadgets and technologies in the classroom as teaching materials while using ICT in

education. Such gadgets include; computers, projectors, instructional television, interactive whiteboard, etc. The globe nowadays is regarded as a global village owing to the usage of ICT in a wide range of educational, political, economic, and social contexts (Ajayi, 2008). Knowledge of ICT is now applicable in almost all situations, to produce more effective results. As such, it becomes necessary for teachers to equip and acquaint themselves with technological advancements and changes induced by technology (Noor-Ul-Amin, 2013; Al-Rahmi, Alzahrani, Yahaya & Kamin, 2020).

ICT while playing a significant role in our everyday life and future, is imbued with the potential to influence and alter the nature and scope of education including where and how teaching and learning take place as well as the role of students and teachers in the educational process (Henderson, 2020). The application of information and communication technology (ICT) to education has been noted to possess several benefits to the teaching and learning process. Livingstone (2012), states that it helps in facilitating students' learning and improves teaching in education. Some of the benefits derivable from applying ICT in education include; the promotion of active learning, enhancement of knowledge retention, motivation, and empowerment for both teachers and learners in any instructional process, etc. Applying ICT in the instructional process also enhances investigation and experimentation with instructional ideas (Flugested, 2011). Thus, the nature of teaching and learning has changed considerably due to the availability of ICT and will only continue to change.

The desire to enhance the teaching and learning environment prompted the growth of technology in a broad variety of fields, including educational institutions (Al-Qahtani & Higgins, 2013; Philip, Oluwagbemi & Oluwaranti, 2010). Teaching and learning should change away from a traditional teacher-centered approach to one that emphasizes active participation by students, which is why ICT was used in education (Voogt, 2010; Voogt et al., 2013).

To achieve efficient teaching in the classroom, the teacher is typically required to have solid content knowledge not just about their topic but also about the different methods of delivering their teachings (pedagogical knowledge). According to Fu (2013), ICT may be utilized to supplement the teacher's material and pedagogical skills for successful educational practices in the classroom. Teachers in the contemporary classroom must also be exposed to ICTs regularly to assess and pick relevant learning materials.

Given the significance of ICT, it has become a need for instructors to be proficient in its use. Teachers' digital abilities have long evolved beyond being able to utilize word processing and spreadsheet applications (Buabeng-Andoh, 2012). To be a 21st-century teacher, one must be able to utilize cloud services and networking solutions, social networking sites, picture editing tools, presentation software, and overall multimedia tools. The necessity of these skills/ICT competencies by teachers is more prevalent in recent years, especially with the rapid growth and promotion of virtual learning as an educational outcome and solution during the Covid-19 pandemic.

A successful teacher must be prepared to provide children with the benefits that technology may provide. The United Nations Educational, Scientific and

Cultural Organisation (UNESCO, 2011) states that to teach effectively in both physical and virtual classrooms, teachers must have access to a wide range of technology tools and capabilities, as well as the ability to combine them with their subject matter expertise. UNESCO (2011) recognized many areas of teacher professional development competency criteria, including technological literacy, knowledge enrichment, and knowledge production.

The Commission on Information and Communication Technology [CICT] (2012) identified many metrics to measure a teacher's competence and ICT expertise in an educational context. These competency indicators were roughly classified into four divisions or domains: technological operations and concepts, social and ethical, instructional, and professional domains. The different domains of ICT competencies as stated by CICT (2012) are discussed below;Technology operations and concepts refer to competencies of the teacher related to understanding and usage of technical operations and concepts, directed towards increased productivity using numerous ICT devices like computer and communication services, as well as applications available online and offline. It includes the competency of the teacher to demonstrate knowledge and skills in basic computer operations, use of necessary and appropriate tools for production, effective usage of the internet, and its resources to support the learning environment (Las, 2017).

The social and ethical domain, on the other hand, focuses on skills connected to social, ethical, legal, and human concerns and connections with the community. It involves knowledge and understanding of legal and ethical practices in the use of ICT and conformity to those legal standards in areas like software licensing. ICT is associated with a host of ethical standards for its proper usage, as it changes the instrumentation of human actions. The main issues of this ICT domain include inversion of corporate and individual piracy, people rights, intellectual rights, property rights, accountability, and presentation of values due to the use of ICT (Olabimitan, Yongo & Unar, 2021).

