Effectiveness of the infusion teaching approach for the development of general ICT skills in Nigerian tertiary education

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Abstract

Purpose – There is considerable efforts by government and various agencies towards the development of information and communication technology (ICT) skills in the developing nations. The efforts include the procurement and deployment of ICT devices and curriculum development; but, these are not yielding the ultimate results as the digital divide continue to widen regionally. This calls for innovation in teaching and learning in ICT. The study assessed the effectiveness of infusion approach to teaching and learning in the tertiary education level. This approach utilises a framework and student-centred approach for which its effectiveness as an instructional delivery was tested for efficacy.

Design/methodology/approach – The study adopted quasi-experimental design with pretest and posttest comparison to assess the treatment given. Performance was measured quantitatively through online assessment.

Findings – The results showed a phenomenal effectiveness of infusion approach to teaching and learning of general ICT skills as the participants achieved very high performance at the end of the instructional period.

Research limitations/implications – This research is based on general ICT skills and covers a regional cross-section of Nigeria.

Practical implications – Adoption of infusion approach to teaching and learning in ICT would close the prevailing knowledge gaps in the development of ICT skills.

Social implications – This infusion approach would close the prevailing digital divide, thereby enhancing societal well-being.

Originality/value – This is a novel approach to the development of ICT skills, which would enhance teaching and learning in ICT.

Keywords Innovation, Digital knowledge gaps, ICT instruction, Infusion approach, Infusion framework, Student-centred learning

Paper type Research paper

Introduction

Developing information and communication technology (ICT) skills in less-developed countries (Nigeria inclusive) continue to pose some difficulties. The ICT infrastructure (hardware and software) deployment is inadequate in some cases and the teachers lack the required ICT competencies to effectively impart the skills. Apagu and Wakil (2015) found that in Nigeria there is shortfall in ICT facilities deployment. The qualified teaching personnel are

grossly inadequate just as Mulji (2018) and Siddiquah and Salim (2015) have found in Kenya and Pakistan respectively that there are inadequate ICT infrastructure and teachers in the higher education. This situation has led to low rate of ICT skills acquisition by the higher education students in the developing countries and consequently, there is a continuing and widening digital divide between the developed and the less developed nations.

In realisation of the need to address digital divide and to prepare learners for the digital world, the government had made some efforts that facilitate ICT skills development in Nigeria. For instance, there was the establishment of the National Information Technology Development Agency (NITDA) to serve as a bureau for the implementation of National Policy on Information Technology. NITDA focusses on the introduction of Internet technology in almost all the sectors excluding the health sector and education (Idowu *et al.*, 2003). The overriding objective of the National Telecommunications Policy is to achieve the modernisation and rapid expansion of the telecommunications network and services, social development and integrate Nigeria internally as well as externally into global telecommunications environment. In addition to other government agencies such as the National Communication Commission, ICT infrastructure (hardware and software) have been deployed to schools, ranging from the primary school to the tertiary educational institutions (Ifejiofor and Nwankwo, 2015). Particularly, the Tertiary Education Trust Fund has massively deployed ICT infrastructure in terms of computers and personnel training to tertiary institutions in Nigeria with huge expenditure spent in the projects (Oraetoka, 2018). The implication of these efforts by the government is that the teachers would deliver ICT instruction to implement the ICT educational policy of government. This would ensure the production of learner outcome that are best fit for the digital world.

It now behoves the teachers to employ innovative approach to develop the needed ICT skills, though they still operate under ICT infrastructure deficient environment. Given an ICT competent teacher, innovation in pedagogy has become necessary. Innovative teachers are required to explore ways and technique to be employed to close the gap in ICT skills acquisition evidently noticeable in the schools in developing countries and particularly, Nigeria. This cream of teachers is now needed especially as the quest for integration of ICT into the classroom has continued to dominate teaching pedagogical discourse (Henriksen and Fisser, 2016; Majumdar, 2018). From this discourse, the role of the teacher in ICT in the classroom has been emphasised with some models proposed, though the models focus on the broad aspect of ICT integration in education. For instance, Majumdar proposed four-stage framework for ICT development in schools including, emerging, applying, infusing and transforming. At the emerging stage, the ICT has not been fully added to the curriculum, efforts being made to do so; at the applying stage, the school curriculum already incorporate ICT but the teaching of the course is teacher-centred. The infusing stage embraces the stage where ICT is now part and parcel of all aspects of the school curriculum and at the transforming stage, the learning of ICT is student-centred. This model identified stages in ICT development, emphasising the role of the school in the deployment of ICT infrastructure with inclusion in the curriculum. In this case, the role of the teacher is vital to successfully implement the curriculum that would bring about infusion and transformation in ICT in the school.

