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Utilization of digital tools and effect in the teaching and learning of integrated science in tertiary institutions in Southwest, Nigeria

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Abstract

Integrated Science remains the gateway to all sciences that students need to be well grounded in it to be able to study single sciences or choose a career in science. The study examined the effect of digital tools on tertiary institution students' academic performance in integrated science in the Southwest States. The study adopted mixed-methods approach of both the descriptive survey and non-equivalent pretest, posttest control group quasi-experimental research design. The population of the study comprised all integrated science students in tertiary institutions, lecturers and Information Communication Technology (ICT) administrators. Multi-stage sampling procedure was used to select the sample size for the study. The six state were grouped into three strata with two State each, three states were selected from the strata using stratified sampling, from each state, tertiary institutions offering integrated science were purposively selected and the sample size were selected using simple random sampling techniques. The sampled States were randomly assigned to two experimental groups and one control group respectively. The sample consisted of 163 students for the treatment group with 18 others that are lecturers and ICT administrator. Experimental group A was taught BST concepts using digital tool (virtual classroom), experimental group B was taught the same concepts using digital tool (flipped classroom) and the control group was taught using the conventional method. The treatments lasted for twelve weeks. Two instruments were used for data collection. They are: "Integrated Science Achievement Test" (ITSAT), used to examine students' academic performance for the pre, post and retention tests, and questionnaire ⍰⍰Digital tools utilization Questionnaire in the teaching and learning of Integrated Science' ' (DITUQTLITS), Data collected were analysed using mean, standard deviation, analysis of covariance (ANCOVA) and post-hoc analysis. The results of the descriptive analysis shown that perceptions and attitudes of integrated science educators and students towards the use of digital tools in teaching and learning are positive with 142 (87.1%), also, that digital tools and learning platforms such as flipped classroom, interactive whiteboard, projector, virtual(online) classroom, multimedia podium are the commonly available and use for teaching and learning of integrated science courses in tertiary institutions with 99 (60.7%). Pointing out that power failure, poor maintenance culture, inadequate personnel with goo hmm lmkd knowledge on of usage of the digital tools are barriers to its effective utilization with 101 (62%) with the submission that training and retraining of Integrated educators, employment of more personnel that are ICT inclined will enhanced the use of digital tools in teaching and learning of integrated science courses in tertiary institutions 155 (95.1%). The results of the study showed significant effect of the treatment groups and conventional method on students' academic performance in BST in junior secondary schools in Ogun State ($F= 57.536$, $p < 0.05$, partial $\eta^2= 0.420$) with flipped classroom instructional strategy has the highest significant effect with mean score (24.860), followed by virtual classroom (22.818) while conventional method had a mean score (20.290), the differences in mean values showed they are statistically significant..

Keywords: Digital tools; Utilization; Teaching; Learning; Integrated Science

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1. Introduction

Teaching and learning in institutions of higher learning is moving from the conventional and teachers expository method of teachers centered that is always mar with poor performance, negative attitude and interest in subject taught, most especially sciences and integrated science that involves physics, chemistry, biology to a more technological classroom setting with the use of digital tools to improve academic performance, attitude and interest and students retention ability in concepts taught. The integration and utilization of digital tools such as Information and Communication Technology (ICT devices and learning platforms) in the field of education have tremendously improved teaching and learning processes around the globe. In Nigeria, the adoption of digital tools in education (Akpan, 2020). Particularly in the teaching and learning of sciences and integrated science subjects/courses, holds the potential to enhance scientific educational outcomes. Integrated Science is seen as the conceptual unity of the sciences. A unified process of scientific enquiry. Iwuji (2012) opined that at junior secondary school level, integrated science was introduced to give foundation skills and knowledge for subsequent science studies at the higher level. The acquisition of appropriate skills and the development of mental, physical and social abilities and competencies for the individual to live in and contribute to the development of the society in which he lives, has been a major concern of integrated science at all levels.