The pedagogical domain of competencies deals with the use of modern technologies in the diverse aspect of the instruction process like designing a learning environment that supports the use of technology and integration of ICT into these environments to enhance learning outcomes while promoting students' creativity and higher-order thinking skills as it relates to the use of ICT to carry out tasks and communicate results. Research, invention, and cooperation are all included in what is referred to as the professional domain. When teachers are actively involved in discovering new and innovative technologies, they are constantly assessing their use of ICT in the classroom and the profession as a whole, as well as their students' use of ICT. To do this, technology in education must be improved, as well as in other fields (CICT, 2012).

While there have been several studies exploring teachers' and students' competencies with ICT, most of them focused more on the technological aspects, and the social and ethical domain is largely ignored. This is an issue due to the rise of unethical usage of the internet and ICT gadgets in recent years. Some studies assessing teachers' competency in the

social and ethical domain are discussed below.

For instance, Guilo and Guilo (2017) conducted a study assessing the ICT competencies of teachers and students at Batangas State University. They stated that both instructors and students had a high level of competence in the four areas of the National ICT competency requirements. The study reported that teachers are greatly proficient in the social/ethical domain of the ICT standard. Puno (2021) in his study explored the information and communication technology needs of teachers. The study reported that the overall ICT competency of the teachers based on the National ICT Competency Standards (NICS) was average, but their level of competency for social and ethical domains was high. A little variation from this is the study by Ariaz (2018). ICT coordinators in secondary schools were found to have average competencies in all four categories, including the social and ethical standards.

Marcial (2017), is one study that focused solely on the social and ethical competency among teachers. Teachers' social and ethical competence was found to be high, according to the survey, but while the respondents are competent in tasks connected to the domain, they rarely experience the need for applying that competency, as there is no effect on the integration of the ICT tools to the educational setting. It is worthy to note that none of the studies cited above were conducted in Nigeria.

This study is supported by the competency theory of McClelland, first published in his work in 1973. The theory states that an individuals' competency in any field consists of several variables with the major area composed of not just their knowledge but also their skills and attitudes and that classical intelligence and ability tests are usually insufficient to determine true competency and future success (Skinjaric, 2022; Kopaiboon, Reungtrakul, & Wongwanich, 2014). This theory is relevant to this study as the social and ethical ICT competency under review can be linked to the attitude variable of competency in the theory.

Statement of the Problem

In today's global culture, information and communication technology (ICT) has become an essential aspect of everyday life. Its applicability has been promoted to a wide range of areas and domains including the educational setting, due to the several advantages that have been associated with its integration.

Teachers are at the center of educational innovation and thus the first stage toward the successful integration of ICT and education lies largely in the hands of the teachers. Considering this, if the teachers are not competent in the usage, the integration of ICT is doomed to fail. While there have been many studies exploring teachers' competencies with ICT, relatively few have focused on the social and ethical domain of those competencies and all of them are set in regions outside Nigeria. Thus this study was designed to explore final year mathematics and science student-teachers ICT social and ethical competencies, as a precursor to their future performance, as these individuals are set to be future instructors in the educational setting.

Research Questions

The following four research questions guided the study.;

a) To what extent do final year mathematics and science pre-service teachers understand and observe legal practice in the use of technology?
b) To what extent do final year mathematics and science pre-service teachers plan and promote a safe and sound technology-supported learning environment?
c) To what extent do final year mathematics and science pre-service teachers recognize and practice ethical use of technology at both personal and professional levels?
d) To what extent do final year mathematics and science pre-service teachers facilitate equitable access to technology that addresses learning social and cultural diversity?

Methodology

A descriptive survey method was used in this investigation. A simple random sampling technique was employed to choose one hundred and sixty-eight (168) undergraduate students from the Departments of Science Education in two tertiary institutions in Bayelsa State. A self-developed twenty-two-item questionnaire titled "Assessment of Social and Ethical ICT Competencies of Pre-Service Mathematics and Science Teachers Questionnaire" (ASEICPMSTQ) was used to collect data. The instrument was a 4-point Likert scale type of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), with scores of 4, 3, 2, and 1 respectively. The instrument was face and content validated by experts. The instrument had a reliability value of 0.82 using Cronbach Alpha. Mean and standard deviation was utilized to answer the research questions and a cut-off point of 2.50 was employed as a decision rule.

Results

Research Question One

To what extent do final year mathematics and science pre-service teachers understand and observe legal practice in the use of technology?