The search for innovative approaches for ICT development has become very important and imperative in consideration of the impact of COVID-19 pandemic. The COVID-19 pandemic accelerated the adoption of ICT as tools for both learning and instructional delivery at higher education level all over the world (Singh *et al.*, 2021). In Nigeria, as in the case for other countries, the traditional classroom teaching and learning gave way to online learning, where students took courses for the greater part of the 2020–2021 session online. Unfortunately, for many of the students, skills in ICT were insufficient among other factors. This gap must be filled to enable the students participate in the "COVID-19 enabled new teaching and learning" which is largely ICT-driven.

As has been noted, the role of the teacher is vital in ICT skill development; and different approaches have been adopted, of which two of them are outstanding – teacher-centred approach and students-centred approach (Euro Pass Teacher Academy, 2018; Shaw, 2016). The teacher-centred approach is fashioned after the traditional techniques where the teacher is the focal point in the instructional process, while the students-centred approach is emerging, and the learner is the focal point in the learning process. Nonetheless, the teacher still plays varying role in the two approaches, though at various levels of involvement. Student-centred approach has been found to be effective generally in developing skills (ICT inclusive) (Lu *et al.*, 2010). This study is an exploratory research that proposes and assesses the effectiveness of the infusion approach to the development of general ICT skills in the tertiary education, Nigeria. Infusion approach in this context is students-centred approach to teaching which originally was adopted for teaching critical thinking (Al-ghadouni, 2021; Aizikovitsh, 2019), but could now be applied to other subject areas (Kurniati *et al.*, 2020). The rationale for this study stemmed from the current scenario of paucity of research that demonstrates effectiveness of an infusion teaching approach to the development of ICT skills in Nigeria and currently ICT skill is acquired mainly as a specific subject in the traditional classroom settings. Thus, this research has the potential benefits of contributing to accelerating skills acquisition in ICT to meet current demands occasioned by COVID-19 pandemic, where instructional delivery and learning has become ICT-driven.

Infusion approach

National Project on Career Education (1981) offered a description of infusion distinctly as the process of weaving concepts of a subject into another, such as concepts in career education into mathematics, language arts, science or social studies, stressing that it can make teaching more effective by increasing the relevance of existing academic content. In the same vein, Pine Street Elementary School (PSS) (2021) implied that infusion (also called integration) is an approach to teaching and learning that integrates skills and content from a subject with another subject area (e.g. mathematics, science, language arts, social studies); having instructional objectives in both areas, the goal of this blending is to deepen student understanding in the subject area as well as that particular subject, allowing both disciplines to mutually support and strengthen each other. In relation to the arts education, infusion has been described (PSS, 2021) as an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both. Furthermore, arts infusion engages and motivates students by emphasising active learning rather than passive learning. Understanding that students have different learning styles and various multiple intelligences, the arts generate numerous ways for students to construct and demonstrate their understanding of subject matter. This approach to teaching gives greater context to students' learning and makes their educational experiences more meaningful. From these definitions and description of infusion approach, it could be understood that infusion approach is both independent and individualised teaching approach which is student-centred rather than the traditional teacher-centred approach to teaching and learning.

Infusion approach to pedagogical instructional delivery has been perceived since the 1970s to provide an alternative to the traditional approach of subject-specific approach, though it was applied largely to teaching and learning in the primary schools, secondary schools and special education. Clark (1979) outlined its benefits, including:

(1) Infusion makes abstract academic content more concrete, more relevant, and consequently, easier to learn.

(2) Infusion increases the possibility for exposure to a wider range of career education concepts and skills.