The gateway to science and technology growth and advancement of any nation is science education which acquired with science literacy in which Integrated Science is core in achieving that, thus, making the Nigerian government to encourage and foster the citizens interest in science education (Bash, *et. al*., 2017). Integrated Science is the foundation of all sciences. Nigeria Integrated Science Teacher Education Project NISP (1983) explained Integrated Science as a subject where various concepts in different subjects like Geography, Mathematics, Physics, Chemistry, and Biology are integrated to come up with a curriculum which when taught, an individual with the integrated conception of sciences, will be able to teach Integrated Science at the junior secondary schools, including higher institutions of learning. National Commission for Colleges of Education (2008), built philosophy of Basic Science on a fundamental unity of science, solving science related problems with scientific method, and on the functions of science in dailies life. Integrated Science seeks to bring together concepts, perspectives, and pedagogical strategies in different scientific disciplines to be able to comprehend scientific occurrences in daily tasks. Integrated Science put together various fields like Chemistry, Biology, and Physics, therefore, serves as foundation for all single sciences that students must be well grounded in it for them to study single science course or choose a career in sciences. Integrated Science educators have obstacles in teaching the subject across different levels of education, and more often, they resulted to teaching the subject using teacher-centred approach and reducing students' activeness. In addition, they continue to emphasize their preferred subject(s), finding it difficult to teaching effectively all the integrated subjects (Dorsah, *et, al*., 2024).
The use of digital tools in integrated science classroom situation sees the teachers as facilitator rather than dispenser of knowledge. It is therefore imperative to utilize digital tools in teaching and learning not to be left out of the global village of internet, extranet and intranet. However, the level of utilization of these tools in integrated science teaching in public tertiary institutions remains underexplored. This study aims to investigate the extent to which digital tools are utilized in the teaching and learning of integrated science courses in public tertiary institutions in Nigeria.

1.1. Statement of the Problem

Digital tools are gradually becoming an essential component of our lives. Certainly, this is promoting knowledge at a speed, making teaching and learning easy against the conventional classroom where students listen to the instructor in an overcrowded classroom. Despite the recognized benefits of digital tools in enhancing the teaching and learning process, there appears to be a gap between availability and utilisation in Nigerian public tertiary institutions. The main source of concern is the fall in the quality of science graduates and the shortfalls of the facilities needed for effective integration and utilisation of digital tools in teaching and learning of integrated science. Preliminary observations suggest that many integrated science educators may not fully integrate digital tools and make use of it in their teaching practices due to various challenges such as inadequate funds to sustain ICT Infrastructure, lack of training, or resistance to change, low level of internet access and usage, electricity supply, inability of institutions administrators to keep up with the pace of development in ICT (Afolabi, 2020) and inadequate integrated science educators with appropriate skills to manage ICT both at the strategic and operational levels. This research seeks to identify the current level of digital tools utilization, the factors influencing its integration and usage, and effects on academic performance, call for investigation; hence, this study.

1.2. Objectives of the Study

The Objectives of the study are to:

- determine level of utilization of digital tools in the teaching of integrated science courses in public tertiary institutions in Nigeria.
- identify the types of digital tools commonly used and available in these institutions.
- examine the perceptions and attitudes of integrated science educators and students towards the use of digital in teaching and learning of integrated science.
- identify the challenges faced by integrated science educators in the integration of digital tools in their teaching practices.
- propose strategies for enhancing the utilization of digital in the teaching and learning of integrated science courses

1.3. Research Questions

This study will be guided by the following research questions:

- Does the perceptions and attitudes of integrated science educators and students encourage the use of digital tools such as ICT in teaching and learning?
- What types of digital tools are available and commonly used in these institutions for teaching integrated science courses?
- What is the current level of utilization of digital tools in the teaching of integrated science courses in public tertiary institutions in Nigeria?
- What challenges do integrated science educators face in integrating ICT tools into their teaching practices?
- What strategies can be proposed to enhance the utilization of digital tools such as ICT in the teaching and learning of integrated science courses?

