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Technology Readiness and Implications for Higher Education in Universities in North-Central Nigeria

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Abstract: The fourth industrial revolution emphasises classroom innovation with digital and smart technology. It examined students' preparation for technology-driven education in higher education and the fourth industrial revolution. A descriptive survey research design was adopted for this study. The population consisted of students from tertiary institutions, while the target population included university undergraduate and postgraduate students in universities in North-Central Nigeria. The sample comprised five hundred and seventy students across three types of institutions in Nigeria (i.e. private, state, and federal-owned institutions), drawn using proportionate and cluster sampling techniques. Data were collected using a researcher-designed and validated questionnaire with an overall reliability index of 0.86. The collected data were analysed descriptively, and non-parametric inferential statistics were tested at a 0.05 level of significance. Students were ready to use educational apps for studying, engage with immersive tech tools while learning, learn about IoT as part of their learning trajectories for 4IR compliance, embrace many technological innovations while learning, and engage in lifelong learning. Moderately technology-ready students had significant gender, age, institution, and degree of study demographics. Also, given the contemporary 4IR reality, students were somewhat ready for technology-enhanced education and positively inclined toward technology-driven abilities. Group dynamics are crucial to preparation. Therefore, it is recommended that students be given the opportunity to improve their technical abilities to prepare them for meaningful teaching and learning. This can be done by investing in technology, training students, and passing regulations that support worldwide competitive online learning.

Keywords: Tertiary institutions, readiness, 4IR, technology-enhanced education.

1. Introduction

Industrial revolutions are characterised by paradigm shifts and revolutionary inventions that fundamentally alter human existence and societal institutions. The Fourth Industrial Revolution (4IR) is a combination of technologies that make it difficult to distinguish between the digital, biological, and physical domains across different economic sectors (Nabi & Zohora, 2022; Sihlongonyane et al., 2020). With the advent of numerous rapidly evolving smart technologies for teaching and learning, there has been a movement in education towards the development of self-sufficient individuals capable of creative problem-solving on both local and global scales (Ayanwale et al., 2022; Oladele et al., 2024; Sharma, 2019). Therefore, education in the 4IR is characterised by the convergence of modern technologies such as artificial intelligence (AI), robotics, the Internet of Things (IoT), and big data to enhance meaningful and functional learning (Bonfield et al., 2020; Latinovic, 2023; Mansor et al., 2020; Oladele et al., 2022; Omodan & Marongwe, 2024).

Technology is rapidly affecting every sector, including education worldwide. The term "technology-driven education" (TDE) describes an educational approach that is evolving to meet the demands of the rapidly changing technological landscape. It seeks to alter traditional educational methods and procedures to provide a learning experience that is more individualised, adaptable, and skills-focused (Friyanto et al., 2021; Pallathadka et al., 2021). TDE is made possible by a plethora of e-

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learning resources that offer excellent options for self-paced study (Shirk, 2020). Educational innovations like flipped classrooms are powered by technologies such as video creation tools, learning management systems (LMS), content repositories, collaboration platforms, podcasts, and online assessment tools, which are valuable because they allow students to engage in interactive learning within the classroom while studying theoretical aspects outside of it (Akçayır & Akçayır, 2018; Awidi & Paynter, 2019; Baig & Yadegaridehkordi, 2023; Oladele et al., 2021). By leveraging adaptive technologies, TDE can customise the learning process to meet the unique needs of every student (Ezzaim, 2023; Oladele et al., 2022). Furthermore, students' confidence in their academic abilities can be enhanced through the use of positive reinforcements, which are employed to foster a positive learning experience (Eriksson, 2010; Heidenreich, 2007). Motivating students in e-learning environments through reinforcement is particularly relevant, given the numerous challenges faced in the higher education landscape in Africa (Mansor et al., 2020; Oladele, 2023).