(3) Infusion assumes that everyone in the educational process will be participating from his or her own perspective, providing a broad-based support system,

(4) If infusion is operative in the entire educational programme, there is some assurance that the content of the curricula in regular classes will be more appropriate for many handicapped children. (p. 160)

Owing to its benefits, infusion approach to teaching and learning continued to receive attention from educators that report favourably on its effectiveness and applicability to various subjects in the primary and secondary schools (Swartz and Parks, 1994; Dewey and Bento, 2009; McGuinness and Sheehy, 2008; Swartz, 2001; Aizikovitshi and Amit, 2010; Zulkpli *et al.*, 2017; Lin, 2018). It was found to be very effective in teaching and learning of critical thinking from the 1990s (Aizikovitshi and Amit, 2010; Lin, 2018).

In applying infusion approach to instructional delivery, frameworks were conceptualised, for example, the work of Lin (2018). In using, infusion approach for teaching and learning in critical thinking, Lin (2018) conceptualised infusion approach to teaching critical thinking as a flow chat, flowing from top to the bottom, consisting of introduction, thinking activity, thinking about thinking and applying thinking. At the introduction, the teacher provides instructions on thinking skills and content objectives. In the thinking activity, the teacher models how to use thinking skills to solve learning problems; students complete thinking tasks in groups by using thinking skills and subject knowledge and share group ideas with the class members. In the thinking about thinking, the teacher asks questions to guide students to reflect on the thinking process. At the bottom stage, the applying thinking, the teacher facilitates additional opportunities for students to apply their thinking skills to similar and different contents to promote transfer. This frame implies that there must be well-stated objectives and instructional experiences provided for the students. There are activities for the students to engage in and a stage of reflection and application of the skills learnt. Following these stages, Lin (2018) reported that infusion approach was effective in teaching and learning critical thinking, similar to the other report by Sedaghat and Ralmani (2011)to buttress beneficial value of infusion teaching approach. Critical thinking has been receiving global attention and veritable skills for problem-solving and societal survival, since the 1990s just as the ICT skills have become increasingly important to the contemporary world. In addition, Swartz (2012) reported a great deal of success recorded in the school that practised infusion (also described as Thinking-based Learning – TBL) teaching approach to critical thinking, stating that the students had tremendously improved on their thinking ability while in schools and in the learning of the content areas of their studies. Thus, infusion teaching is a catalyst to improvement in both thinking ability and course of studies in schools.

COVID-19 pandemic and instructional delivery in the tertiary education

The National Policy on Education (Federal Republic of Nigeria, 2013) defines tertiary education as the post-secondary section of national educational system, including universities, polytechnics and the colleges of education. This level of education produces top human resources for the economy and is considered very vital to the economy. As a result, any disruption in the academic activities is tantamount to downturn in the economy. This was the case in Nigeria during the COVID-19 pandemic, where all the tertiary education sector experienced lockdown. Udem *et al.* (2021) wrote that as of March 2020, all schools in Nigeria including the tertiary education sector were closed to curtail the spread of the dreaded COVID-19 and as a result, academic activities were stalled throughout the country just as it was the case in the global education scene. This situation created crisis in the educational system as students had to discontinue the educational activities, though as palliative, some forms of online learning were recommended. According to Aiyedun and Ogunode (2020), the

shutting down of tertiary education in Nigeria caused disruption in academic programmes and some frustrations to the students because the online remedy option recommended by the government could not be implemented as majority of the students did not possess the requisite skills in ICT and with virtually non-existent Internet connectivity. No doubt, COVID-19 experience, though not completely gone with schools now resumed, has posed a challenge to the educators in the tertiary education. The traditional face-to-face instruction must be complemented by remote learning (e-learning or digital learning). Both teachers and students must brace up to the skill requirements in ICT to cope with the post-COVID-19 era (Aiyedun and Ogunode, 2020; Singh *et al.*, 2021). Thus, it is now imperative to seek for accelerated approach for acquiring these ICT skills to successfully implement the post-COVID-19 tertiary education demands that would be ICT-driven.