1.4. Hypothesis

The hypothesis was formulated and tested at 0.05 alpha level of significance:
$H_0$1: There is no significant difference in the effect of digital tools utilisation on students' academic performance in integrated Science at public tertiary institutions in Nigeria

1.5. Significance of the Study

This research would to provide a comprehensive understanding of the utilization of digital tools in the teaching and learning of integrated science courses in public tertiary institutions in Nigeria. By identifying current practices, challenges, and opportunities, the study will contribute to the development of strategies that can enhance digital tool integration in education, ultimately improving the quality of science education in the country. The study findings would offer experimental proof on the effect of digital use utilization at improving students' performance, retention in the regards of integrated science. Findings from the study would justify the fact that the issue of poor performance, retention and interest in Integrated Science and Technology can be addressed through the use of digital tools and with online learning platforms.

This study will would improve the learning outcomes of students in integrated science since integrated science educators will be exposed to the benefits of utilisation of digital tools in integrated science teaching and this will continue to guarantee students interest in learning science for national development. Furthermore, the finding of the study would also improve knowledge, provides guidelines that may be of help to policymakers on the use digital tools as a better alternative to conventional classroom instruction. The research would be of importance to planners, implementers, and recipients of the curriculum to the effect that it could enhance learners' academic achievement in integrated science. The study would be of significance to Integrated Science teachers and the way in which they address gaps in the learners' knowledge and understanding.

2. Literature Review

The integration of digital tools (Information and Communication Technology devices and learning platforms) in education has become a global trend, driven by the potential of digital tools to enhance teaching and learning outcomes. In the context of Nigeria, the adoption of ICT tools in public tertiary institutions is critical for improving the quality of education, particularly in science disciplines such as integrated science (Eze and Adu (2018) 2018). This literature

review explores the theoretical frameworks, existing studies in integrated science and on digital tools utilization in science education, the barriers and benefits of digital tools integration, and the specific context of digital tools use in Nigerian tertiary institutions.

2.1. Theoretical Framework

Several theoretical models have been developed to explain the integration and utilisation of technology in education. This study will be guided by:

2.1.1. Constructivist Learning Theory and Technology Acceptance Model

Constructivist Learning Theory: Constructivism may be defined as an epistemological theory which sees the learner as an active participant, construct knowledge rather than just passively takes in information the teaching/learning process. According to Vygotsky (1978), learning is a social process that is enhanced through interaction with others and the environment and by observation and exploration of events Driver (1994). ICT tools can facilitate such interactions, making them valuable in constructivist learning environments.

Technology Acceptance Model (TAM): Developed by Davis (1989) as cited by (Becta, 2004), TAM suggests that perceived ease of use and perceived usefulness are the primary factors influencing the acceptance and use of technology. This model has been widely used to study ICT adoption in educational settings. These theoretical frameworks provide a foundation for understanding how and why educators and students in Nigerian public tertiary institutions might adopt and utilize ICT tools in teaching and learning integrated science.

2.2. Conceptual Review

2.2.1. The Concept of Integrated Science, Philosophy and objectives of Integrated

Science Teacher Education Curriculum

Integrated science programme is integration of various sciences as well as process through which the spirit of inquiry and other important psychomotor skills can be taught to student' s right from primary schools, junior secondary school and senior secondary level and at the higher institution level, teachers are produced for this job. Ajibola (2008) laments that this great effort has not yielded much as fewer students still opt to study science. This deficiency he attributed to lack of solid basic foundation in science which points to integrated science as a course. If a child is not grounded in integrated science at this lower basic level, he/she might not show interest in offering core science courses in Biology, Physics and Chemistry. Nigeria integrated science Teacher Education Project (1983) described integrated science as a course in which various concepts in basic sciences like geography, public health, physics, chemistry, biology and so on are integrated to produce curriculum which when taught, an individual with an integrated conception of science, who will be capable of teaching integrated sciences as a core subject in universities. NCCE (2008) anchored the philosophy of integrated science on the Fundamental unity of science, the use of scientific method as a common approach in solving problems of scientific nature and the role and functions of science in everyday life. While the objectives includes enabling students gain the concepts of the fundamental unity of science, instilling in student' s a commonality of approach to problems of a scientific method, increasing student' s understanding of the role and functions of science in everyday life and in world which they live and enabling students carry out scientific investigations, emphasizing cooperation and development of appropriate scientific process and skills and improving their written and oral communication skills. The philosophy and objectives of integrates science are further more based upon six themes as cited by Dogara (2006) some of the themes include the following:

- Living things and the environment
- Non-living things in the environment
- Controlling the environment.