Digital Africa (2024) reports that governments and businesses in Africa have invested considerably in digital infrastructure to boost digitalisation through internet and mobile access while creating new education and skill development opportunities. Similarly, another report identifies Africa as a significant centre for educational technology, which was brought to the limelight by the global health crisis that resulted in the closure of most schools around the world (Ayanwale & Oladele, 2021; UNESCO, 2023; van der Rijst, 2023). This occurrence has significantly prompted many countries in Africa to embrace technology-driven education (TDE), which is fast gaining relevance with the fourth industrial revolution (4IR). Nkala (2024) reported that with programmes like One Laptop per Child and smart classrooms, Rwanda has made significant progress in incorporating ICT into its education system. Kenya has also emerged as a hotspot for educational technology entrepreneurs generating African-specific digital content and learning tools.

In Nigeria, there are 274 universities comprising private, state, and federal-owned institutions (National Universities Commission, 2024). Considering the realities of the 4IR, the extent to which these universities leverage technology in pedagogical engagements raises important questions. While TDE is widely accepted as a beneficial development, its readiness remains a pertinent issue for meaningful engagement. TDE readiness denotes the mental, physical, and material preparedness of universities involved in an e-learning project, which is essential for a successful e-learning experience and implementation. As a basic requirement, higher education institutions (HEIs) must ensure they possess adequate environmental, technological, and other facilities when implementing TDE (Nwagwu, 2020).

Lecturers at the Nigeria's premier university were uncertain about students' TDE readiness in terms of their understanding of e-learning and having sufficient IT/web skills required to support e-learning (Nwagwu, 2020). Findings from another study conducted at a privately-owned university in North-Central Nigeria suggest that, generally, students are positive and open-minded about the potential of AI to enhance their learning experiences while also expressing concerns regarding privacy in relation to data collection and utilisation, alongside the necessity for sufficient training to effectively employ AI tools (Suleiman, 2024). Readiness for TDE is widely acknowledged as an essential precondition for its implementation, providing evidence to support its potential value (Livet et al., 2022). It is against this backdrop that this study investigates students' readiness for TDE on a wider scale in universities in North-Central Nigeria.

2. Literature Review

With a plethora of smart learning technologies in the 4IR era, students can choose how to learn, while the organisations responsible for the curriculum set the learning objectives for each course (Ayanwale et al., 2024; Oladele et al., 2020; Sosa et al., 2018). Blended learning, the flipped classroom, and the Bring Your Own Device (BYOD) approach are some of the alternatives that lecturers can implement to provide students with the opportunity to be creative in their learning (Afreen, 2014;

Baig & Yadegaridehkordi, 2023; Galindo-Dominguez, 2019; Hrastinski, 2019). Technology-Driven Education (TDE) facilitates personalised learning that encourages creativity, invention, and problem-solving, while also providing more time for individual instruction (Intel Corporation, n.d.). Other advantages include remote learning, customisable instruction, and adaptability of learning resources (Lawrence et al., 2019; Panagiotopoulos & Karanikola, 2020). Furthermore, there should be an increased emphasis on student-centred learning approaches, such as experiential and problem-based learning, which have been empirically proven to be effective for teaching and learning (Daramola et al., 2024; Oladele et al., 2024). Additionally, TDE equips students with the information and skills they will require in the digital age, preparing them for the challenges posed by 4IR. The technology-driven educational model emphasises the effective dissemination of information. It also enhances students' capabilities, revitalises their problem-solving skills, increases motivation, fosters individual talents, and improves learning outcomes, all of which are central to a student-centred educational approach (Udvaros et al., 2023).

There are varying degrees of readiness for achieving success within the technology-driven education space based on demographic information, such as age, which categorises individuals as "digital natives" or "digital immigrants" (Creighton, 2018; Wang et al., 2013). To elaborate, "digital natives" are those who have always used and been connected to technology-based tools (Machaba & Bedada, 2022). These individuals are more likely to successfully employ technology-based resources when making educational decisions. However, it is typically considered that digital immigrants struggle with information technology. That said, with increased internet usage, digital immigrants could become quite skilled at utilising a range of technological tools throughout their lives in an adaptive way (Helsper & Eynon, 2009). Therefore, age becomes an important factor for understanding students’ readiness for technology-driven education.