Information and Communication Technology (ICT) skills

ICT has impacted all disciplines and spheres of life in the contemporary world and there is now hardly any human sphere that is not touched in any way by ICT. It is encountered in the home, business offices, schools and entertainment industries. It is the convergence of various technologies in communications and telecommunications that has brought about ICT which is now being defined in many ways by different authorities to follow either a wider or narrower view. One common definition describes ICT as the use of computers and other electronic equipment to store and send information. This depicts the meaning of ICT in narrower view as the use of the computer is the focus of the definition. Similarly, Ekwelem (2019), gave the definition of ICT as technologies that enable society to create, collect, consolidate, communicate, manage and process information in multimedia and various digital formats for different purposes, i.e. computing and telecommunications technologies like the personal computer, CD-ROM, cable TV, cellular phones and the Internet, just as UNESCO (2006) describes ICT as forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means. It includes not only traditional technologies like radio and television but also modern ones like cellular phones, computer and network, hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing.

From these definitions, it is understood that the core of ICT is digital technology. It involves the use of the computer and forms of digital technologies for information management including the creation, processing, storage, display, transmission and exchange of information.

In relation to ICT skills, Doyle (2020) wrote that ICT skills refer to one's ability to converse with people through various technologies, stressing that it could also refer to technology use for regular, everyday tasks: sending an email, making a video call, searching the Internet, using a tablet or mobile phone and more and that ICT skills could also include the ability to use older communication technologies such as telephones, radios and televisions. To this end, the basic or general ICT skills would include:

(1) E-mail: Being able to effectively and successfully communicate using e-mail. Presently, one needs to send e-mails to colleagues, employers, clients, vendors and so on. Companies expect their employees to write professional and well-written e-mails, as well as respond promptly to messages received in their inboxes.

(2) Online research: This is the ability to use the Internet to make search for any knowledge and information one requires. Almost every job requires at least some online research. From looking up new lesson plans in a subject or checking out the latest news on your company's competitor, you need to be able to search through all

the information online to find what you need. This involves basic online information management skills.

(3) Social media: This is the ability to interact with people online through social media platforms. The more you know about the benefits of and limits to social media, the more you can begin to use that media in valuable ways at work.

(4) Online collaboration: This refers to any means of sharing information with your people or co-workers online. This includes adding a meeting to a shared online calendar, providing feedback on a document through a web-based document application and holding an online video conference with colleagues.

(5) Spreadsheets: From researchers to administrative assistants to schoolteachers, almost everyone now needs to be able to develop and manage data using spreadsheets. Therefore, competencies in the use of programmes like Microsoft Excel is critical in today's world.

(6) Desktop publishing: Desktop publishing involves the creation of a variety of print materials using a computer. These might include fliers, brochures, newsletters and other materials that include graphics. Because you can create so many materials using desktop publishing, almost any job requires some basic skills in this field. People with creative, artistic eye might be particularly good at desktop publishing, but anyone can get better with practice.

(7) Smartphones and tablets: Many employers require that their employees use smartphones and tablets; they might even issue phones to employees or state that workers must be accessible by email during certain hours. For these reasons, it is important to know how to use a smartphone.

(8) Word processing: Currently, it is pretty much understood that all applicants for employments must know how to use word processing software (e.g. Microsoft Word) to produce written documents (including business letters, meeting minutes and more). Candidates also need to be able to keyboard quickly and accurately.

(9) Machine manipulative skills: This is required to effectively use the arrays of machine available, for example, copiers, scanners, cameras.

(10) Teamwork skills: Technologies are implemented by people, and one requires team skills to go along with colleagues. (p. 1)

ICT has become an umbrella concept that mean several things to people and professionals and its continued advancement has influenced the society and professionals in a greater dimension, particularly resulting in efficiency and effectiveness in information management. The computer and the telecommunication technology are the focal technologies in ICT convergence. This implies that in the contemporary world, everyone requires adequate skills in ICT for effective information processing and management. ICT along with its effective use has now become an imperative for all youths and adults alike and educators must be concerned on its effective impartation to the citizenry.