2.2.2. Digital tools in Education: Global Perspectives, Educators' and Students' Perceptions

Globally, the use of digital tools in education has been recognized as a means to enhance teaching and learning processes. According to UNESCO (2020), digital tools can support a wide range of educational activities, from interactive simulations and virtual laboratories to collaborative platforms and online assessments. Studies have shown that digital tools integration can lead to improved student engagement, higher-order thinking skills, and better learning outcomes (Voogt, 2013). However, the success of digital tools integration depends on various factors, including teacher training, infrastructure, and institutional support. Research by Tondeur (2016) highlights the importance of professional development programs that equip educators with the necessary skills to effectively use digital tools in their teaching.

Research by Eze and Adu (2018) indicates that while many educators acknowledge the potential benefits of digital tools in enhancing teaching and learning, there is often resistance to change due to a lack of familiarity with the technology or concerns about the reliability of digital tools. Similarly, students' attitudes towards digital tools use are influenced by their prior experience with technology and the perceived relevance of digital tools to their learning (Olatunji, 2019).

2.2.3. Digital tools Utilization and Adoption Rates in Nigerian Tertiary Institutions

In Nigeria, the government and educational institutions have recognized the importance of digital tools in education. The National Policy on Education (2013) emphasizes the need for digital tools integration across all levels of education. Despite these policy directives, the actual level of digital tools utilization in Nigerian tertiary institutions varies widely. Studies by Olaniyi (2021) and Oye (2014) reveal that while some institutions have made significant strides in adopting digital tools, others lag due to various challenges. For instance, Oye (2014) found that the use of digital tools in teaching and learning in Nigerian universities is often limited to basic applications such as PowerPoint presentations and internet searches, with less emphasis on more advanced tools like virtual laboratories or educational software.

2.2.4. Benefits of Digital tools Integration in Science Education and Barriers towards its a Utilisation

The integration of digital tools in science education offers numerous benefits, particularly in enhancing the teaching and learning of complex scientific concepts. According to Akpan (2020), digital tools such as simulations, animations, and virtual experiments can make abstract scientific concepts more tangible, thereby improving students' understanding and retention. Additionally, ICT facilitates collaborative learning and provides access to a wealth of online resources that can enrich the curriculum (Ndukwe & Daniel, 2017). Several Barriers hinder the effective utilization of digital tools in Nigerian tertiary institutions. Barriers that discourage the use of digital tools by teachers were also reviewed. These factors categorized are into teacher-level, school-level and system-level barriers. Teacher-level barriers include lack of teacher digital tools skills; lack of teacher confidence; lack of pedagogical teacher training; lack of follow-up of new and lack of differentiated training programmes. The school-level barriers comprise absence of ICT infrastructure; old or poorly maintained hardware; lack of suitable educational software; limited access to digital tools; limited project-related experience; lack of digital tools mainstreaming into school's strategy and the system-level barriers include rigid structure of traditional education systems; traditional assessment; restrictive curricula and restricted organizational structure. Knowing the extent to which these barriers affect individuals and institutions may help in taking a decision on how to tackle them (Becta, 2004). A study by Afolabi (2020) also points to the high cost of digital tools and maintenance as a significant barrier to widespread adoption.

3. Methodology

3.1. Research Design:

This study adopted a mixed method of descriptive and non-equivalent pretest, posttest, control group quasi-experimental research design. This research design opined that assessment is taken before and after the intervention alongside with a comprehensive analysis of the level of digital tools utilization in the teaching and learning of integrated science courses in southwest Nigerian public tertiary institutions.

3.2. Population and Sampling

3.2.1. Population

The population for this study comprised of 16300 14500 of students, with 36 lecturers and ICT administrators in public tertiary institutions across Nigeria, particularly those involved in the teaching and learning of integrated science courses.