Gender is another variable increasingly regarded as significant in assessing students’ readiness for technology-enhanced education within the higher education space, considering that findings have been inconclusive. A study by Oladele et al. (2021) revealed significant differences related to the male gender, while Ayanwale et al. (2024) found significant differences associated with the female gender which leaves room for further investigation. Mourdoukoutas (2017) indicated that the advent of the digital revolution holds great potential for Africa while stressing that turning a digital divide into dividends will require bridging gender disparities, as women are fifty per cent less likely to use the internet than men. Similarly, Petrosyan (2024) reported that the percentage of women who actively use the internet worldwide is quite low compared to men, necessitating deliberate action to close the gender gap, with internet use as a key driver of 4IR. The funding model adopted is another important factor that must effectively enhance technology integration in Nigerian public institutions, which are mostly government-funded. This factor remains crucial, given that human capital development cannot be accomplished without quality higher education (Akpoghome & Nwano, 2020).

Higher education in the 4IR should prepare students for a world driven by AI, automation, and advanced technologies (Oladele et al., 2022; Rane et al., 2023; World Economic Forum, 2024). Digital technologies, such as reliable internet services and ICT platforms that support virtual classrooms with web conferencing and LMS are necessary for effectiveness (Satori et al., 2019; Udvaros et al., 2023; Yakubu & Dasuki, 2021). Assessing students' readiness for the 4IR is crucial for cultivating competent, knowledgeable, and trained graduates capable of enhancing the nation's skilled workforce. This assessment will assist higher education institutions (HEIs) in ensuring that their graduates possess the requisite skill sets for employment in the 4IR (Al-Maskari et al., 2022).

A study was conducted on readiness for technology-driven education within the context of basic education (Alakrash et al., 2020; Ricablanca et al., 2024). Another study focused on the higher education sector in Ghana (Narh-Kert et al., 2022). Similarly, Pahugot et al. (2022) investigated the level of basic school readiness in adopting technology-driven education related to teaching and learning practices, considering the necessary infrastructure. Additionally, Oladele et al. (2021) and Mohammed et al. (2024) concentrated on the readiness of lecturers for technology-driven education. Ayanwale et al. (2024) also explored the readiness of in-service computer science teachers for technology-driven education. However, the extent to which Nigerian universities are prepared for technology-driven education, from the perspectives of students who are major stakeholders, still requires urgent investigation. In response to this need, this study aims to assess the readiness of students in Nigerian universities for technology-driven education while identifying challenges and opportunities for growth and development within the higher education context. The specific questions are as follows:

- What is the perceived students' readiness to acquire relevant skills through technology-driven education?
- What is the level of students' readiness for technology-driven education?

The following hypotheses were generated for this study:

- H_{01}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on gender.
- H_{02}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on age.
- H_{03}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on institution type.
- H_{04}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on the level of study.

3. Methodology

This study adopts a descriptive research design of survey type. This research design is deemed appropriate for providing an overview of lecturers' readiness for technology-driven education without any form of manipulation by the researcher (Siedlecki, 2020). This design also promotes simplicity, allowing for dissemination in an understandable form, which is a requirement for the implementation of research findings (Faryadi, 2019).

The population for this study comprises students in higher institutions in North Central Nigeria, while the target population includes undergraduates and postgraduates studying in private, state, and public universities in Kwara State. The average enrolment rates in these targeted universities are 950, 9,500, and 42,500 students in the selected private, state, and federal-owned universities, respectively (uniRank, 2005-2024).