The Nigerian government through the Federal Ministry of Education (FME) has formulated a comprehensive ICT policy for the education sector. On effective inculcation of ICT skills, FME (2019) outlines that instructional repertoire is expanded allowing opportunities for multimedia and interactivity that are impossible with more traditional instructional techniques, while the students/learners are transformed from passive recipients of the knowledge of the teacher/trainer to active participants in knowledge-seeking and knowledge construction, with the teachers/trainers often learning new technology

programmes along with them. This policy realises that instructional delivery in ICT would be effective if there is paradigm shift from the traditional approach but following innovative approach where the learners are active participants rather than being passive learners. However, at the tertiary level, the ICT curriculum models the traditional subject-specific approach, and it is teacher-centred.

The ICT skill development in the tertiary education in Nigeria is currently abysmally implemented (Communications Week, 2019). There is the worrisome scenario in strong terms that most Nigerian graduates leave institutions of higher learning without even touching a computer, leaving them without requisite skills to integrate into the ICT-driven business environment. There is no defined curriculum for ICT in the higher education, rather pockets of ICT topics are infused into Computer Studies and appreciation which are mostly taught theoretically with no hands-on experience. Some few forwarding looking tertiary institutions are now realising the importance of the skills, though are adopting traditional approach in ICT training. For instance, the Obafemi Awolowo University (OAU) was reported to engage the fresh graduate students on the basic ICT training on subject-specific approach. The aim of the ICT training is to impart basic ICT skill into the students right from the onset of their educational career in the university with the contents including, student e-mail services, smart classrooms, multimedia driven lecture delivery, intra-university voice communication "Keedu", increasing online engagement, course registration, TCC project, e-assessment, inter-university online collaboration (OAU and Unilag) and technopreneurship. These are in addition to various existing services such as online meetings and interviews via telepresence and videoconference, advanced search, e-library, Internet access (Akemim, 2021). This is impressive, but the challenge of implementation that would yield the desired goal may be inevitable as has been observed currently in the tertiary education sector in the country.

Undoubtedly, ICT skills development in the tertiary education in Nigeria is beset with challenges and it is imperative on the educators to fashion out innovative approaches to catch up with the challenges posed by the mismatched skills development in ICT in the higher education in Nigeria. This gap forms the basis for this study, in which infusion approach that ensures some departure from the traditional approach was sought for and tested for effectiveness.

Methodology
The study adopted quasi-experimental design modelled on pretest–treatment–posttest framework. Quasi-experimental design is used instead of true experimental design, and it is suitable for social science research as true experimental conditions cannot be obtained as in the pure science. Thomas (2020) affirms that quasi-experimental design is useful in situation where true experimental cannot be used due to ethical or practical reasons. In this context, true experimental conditions cannot be obtained with the humans and in the teaching and learning situations, thereby quasi-experimental design was adopted to determine the cause-and-effect relationship between the independent variable (infusion teaching approach) and the dependent variable (subjects' assessment scores). The study subjects were drawn from Higher National Diploma class of 2019–2020 first semester of the Department of Office Technology and Management, the Federal Polytechnic, Idah, Nigeria. The quasi-experimental design with pretest–treatment–posttest design was particularly appropriate in this context because it is not practicable to randomise and assign control and experimental groups. According to Price et al. (2019), quasi-experimental design is like experimental design because in both, the independent variable is manipulated for outcome but differ in selection process. The subjects in the quasi-experimental designs are not randomly selected because it is not practicable to do so, stating that they are often conducted to evaluate the effectiveness of a treatment – perhaps a type of psychotherapy or an educational intervention. In this study there was a single class

that took the semester course, and everyone underwent the same instruction for the semester, though only the volunteered members of the class took part in the study who were given equal treatment over time; hence it was not necessary to categorise random groups into experimental and control groups. Thus, the fittest design is pretest–treatment–posttest. The pretest conditions form the baseline for comparison at the posttest, after the treatment (infusion teaching approach). The design notation is 01×02, where 01 is the result of the pretest, X is the treatment (infusion teaching approach) and 02, the posttest outcome.