3.2.2. Sampling Technique:

A multi-stage sampling procedures were employed, Purposive Sampling was used to select public tertiary institutions known for offering integrated science courses in the 6 southwest states of Nigeria. The six Southwest were further divided into three strata; Ogun and Lagos, Ekiti and Osun, and Oyo and Ondo state, while Stratified sampling procedure was used to pick a State from each stratum, with Ogun, Osun and Oyo as the sampled States for the study with further consideration on factors such as regional representation, ICT infrastructure, and student enrollment in integrated science programs. Lecturers, students, and ICT administrators were sampled as subjects for the study. They were randomly selected using simple random sampling techniques with 10% of the student's population for test retest, with half of the lecturers and ICT administrators for questionnaire as the sample size.

3.3. Research Instruments and Validation

Two instruments were used for data collection. They are questionnaire Digital tools utilization Questionnaire in the teaching and learning of Integrated Science' ' (DITUQTLITS) for lecturers, ICT administrators and students and test retest, Integrated Science Achievement Test' ' (ITSAT) for students. Face, Content and Construct Validity of the questionnaire was ensured by Integrated Science Educators, while, for reliability, 20 copies of the ITSAT were administer on 20 students in an institution not involved in this study, but, with the same characteristics to those of the sampled schools, for trial testing of the instrument. The students were subjected to test-retest method, and the data collected was subjected to reliability test using Cronbach's Alpha with reliability coefficient of 0.75

4. Results

The results shown the analysis of the collected data

Table 1 Descriptive analysis of the Digital tools utilization in the teaching and learning of Integrated Science

S/N	ITEMS	SA N/%	A N/%	D N/%	SD N/%
1.	Perceptions and attitudes of integrated science educators and students towards the use of digital tools such as ICT in teaching and learning is negative.	14 8.6	7 4.3	25 15.3	117 71.8
2.	Digital tools and learning platforms such as flipped classroom, interactive whiteboard, projector, virtual(online) classroom, multimedia podium are the commonly available and use for teaching and learning of integrated science courses in tertiary institutions.	59 36.2	40 24.5	33 20.3	31 19.0
3.	The digital tools are frequently used in teaching and learning of integrated science courses in tertiary institutions.	60 36.8	41 25.2	27 16.6	35 21.4
4.	Power failure, poor maintenance culture, inadequate personnel with good knowledge on usage of the digital tools are barriers to its effective utilization	84 51.5	52 31.9	17 10.4	10 6.2
5.	Training and retraining of Integrated educators, employment of more personnel that are ICT inclined will enhanced the use of digital tools in teaching and learning of integrated science courses in tertiary institutions	100 61.4	55 33.7	3 1.8	5 3.1

The result presented in table 1 showed the descriptive analysis of the responses of the respondents. The analysis shown that perceptions and attitudes of integrated science educators and students towards the use of digital tools in teaching and learning is and not negative as presented in the item on the questionnaire, with 142 (87.1%) of the respondents disagree and strongly disagree with the item, while 21 (12.9%) agree to the statement. More so, the result further showed that digital tools and learning platforms such as flipped classroom, interactive whiteboard, projector, virtual(online) classroom, multimedia podium are the commonly available and use for teaching and learning of integrated science courses in tertiary institutions with 99 (60.7%) attested to this as against 64 (39.3%) that against it. In addition, the result showed that power failure, poor maintenance culture, inadequate personnel with good knowledge on usage of the digital tools are barriers to its effective utilization with 101 (62%) agree as against 62 (38%) that against this submission. Conclusively, 155 (95.1%) of the respondents agree that training and retraining of Integrated educators, employment of more personnel that are ICT inclined will enhanced the use of digital tools in teaching and learning of integrated science courses in tertiary institutions as against 8 (4.9%) that disagree.

4.1. Testing of Hypotheses

Hypothesis One: There is no significant difference in the effect of digital tools utilisation on students' academic performance in integrated Science at public tertiary institutions in Nigeria.

In order to test the hypothesis, data collected on integrated science students' academic performance having been taught using digital tools; virtual, flipped and conventional instructional strategies were subjected to descriptive analysis, analysis of covariance (ANCOVA) and post-hoc analysis of Bonferroni using the students' posttest scores in Integrated Science and Technology Achievement Test (ITSAT) as the dependent variable and the pretest scores as the covariates while the treatment groups serve as the fixed factors. The results are presented in the Tables 2, 3, and 4 respectively.