The multi-staged sampling technique was employed to draw participants from the target population. At the first stage, Kwara State was purposively selected from the six states in the North Central geo-political zone of Nigeria because it has the highest number of universities (Mogaji, 2019; National Universities Commission, 2024; Sasu, 2024). There are ten universities in the selected state, comprising one federal university, one state university, and eight privately-owned institutions. At the second stage, the proportionate sampling technique was used to select one university from each of the three types (names withheld to ensure institutional non-disclosure). By default, the federal and state-owned universities were selected, along with three private institutions. The sample size was determined using an online sample size calculator based on a confidence level of 95%, with the real value expected to fall within ±5% of the measured/surveyed value, and at a proportion of 1:1:3. This amounted to 70, 137, and 381 students from private, state, and federal institutions involved in the study, respectively. Students in each of the selected universities were reached in clusters (university-based WhatsApp groups) where the research survey link was shared, resulting in five hundred and eighty-eight (588) responses received. The data was cleaned to include only responses from participants who indicated knowledge of the use of technology in education, constituting the attrition rate. Therefore, five hundred and seventy (570) responses were included in the analysis, amounting to a ninety-seven percent (97%) data collection rate.

The instrument for the study was a questionnaire adapted from existing related questionnaires for assessing readiness for technology-driven education (Ayanwale et al., 2024; Narh-Kert et al., 2022). The adapted questionnaire consisted of five sections. Section one aimed to inform participants about the research and obtain their informed consent. Section two contained a Declaration Section regarding participants' understanding of technology-driven education. Section three was designed to collect demographic information from the respondents, while section four included a scale to assess students' readiness to acquire relevant skills for technology-driven education and the associated challenges. The final section of the questionnaire was an appreciation section (section five). The scale section of the instrument was face-validated and content-validated by experts in educational measurement and psychometrics. The instrument was pilot-tested with students in non-university higher institutions. The responses received were subjected to reliability analysis using the measure of internal consistency, and the reliability index obtained for the scaled section on students' readiness was 0.923. With a benchmark of 0.7 for scaled instruments, the obtained reliability index confirmed that the instrument was reliable. The validated instrument was administered through Google Forms, and the link was disseminated via various students' WhatsApp groups.

Descriptive statistics of frequency and percentages were used to answer non-testable research questions, while the generated hypotheses were tested using the non-parametric Mann-Whitney U Test and Kruskal-Wallis Tests. The author ensured that participants were properly informed about the study's goal and action-oriented strategy. Furthermore, the data collection process was explicitly described to the participants. Prior to implementing the research project, the researcher sought ethics approval from the relevant authority and obtained informed consent from all parties involved in the study, with all surveys completed on a voluntary basis. The conclusions of this study are not identity-specific, and institutional confidentiality is maintained.

4. **Presentation of Results**

4.1 Demographic information of respondents

The demographic information of respondents was analysed using descriptive statistics, including frequency and percentages, as shown in Figures 1 to 4.