The subjects of the study were drawn from students enrolled for Entrepreneurship Development course for one semester and the total number of the registered students were 58, but 25 fully participated in the study which requires them to respond to online survey eliciting their level of ICT skills acquisition at the pretest and the posttest after which instructions, assignments and assessments were given during the semester both on the main and the infused learning experiences. During the semester, the participants wrote assignments and quizzes, then at the end of the semester, the posttest was administered. The data from the participants was used for the analysis for the study. The study assessed the effectiveness of the infusion teaching approach for developing general ICT skills; thus, hypotheses were tested to reveal the effectiveness of the infusion teaching approach. This hypothesis tested the difference in mean performance of the participants at the pretest and the posttest to reveal the effectiveness of the infusion teaching approach. The hypothesis was tested at 95% significance level employing two-tailed "t-test" statistic. The study proposed that if the treatment variable (infusion teaching approach) is not effective, there would be no significant difference in the mean responses ($p \geq 0.05$) for the pretest and posttest performances; thus, the hypothesis is not rejected, but if there is significant difference, the hypothesis would be rejected implying that the treatment variable is effective – thus, infusion teaching approach is effective in developing general ICT skills.

On the treatment variable, a self-constructed framework, known as "The Infusion Wheel of ICT Skill Development Framework", was developed by the researcher as follows (see Figure 1):

The infusion framework is circular, and it presupposes that the instructional approach progresses as a wheel, beginning from objectives and ending at the feedback. In the approach, the students were informed that in addition to the main course, they were expected to independently learn selected ICT skills for the semester (instructional objectives). From here, the teacher delivers the instruction in the main course (instructional activities); in the process, ICT skills would be embedded into the class activities, introducing the ICT skills. The students were required to undertake some assignments (infusion activities) and they were also given certain assignments that would involve the use of certain ICT skills (assignments). The students after they were coached would take the assignment home, and with the aid of certain applications of ICT skills, they would complete the assignment for the teacher to evaluate (instructional evaluation). From the performance at the evaluation stage, the teacher through intervention gives additional coaching for further assignments (instructional intervention) and finally there would be feedback for the teacher to analyse the overall performance of the teaching approach.

In applying this framework as an infusion teaching approach by the researcher during the course in entrepreneurship, the learners were given the ICT objectives as embedded in the semester course. The objectives include: (1) the learners would demonstrate skills in browsing the net and bookmark; (2) communicate with email; (3) participate in activities involving Facebook and (4) write online assignments. To achieve these objectives, the students were coached on how to browse the Internet, bookmark, engage in Facebook discussion and send and receive emails, as well as participate in online quizzes. This is the instructional activities stage which was embedded (infused) into the entrepreneurship course for the semester and following other stages of the "wheel" to the last stage (feedback). This process constituted the
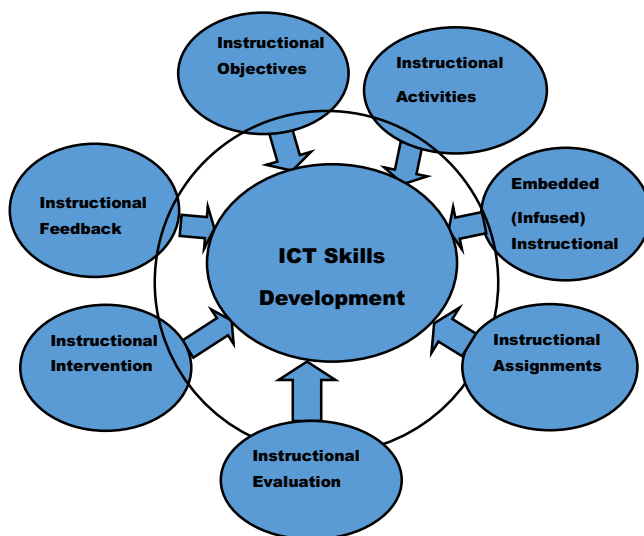
Source(s): Researcher, 2021

Figure 1.
The Infusion Wheel of
ICT Skill Development
Framework

treatment for the experiment. The students were then given overall evaluation of the semester's instructional activities on the ICT skills embedded into the class activities. To evaluate the entry behaviour on ICT skills, the online questionnaire was designed using Google Forms and administered online for both tests and the scores obtained were used to analyse the study preposition.