Table 2 Descriptive analysis of the effect of Digital tools (Virtual and Flipped classroom) on students' academic performance in integrated science courses in tertiary institutions

S/N	Treatment groups	N	X	S. D
1	Virtual Classroom (Osun State)	44	22.818	1.46704
2	Flipped Classroom (Oyo State)	57	24.860	3.60772
3	Control Group (Ogun State)	62	20.290	1.24647

N=163

The results presented in table 2 showed the descriptive analysis of the effectiveness of Virtual, flipped classroom and conventional instructional strategies on students' academic performance in integrated science courses in tertiary institutions in the Southwest part of Nigeria. It can be seen from the table that integrated science students taught with digital tool (flipped classroom instructional strategy) had the highest mean score (X = 24.860), integrated science students exposed to digital tool (virtual classroom instructional strategy) had a high mean score of (X = 22.818), while learner taught using the conventional instructional strategy had a mean score of(X = 20.290).

Table 3 showed the effects of the effect of Digital tools (Virtual and Flipped classroom) on students' academic performance in Integrated Science Achievement Test (ITSAT) in tertiary institutions in Southwest States

Table 3 Analysis of Covariance of the effect of Digital tools (Virtual and Flipped classroom) and Conventional method of teaching on students' academic performance in Integrated Science in tertiary institutions in Southwest States

Tests of Between-Subjects Effects **Dependent Variable: post_test_performance_virtual_classroom**						
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	91.338[a]	3	30.446	38.492	.000	.421
Intercept	375.861	1	375.861	475.184	.000	.749
pre_test_performance_ virtual_classroom	.640	1	.640	.810	.370	.005
Strategies	91.019	2	45.510	57.536	.000	.420
Error	125.766	159	.791			
Total	35968.000	163				
Corrected Total	217.104	162				

R Squared = .421 (Adjusted R Squared = .410); (F= 57.536, P<0.05 η^2= 0.420)

This result showed a significant effect of digital tools (virtual and flipped classroom instructional strategies) and the conventional method on students' academic performance in Integrated Science achievement test in tertiary

institutions in Southwest States achievement at ($F= 57.536$, $P<0.05$ $\eta^2= 0.420$). Therefore, the null hypothesis state that there is no significant difference in the effect of digital tools (virtual classroom and flipped classroom instructional strategies) on students' academic performance in Integrated Science in tertiary institutions in Southwest States is hereby rejected. The partial eta squared value of 0.420 accounted for the effect size of 42.0% variation on students' academic performance in Integrated Science in tertiary institutions in Southwest States.

Table 4 presents the Bonferroni post-hoc analysis of the use of digital tools (virtual and flipped classroom instructional strategies) and the conventional method on tertiary institutions students' academic performance in Integrated Science.

Table 4 Bonferroni post-hoc analysis of the use of digital tools (virtual and flipped classroom instructional strategies) and the conventional method on tertiary institutions students' academic performance in Integrated Science.

Pairwise Comparisons **Dependent Variable: post_test_performance_virtual_classroom**						
(I) Strategies	**(J) Strategies**	**Mean Difference (I-J)**	**Std. Error**	**Sig.[b]**	**95% Confidence Interval for Difference[b]**	**95% Confidence Interval for Difference**
					Lower Bound	Upper Bound
Virtual	Flipped	-1.484*	.178	.000	-1.916	-1.052
	Control	.160	.178	1.000	-.271	.591
Flipped	Virtual	1.484*	.178	.000	1.052	1.916
	Control	1.644*	.166	.000	1.242	2.047
Control	Virtual	-.160	.178	1.000	-.591	.271
	Flipped	-1.644*	.166	.000	-2.047	-1.242

Based on estimated marginal means; *. The mean difference is significant at the .05 level.; b. Adjustment for multiple comparisons: Bonferroni.

The post-hoc analysis test showed the result of Bonferroni comparison conducted to determine where the difference exists among the three groups in the study. It can be deduced from the table that students taught with digital tools (Virtual Classroom; Mean Difference = 1.484, $p < 0.00$, Flipped Classroom; Mean Difference = 1.644, $p < 0.05$ and Conventional method Mean Difference = 0.160, $p < 0.05$) are significantly different.