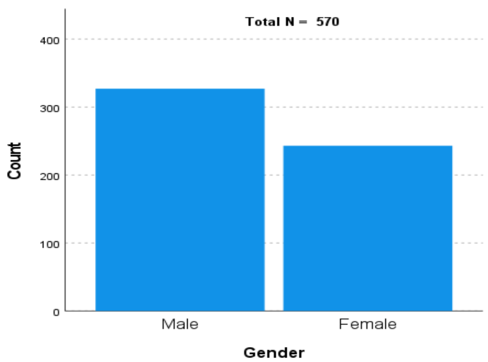

Figure 1: *Field information on students' gender*

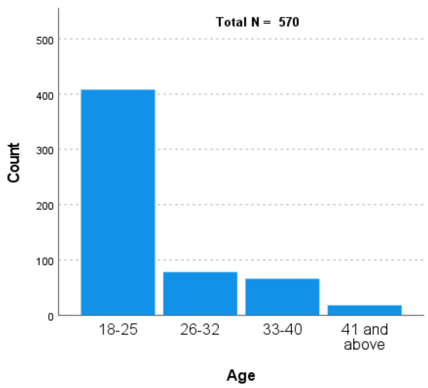

Figure 2: *Field information on students' age*

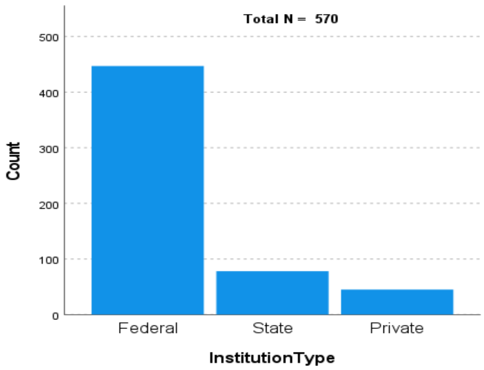

Figure 3: Field information on students' institution type

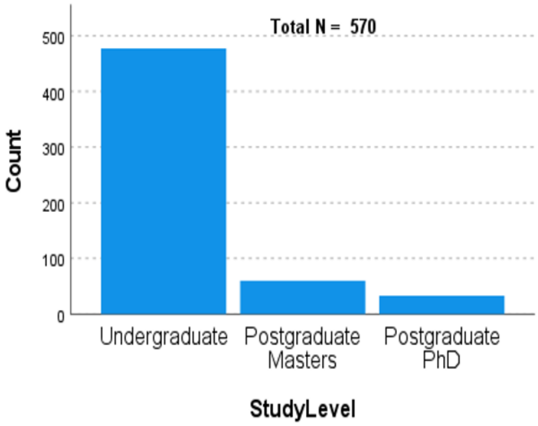

Figure 4: Field information on students' level of study

(42.6%) were female. This indicates that more males participated in the study than females. In terms of the participants' age range (Figure 2), 408 (71.6%) were aged between 18 and 25 years, 78 (13.7%) were aged between 26 and 32 years, 66 (11.6%) were aged between 33 and 40 years, while 18 (3.3%) were aged 40 years and above. This information on age categories reveals that the majority of study participants were aged between 18 and 25 years. Additionally, the statistics on institutional ownership and level of study (Figures 3 and 4) indicate that 477 (83.7%) of the participants were from federal universities, 60 (10.5%) from state universities, and 33 (5.8%) from private universities. This suggests that most of the study participants were from federal universities in Nigeria and were studying at the undergraduate level.

4.2 Answering the non-testable research questions

Research Question 1: What is the perceived students' readiness to acquire relevant skills through technology-driven education?

The readiness scale consisted of twenty items assessed on a four-point scale: Not at all (NA) weighted as 1, To some extent (SE) weighted as 2, To a large extent (LE) weighted as 3, and to a very large extent (VLE) weighted as 4. The responses were analysed using frequency (F), corresponding percentages (%), and median scores, as shown in Table 1.

***Table 1:** Perceived students' readiness to acquire relevant skills*

S/N	Item	NA F (%)	SE F (%)	LE F (%)	VLE F (%)	Median
1	I am ready to embrace the opportunities presented by 4IR by using the educational app for my study.	45(7.9)	282(49.5)	174 (30.5)	69 (12.1)	2
2	I am ready to enhance my capabilities for learning using Moodle as a learning management system, among others	30(5.3)	222 (38.9)	228(40.0)	90(15.8)	3
3	I am ready to join forward-thinking learners who are gearing up for 4IR.	36(6.3)	195 (34.2)	234 (41.1)	105(18.4)	3