At the end of the semester, data was obtained from 25 participants (volunteered members of the class) who completed the posttest, recording three mortalities from the pretest participants of 28 students. The results obtained were used to test the hypotheses to determine the effectiveness of the infusion teaching approach to the development of ICT skills. The results were presented in table and analysed respectively. Two hypotheses were formulated and tested with *t*-test statistical tools at 0.05 significance level. These hypotheses are:

(1) There is no significant difference between the mean performance of subjects who were taught with infusion teaching approach for ICT skills development at the posttest and pretest assessments.

(2) There is no significant difference between the mean performance of subjects who were taught with infusion teaching approach for ICT skills development according to the gender at posttest assessment.

Findings

The participants rated themselves on the four-point rating scale on the extent to which they possess the selected (general) ICT skills – least possessed, moderately possessed, highly possessed and very highly possessed, with assigned numerical values of 1, 2, 3 and 4 respectively (Appendix). Data was generated from 25 participants on the posttest and pretest. This is presented and analysed in Tables 1 and 2.

Table 1 presents data on the posttest and pretest, containing mean performance of the study respondents of 25 on selected 20 general ICT skills. The two-tailed *t*-test statistic was

employed to test the hypotheses to determine the effectiveness of the experimental treatment. The degree of freedom is 48 and at 5% level of significance, the critical "t-value" is 2.04. The computed t-value for the 20 skills is far more than the critical "t-value" and this shows that the hypothesis of "no significant" performance of the two tests is rejected, implying that there is significant difference tending to the posttest (the performance of the respondents is better at the posttest than the pretest). The performance showed a phenomenal effectiveness of the infusion teaching approach for developing general ICT skills using the Infusion Wheel of ICT Skill Development Framework.

In addition, hypothesis 2 relates to the posttest performance based on subjects' gender and the data is presented in Table 2. At 0.05 level of significance, t-test statistics was employed. The two gender categories used were male and female, with 16 and 9 for male and female, respectively. The degree of freedom is 23 and the critical t-value is 2.02 (two-tailed). The results showed that both genders performed creditable well at the posttest (after they were taught with infusion approach). Both genders performed equally, and the results showed no significant difference in the performance of the male and female genders. This performance reveals fantastic performance on all the four clusters of ICT skills used for the experiment.

Implications of findings

The findings from this exploratory study have shown that infusion teaching approach can be applied to the development of basic ICT skills at the tertiary education level. It provides further evidence that with the adoption of the framework proposed in the study (the Infusion Wheel of ICT Skill Development Framework), students offering other courses can equally develop their ICT skills; thus, there is a dual benefit to this teaching approach – ICT skills are enhanced and the content areas are equally achieved. This was reported by Swartz (2012) that students taught with infusion approach gained both in the thinking ability and the content areas, though in this context the objective was to improve general ICT skills.

S/No	General ICT skills	Mean performance		t-value	Decision
		Posttest	Pretest		
1	Browse the net	3.56	1.88	8.89	Significant
2	Bookmarking	3.24	1.60	7.36	Significant
3	Open email account	3.60	1.84	11.30	Significant
4	Read email	3.68	1.72	11.03	Significant
5	Read email attachment	3.44	1.64	9.86	Significant
6	Download email attachment	3.36	1.52	10.24	Significant
7	Send email	3.64	1.68	9.08	Significant
8	Send email attachment	3.60	1.72	10.14	Significant
9	Open Facebook account	3.76	1.60	12.70	Significant
10	Read Facebook messages	3.76	1.56	17.04	Significant
11	Use Facebook chat	3.80	1.56	14.38	Significant
12	Join Facebook group	3.60	1.56	10.92	Significant
13	Participate in Facebook discussion	3.48	1.72	8.07	Significant
14	Open files from Facebook	3.52	1.64	9.68	Significant
15	Send Facebook messages	3.52	1.48	10.92	Significant
16	Make Facebook comments	3.64	1.60	10.43	Significant
17	Use Facebook advertisement	3.36	1.56	8.05	Significant
18	Write online assignment	3.52	1.48	12.92	Significant
19	Write online quizzes	3.44	1.68	8.70	Significant
20	Use search engines (e.g. Google)	3.72	1.68	12.92	Significant