Table 1

Summary of Mean and Standard Deviation Scores Showing Final Year Pre-service Teachers' Understanding and Observing of Legal Practice in the use of Technology N=168

S/N	Items	SA	A	D	SD	X	STD	Decision
1	I can understand the legal implications of software licensing.	64	61	26	17	3.02	0.97	C
2	I can identify basic concepts of intellectual property rights.	47	72	33	16	2.89	0.92	C
3	I can differentiate the copyright	47	65	43	13	2.87	0.91	C
4	I can identify the trademark and patent rights of various products.	45	66	40	17	2.83	0.94	C
	Average Mean Score and Standard Deviation					**2.90**	**0.94**	**C**

C – Competent, NC – Not Competent.

The results in Table 1 shows that the despondence are competent in understanding the legal implications of software licensing (mean X= 3.02, STD= 0.97), identifying basic concepts of intellectual property rights (mean X= 2.89,

STD=0.92), differentiating the copyright (mean X = 2.87, STD= 0.91) and identify the trademark and patent rights of various products (mean X = 2.83, STD 0.94).

From the table, the average mean score and standard deviation (mean X=2.90, STD=0.94) are above the criterion mean of 2.50. Based on this, it can be concluded that pre-service teachers show a high level of competence in understanding and observing legal practice in the use of technology.

Research Question Two:

To what extent do final year mathematics and science pre-service teachers plan and promote a safe and sound technology-supported learning environment?

Table 2

Summary of Mean and Standard Deviation Scores Showing the Extent Final Year Pre-service Teachers Plan and Promote a Safe and Sound Technology-Supported Learning Environment

N= 168

S/N	Items	SA	A	D	SD	X	STD	Decision
1	I can monitor how students use the computer specifically on software.	51	58	40	19	2.84	0.99	C
2	I can monitor how students use the computer specifically on hardware.	42	61	45	20	2.74	0.97	C
3	I can demonstrate proper handling of computer devices and the use of the application.	29	75	43	21	2.67	0.91	C
4	I can monitor how students use the computer and specifically on computer games and internet activities.	50	54	43	21	2.79	0.01	C
5	I can maintain a clean and orderly learning environment with ICT.	44	64	38	22	2.77	0.98	C
6	I can promote and implement rules and regulations on the proper use of computers accurately.	37	64	40	27	2.66	1.00	C
7	I can accurately report malfunction and problems with computer software and hardware.	42	45	49	32	2.58	1.06	C
	Average mean score and standard deviation					**2.72**	**0.99**	**C**

C – Competent NC – Not competent

The above result in Table 2 shows that final year pre-service teachers are competent in monitoring the way learners interact with software on a computer (Mean X = 2.84, STD = 0.99), monitoring how students use the computer specifically on hardware (mean X = 2.74, STD = 0.97), demonstrates proper handling of computer devices and use of the application (mean X = 2.67, STD = 0.91), monitoring how students use the computer and specifically on computer games and internet activities (mean X = 2.79, STD= 0.01), maintaining a clean and orderly learning environment with ICT (mean X = 2.77, STD = 0.98), promoting and implementing rules and regulations on the proper use of computer accurately (mean X = 2.66, STD = 1.00) and accurately report malfunction and problem with computer software and hardware (mean X=2.58, STD = 1.06).

From the table, the average mean score and standard deviation (mean X = 2.72, STD = 0.99) are above the criterion mean of 2.50. Based on this, it can be concluded that pre-service teachers are well-skilled in planning and promoting a safe and sound technology-supported learning environment.

Research Question Three:

To what extent do final year mathematics and science pre-service teachers recognize and practice ethical use of technology at both personal and professional levels?

Table 3

Summary of Mean and Standard Deviation Scores Showing Final Year Pre-service Teachers Recognize and Practice Ethical use of Technology at both Personal and Professional Levels.

N=168.

S/N	Items	SA	A	D	SD	X	STD	Decision
1	I can have the ability to detect plagiarism in students' work.	24	45	53	46	2.28	1.02	NC
2	I can properly acknowledge sources used in owned work.	31	64	45	28	2.58	0.98	C
3	I can be an anti-piracy advocate for the responsible use of various technologies.	19	58	54	37	2.35	0.95	NC
4	I can show respect for privacy and cyber etiquette.	32	62	48	26	2.60	0.97	C
5	I can show respect for the sound use of technology	47	75	33	13	2.93	0.89	C
6	I can show respect for phone etiquette	34	67	42	25	2.65	0.97	C
	Average Mean Score and Standard Deviation.				**2.57**		**0.96**	**C**

C-Competent NC- Not Competent

The above results in Table 3 shows that final year students in education are competent in properly acknowledging source used in owned work (mean X = 2.58, STD = 0.98), showing respect for privacy and cyber etiquette (mean X = 2.60, STD = 0.97), showing respect for phone etiquette (mean X = 2.65, STD = 0.97) and showing respect for sound use of technology (mean X=2.93, STD=0.89). The table also shows that the respondents are not competent in their ability to detect plagiarism in students' work (mean X =2.28, STD =1.02) and in being anti-piracy advocates for the responsible use of various technologies (mean 2.35, STD =0.95).