4	I am committed to capitalising on all possible opportunities to enhance my knowledge.	33 (5.8)	207 (36.3)	210 (36.8)	120 (21.1)	3
5	I am ready to acquire knowledge in modern Ed Tech facilities to learn as demanded by 4IR.	30(5.3)	195 (34.2)	219 (38.4)	126 (22.1)	3
6	I am ready to engage with immersive tech tools while learning.	207(36.3)	234 (41.1)	99(17.4)	30(5.3)	2
7	I am ready to acquire knowledge about IoT as part of my Learning trajectories for 4IR compliance.	39(6.8)	246(43.2)	204(35.8)	81 (14.2)	2.5
8	I am ready to acquire knowledge about smart classrooms in the context of 4IR.	27 (4.7)	198 (34.7)	237(41.6)	108 (18.9)	3
9	I am ready to be a 4IR ambassador by embracing the numerous technological innovations while learning.	36 (6.3)	246 (42.6)	174(30.5)	117 (20.5)	3
10	I am ready to engage with EdTech services for learning.	51 (8.9)	207 (36.3)	222 (38.9)	90 (15.8)	3
11	I am ready to acquire knowledge about AI.	36(6.3)	198(34.7)	177 (31.1)	159 (27.9)	3
12	I am ready for lifelong learning, being a 4IR requirement.	171(30.0)	240 (42.1)	123(21.6)	36(6.3)	2
13	I am ready to align with transformations brought by emerging innovations in education	48(8.4)	237(41.6)	204 (35.8)	81(14.2)	2.5
14	I am ready to gain the skills of creativity and complex problem-solving required in the 4IR era.	33 (5.8)	207 (36.3)	234 (41.1)	96 (16.8)	3
15	I am ready to learn using gargets such as smartphones, laptops, tablets, computers, personalised systems, etc.	42(7.4)	204 (35.8)	168(29.5)	156 (27.4)	3
16	I am ready to learn using print, such as textbooks, handouts, etc.	69(12.1)	246 (43.7)	186(32.6)	65(11.6)	2
17	I am ready to develop the skill to access Internet applications to search for learning materials	48(8.4)	213(37.4)	186(32.6)	123 (21.6)	3
18	I am ready to develop technical skills to prepare my classroom presentation using PowerPoint	93 (16.3)	222(38.9)	186(32.6)	69(12.1)	2
19	I am ready to develop skills for using my university e-mail to submit my classroom assignments and discuss with my teachers and classmates	51 (8.9)	246 (43.2)	171(30.0)	102(17.9)	2
20	I am ready to develop skills with using YouTube to consolidate learning	60 (10.5)	237(41.6)	165(28.9)	108(18.9)	2

Table 1 shows a detailed item analysis revealing that students were to some extent ready to embrace opportunities presented by 4IR by using educational apps for studying (282-49.5% with a median score of 2), engaging with immersive tech tools while learning (234-41.1% with a median score of 2), acquiring knowledge about IoT as part of their learning trajectories for 4IR compliance (246-43.2% with a median score of 2.5), being a 4IR ambassador by embracing the numerous technological innovations while learning (246-42.6% with a median score of 3), acquiring knowledge about AI (198-34.7% with a median score of 3), engaging with immersive tech tools while learning (234-41.1% with a median score of 2), acquiring knowledge about IoT as part of their learning trajectories for 4IR compliance (246-43.2% with a median score of 2.5), being a 4IR ambassador by embracing the numerous technological innovations while learning (246-42.6% with a median score of 3), engaging in lifelong learning as a 4IR requirement (240-42.1% with a median score of 2), aligning with transformations brought by emerging innovations in education (237-41.6% with a median score of 2.5), learning using gadgets such as smartphones, laptops, tablets, computers, and personalised systems, etc. (204-35.8% with a median score of 3), learning using print materials such as textbooks, handouts, etc. (246-43.7% with a median of 2), developing the skill to access internet applications to search for learning materials (213-37.4% with a median of 3), developing technical skills to prepare classroom presentations using PowerPoint (222-38.9% with a median of 2), developing the skills for using university e-mail to submit classroom assignments and discuss with teachers and classmates (246-43.2% with a median of 2), and being somewhat ready to develop skills for using YouTube to consolidate learning, with a median of 2. Furthermore, the analysis revealed that students were to a large extent ready to enhance their capabilities for learning using learning management systems, e.g., Moodle, among others (228-40.0% with a median score of 3), join forward-thinking learners who are gearing up for 4IR (234-41.1% with a median score of 3), enhance their capabilities for learning using learning management systems, e.g., Moodle, among others (228-40.0% with a median score of 3), join forward-thinking learners who are gearing up for 4IR (234-41.1% with a median score of 3), commit to capitalising on all possible opportunities to enhance knowledge (210-36.8% with a median score of 3), acquire knowledge in modern EdTech facilities for learning as demanded by 4IR (219-38.4% with a median score of 3), acquire knowledge about smart classrooms in the context of 4IR (237-41.6% with a median of 3), engage with EdTech services for learning (222-38.9% with a median score of 3), and gain skills in creativity and complex problem-solving required in the 4IR era (234-41.1% with a median score of 3). These results show that most of the students were somewhat ready to acquire relevant skills through technology-driven education, while they were ready to a large extent for others.