Table 1.
Posttest and pretest mean performance on general ICT skills

| S/No | General ICT skills | Mean performance | | t-value | Decision |
		Male	Female		
	Cluster 1				
1	Browse the net	3.94	4.22	−1.29	Not significant
2	Bookmarking	3.75	3.89	−0.81	Not significant
3	Use search engines (e.g. Google)	3.75	3.89	−0.81	Not significant
	Cluster 2				
4	Open email account	3.81	3.67	0.80	Not significant
5	Read email	3.63	3.44	0.85	Not significant
6	Read email attachment	3.81	3.56	1.37	Not significant
7	Download email attachment	3.38	3.78	−2.01	Not significant
8	Send email	3.81	3.78	0.20	Not significant
9	Send email attachment	3.81	3.89	−0.49	Not significant
	Cluster 3				
10	Open Facebook account	3.75	3.67	0.43	Not significant
11	Read Facebook messages	3.75	4.00	−1.66	Not significant
12	Use Facebook chat	3.75	3.67	0.43	Not significant
13	Join Facebook group	3.75	3.78	−0.15	Not significant
14	Participate in Facebook discussion	3.81	3.56	1.37	Not significant
15	Open files from Facebook	3.75	3.78	−0.15	Not significant
16	Send Facebook messages	3.81	3.67	0.80	Not significant
17	Make Facebook comments	3.81	3.67	0.80	Not significant
18	Use Facebook advertisement	3.75	3.67	0.43	Not significant
	Cluster 4				
19	Write online assignment	3.87	3.78	0.62	Not significant
20	Write online quizzes	3.69	3.56	0.64	Not significant

Table 2.
Comparison of gender
mean performance at
the posttest on general
ICT skills

Furthermore, the infusion approach to teaching and learning in ICT can accelerate the rate of learning across disciplines much more than the traditional subject-specific and teacher-centred approach in the post-COVID-19 era where it is envisaged that ICT-enabled teaching and learning would be in vogue in the tertiary education (Aiyedun and Ogunode, 2020). Thus, the approach can enhance massive learning of ICT for closing the digital divide that is prevailing in regions of the world. Already, the infusion approach has been proven to be effective at the primary and secondary levels (Swartz, 2012), and with the findings of this study, the infusion is found to be equally effective at the tertiary level of education in terms of teaching and learning of general ICT skills.

Conclusions
In search of new approach to teaching and learning in ICT to achieve an accelerated rate of learning in post-COVID-19 era and regions experiencing digital gaps, the study was conducted to assess the effectiveness of infusion teaching approach. The evidence from the study has shown that the infusion teaching approach is very effective for developing general ICT skills. The approach is student-centred with focus on independent study as the teacher facilitates and is being anchored by the "Infusion Wheel of ICT Skill Development Framework". The author-constructed framework has been proved to be a workable pedagogical construct for ICT skill development. Students that are guided with the well-constructed pedagogical framework and the infusion teaching approach performed phenomenally high at the posttest implying high effectiveness of the teaching approach to the development of ICT skills. The results showed no significant difference in performance based on the male and female gender taught, implying that the infusion teaching approach is generally effective with the underpinning framework (the Infusion Wheel of ICT Skill Development Framework).

Recommendations

Based on the findings and the conclusions of this study, the following recommendations have been made:

(1) Skills development in ICT by the teachers should not be subject-specific but infused with the courses of the school curriculum in the form of student-centred and independent study with the teacher facilitating the course.

(2) In facilitating the ICT skills development, the teacher should be guided by the framework that ensures a systematic approach such as the "Infusion Wheel of ICT Skill Development Framework".

(3) The teacher should set clear objectives from the beginning and continuously monitor students during the ICT skill development to obtain performance feedback for determining the achievement of the set goals.

(4) This study should be replicated with other courses and other schools in the country and other nations. This would ensure its pedagogical authenticity.

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Appendix
Infusion Intervention Plans

The plan and implementation for this study, using the framework constructed include the following.

Pretest and Posttest Questionnaire

(1) Assignment on research online – the participants to research online for Industry Standards classification and select 100 classifications for submission online to the class email address.

(2) Participants to access the class Facebook group and engage in a discussion ongoing about Technopreneurship ventures available for the OTM students.

(3) Write a pretest and post as set titled "My Status of ICT Skills".

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