5. Discussion of the Findings

The findings of the study established the significant effect on the use of digital tools (virtual and flipped classrooms instructional strategies) and the conventional method on tertiary institutions students' academic performance in Integrated Science, this is evident from the fact that there was a significant difference in the students' performances varying from virtual, flipped, and conventional method. The results also showed that students exposed to digital tool (flipped instructional strategy) performed higher, while students exposed to digital tool (virtual classroom instructional strategy) performed better than those taught with conventional method. This can be attributed to the fact that both instructional strategies can effectively engage the students, facilitate a more profound understanding of the content, and also aid their retention ability, and increases their interest in Integrated Science than conventional method. The result of the hypothesis established that there was a significant effect of the utilization of digital tools (virtual and flipped classroom instructional strategies) method on tertiary institutions students' academic performance in Integrated Science, this is because both strategies activity-based which involved learning by doing, interaction with digital tools powered the virtual and flipped classroom with the audio-visual contents aids the knowledge of the students' , thus performed better academically.

The findings are in tandem with the study conducted by Chen (2020) that Learning is an active practice of permanent behavioural changes through construction of knowledge and meaning. Individuals' construct their own thoughtful of the world around them based on experiences and social interactions. Learners' uses sensory knowledge to construct meaningful learning personally out of given work when actively engaged in learning by doing and contributing thought with colleagues and with the use of environment which is also in line with the constructivism theory of cognitive development by (Piaget, 1954) which emphasized that learners' actively put up their knowledge based on

the previous experiences and interactions. This theory that pointed that knowledge is constructed with the interaction of learners in the environment.

Also, the study is in line with the research carried out by Zhang, *et. al*., (2020), a virtual classroom has taken it real space with developed countries using virtual and flipped classrooms to provide online education for students and bringing a new educational reality in which if classrooms were closed learning will not be interrupted, thus, increasing the learning time and improving performances.

6. Conclusion

The study has shown that students taught with the use of digital tools are rate significantly better in their performance, than those taught with conventional method. Based on the findings that were established from the study, it was shown that digital tool; flipped classroom is the most effective of the two instructional strategies used in the treatment groups, while virtual strategy follows in teaching tertiary institutions students in Integrated Science. The study, therefore, concluded that digital tools utilisation has positive significant effects on tertiary institutions students' academic performance and makes students to develop interest in choosing Integrated Science as a course of study across the Nation.

Recommendations

Based on the conclusions of the findings of this study, the following recommendations were made

- Integrated Science educators should expose their students to use of digital tools in order to improve their performance, retention, and interest towards Integrated Science.
- Seminars, workshops and conferences should be continuously be organised for Integrated Science educators on the effective use of digital tools and the techniques required, which will serve as in-service training for the teachers.
- Students of Integrated Science should be encouraged and always be involved in their learning, with the use of activity-based methods which digital tools stands for.
- Availability of computer system, interactive whiteboard, and other technological apparatus needed for the efficient implementation of digital tools should be made available in schools by governments and other stakeholders
- Ministry of education and other appropriate bodies and stakeholders should see to proper monitoring and strict compliance by teachers on the use of appropriate strategies in teaching of Integrated Science in tertiary institutions.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Full consent of the participants and Formal authorisation and ethical clearance to conduct the study were obtained from Head of the Deparment/Unit and other appropriate authorities of the institutions prior to the study. All participants were given a guarantee of confidentiality and anonymity in reporting the information provided for the study and the research will adhere to ethical guidelines concerning the collection, storage, and dissemination of data. The study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Statement of informed consent

Participation in the study was entirely voluntary. This consent process included a thorough explanation of the study's purpose, procedures, potential risks, and benefits. Additionally, Assent was obtained from each student participant, ensuring their personal willingness to take part.

Participants were explicitly informed of their right to refuse to answer any question or to withdraw from the study at any time without suffering any penalty or prejudice.

Confidentiality and Data Security

All ethical measures were taken to ensure the privacy, anonymity, and confidentiality of the participants and their data.

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