Research Question 2: What is the level of students' readiness for technology-driven education?

To effectively determine the level of students' readiness for TDE, responses which were originally collected on a four-point scale with minimum and maximum values of 20 and 80, respectively, were recorded to 20-40: 1 to indicate not ready; 41-61: moderately ready; and 62-80 to indicate a high level of readiness for students to acquire relevant skills through technology-driven education. The resulting data were analysed using percentage statistics, as shown in Table 2.

Table 2: *Level of students' readiness for technology-driven education*

Level of readiness	Frequency	Per cent
Not Ready	132	23.2%
Moderately Ready	327	57.4%
Highly Ready	111	19.5%
Total	570	100.0

As shown in Table 3, 132 (23.2%) participants reported that they were not ready, 327 (57.4%) reported being moderately ready, while 111 (19.5%) reported a high level of readiness. These results indicate that most students reported a moderate level of readiness for technology-driven education.

2.3 Testing the study hypothesis

The data on students' levels of readiness was subjected to a test of normality using the numeric method—Kolmogorov-Smirnov test of normality—as a requirement for conducting inferential statistics. To do this, the dependent variable of students' levels of readiness for framing the study hypotheses was used, and the result is shown in Table 3.

Table 3: *Kolmogorov Smirnov test of normality for level of readiness*

Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Statistic	*Df*	Sig.	Statistic	*df*	Sig.
.060	570	.000	.990	570	.001

a. Lilliefors Significance Correction

As shown in Table 3, the p-values for both the Kolmogorov-Smirnov and Shapiro-Wilk tests are .000 and .001, which should both be greater than 0.05. However, the result of this analysis shows that both values are less than 0.05, and this indicates that the data is statistically significantly different from a normal distribution and therefore fails the test of normality, which is a requirement for conducting parametric statistics. Based on the normality test results, the non-parametric tests were adopted for testing the study hypotheses, using the Mann-Whitney U Test and Kruskal-Wallis Test for the categorical variables occurring at two levels and more than two levels, respectively. Following are the hypotheses testing results.

H_{01}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on gender**.**

This hypothesis, generated based on the study participants' gender, age, and level of study, was tested using the Mann-Whitney U Test. The results are shown in Table 4.

Table 4: *Independent-samples Mann-Whitney U test summary on level of readiness based on gender*

Test Statistics	**Value**
Total Number	570
Mann-Whitney U	32706.000
Wilcoxon W	62352.000
Test Statistic	32706.000
Standard Error	1942.735
Standardised Test Statistic (z)	-3.616
Asymptotic Sig. (2-sided test)	<.001

The test statistics in Table 4 indicate the actual significance value of the test. Specifically, the statistical significance of students' readiness for technologically enhanced education was higher in the female group compared with the male group (U=32706.000, Z=-3.616; p=0.001). Therefore, the null hypothesis stating that there is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on gender is rejected. These results imply that there is a significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on gender. Furthermore, Figure 5 shows that the mean rank for the two groups (i.e., male and female) indicated that males exhibited a higher mean rank, suggesting a stronger readiness for technology-enhanced education compared to their female counterparts.