From the table, the average mean score and standard deviation (mean X =2.57, STD =0.96) are above the criterion mean of 2.50. Based on this, it can be concluded that final year students in education are competent in ethically using technology, both at home and in the workplace. However, the competency level is largely average

Research Question Four:

To what extent do final year mathematics and science pre-service teachers facilitate equitable access to technology that addresses learning social and cultural diversity?

Table 4

Summary of Mean and Standard Deviation Scores Showing the Extent Final Year Students in Education Facilitate Equitable Access to Technology that Addresses Learning Social and Cultural Diversity

N = 168

S/N	Items	SA	A	D	SD	X	STD	Decision
1	I can design the class activities to minimize the effect on students being left out.	35	49	61	23	2.57	0.97	C
2	I can use technology to prepare lessons and activities appropriate to the level of students' learning.	23	66	52	27	2.51	0.92	C
3	I can use technology to prepare lessons and activities appropriate to the cultural background of students.	23	71	56	18	2.59	0.86	C
4	I can minimize the effects of the digital divide by providing access to digital materials for all students.	35	60	48	25	2.63	0.98	C
5	I can use technology to prepare lessons and adapt activities using specialized hardware and software for physically disadvantaged students	29	63	41	33	2.53	1.00	C
	Average Mean Score and Standard Deviation.					**2.57**	**0.95**	**C**

C – Competent NC – Not Competent

The above results in Table 4 show that final year students in education are competent in having the ability to design class activities to minimize the effect of students being left out (mean X =2.57, STD =0.97), using technology to prepare lessons and activities appropriate to the level of the students learning (mean X =2.51, STD =0.92), using technology to prepare lessons and activities appropriate to the cultural background of students (mean X =2.59, STD =0.86), can minimize the effects of the digital divide by providing access to digital materials for all students (X = 2.63, STD = 0.98) and using technology to prepare lessons and adapt activities using specialized hardware and software for physically disadvantaged students (mean X =2.53, STD =1.00). From the table, the average mean score and standard deviation (mean X =2.57, STD =0.95) are above the criterion mean of 2.50.

Based on this, it can be concluded that final year students in education are competent in facilitating equitable access to technology that addresses learning social and cultural diversity. However, the competency level is within average.

Discussion of Findings

Findings from this study reveal that mathematics and science pre-service teachers are competent in understanding and in observing legal practice in the use of ICT. They are also skilled at planning and promoting a safe and sound technology-supported learning environment which are aspects of the social and ethical use of ICT. This is in agreement with the findings by Guilo and Guilo (2017), who reported that teachers are greatly proficient in the social and ethical domain of the ICT standards. It is also in agreement with the studies by

Puno (2021) and Marcial (2017), which reported high levels of competency for teachers in the social and ethical domains. The competency of these students in these ICT domains could be a result of the general study courses such as introduction to computer and application and introduction to educational technology which exposed the students to knowledge in the use of ICT and computers. Apart from that in this 21st century, most students have access to smartphones, computers, and digital technologies that may have enhanced their knowledge in these areas.

However, in the areas of recognizing and practicing ethical use of technology at both personal and professional levels, their competency level is within the average. The students still demonstrate average skills in facilitating equitable access to technology that addresses learning social and cultural diversity. The result of this study also agrees with that of Ariaz (2018), who reported that the social and ethical ICT competency of teachers was not high but largely average. The average competency in these areas could be a result of the very sensitive, ethical, and more practical nature of these aspects of the social-ethical standards in the use of ICT. Also, it could be that the curriculum of the general courses in computer and application and educational technology did not address these skills. This is to say that students must be exposed to practical lessons in these two areas to upgrade their competency level to be above average.

Recommendations

Based on the findings of the study, the following recommendations are proffered

a) The general study curriculum of tertiary institutions should be designed in a more practical nature to enhance practical skills in ICT in the social and ethical domains.
b) Faculty courses in education that have to do with educational technology should utilize a practical approach to instruction to enhance the skills of students in the use of ICT in teaching especially in the COVID-19 era.
c) Both the general study unit and faculties of education in tertiary institutions should have equipped computer laboratories with relevant equipment to demonstrate these technologies to the pre-service teachers before their graduation.
d) Every university graduate should be encouraged to have a personal computer

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