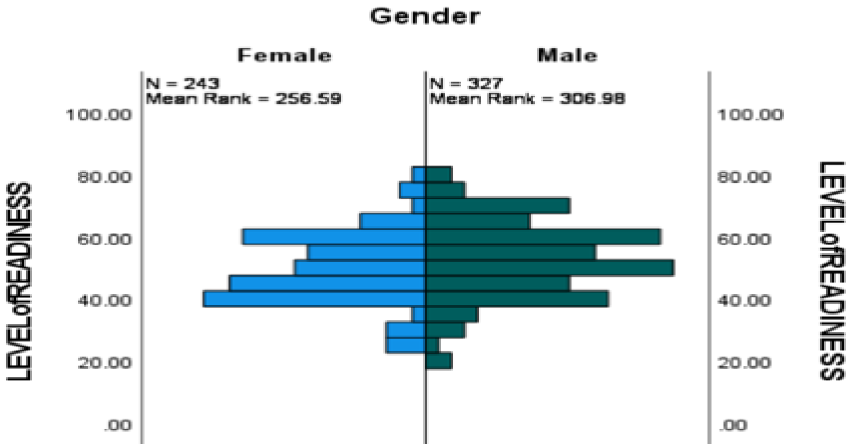

Figure 5: *Independent samples Mann-Whitney U test of readiness*

H_{02}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on age.

The level of students' readiness to acquire relevant skills through technology-driven education, considering their different age ranges, was tested using the Kruskal-Wallis Test. The result is shown in Table 5.

Table 5: *Independent-samples Kruskal-Wallis test summary on students' readiness*

Test	Value
Total N	570
Test Statistic	50.079[a]
Degree Of Freedom	3
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.

Table 5 indicates that the statistical significance of students' readiness for technologically enhanced education was significant based on students' age (H=50.079, df=-3; p=0.000). Therefore, the null hypothesis stating that there is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on age is rejected. These results imply that there is a significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on age. Considering the significant difference recorded, a post hoc analysis was conducted to determine where the mean difference lies in the group using pairwise comparison. The statistical analysis is shown in Table 6.

Table 6: *Pairwise comparisons of age*

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
18-25-26-32	-34.942	20.334	-1.718	.086	.514
18-25-41 and above	-76.923	39.629	-1.941	.052	.313
18-25-33-40	-150.809	21.830	-6.908	.000	.000
26-32-41 and above	-41.981	43.026	-.976	.329	1.000
26-32-33-40	-115.867	27.519	-4.210	.000	.000
41 and above-33-40	73.886	43.753	1.689	.091	.548

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

The result in Table 8 shows that each row tests the null hypothesis that the sample 1 and sample 2 distributions are the same. Premised on the level of significance being 0.05, which has been adjusted by the Bonferroni correction for multiple tests, the result shows that the differences lie within the higher age ranges. Moreover, Figure 6 shows the mean rank for the age groups, indicating that the higher age ranges (26 to 32 and 33 to 40) had a higher mean rank, suggesting a stronger level of readiness for technology-enhanced education compared to their younger counterparts.

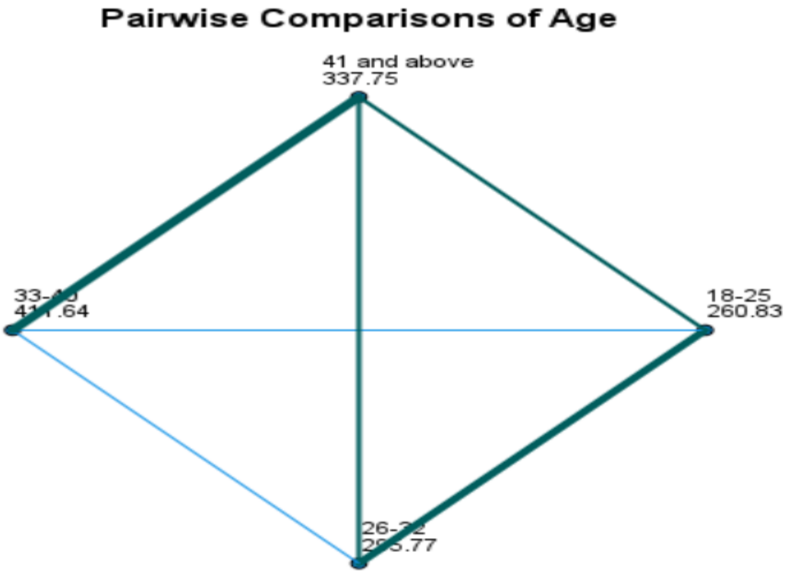

Figure 6: *Mean ranks of students' level of readiness and pairwise comparison (age). Each node shows the sample average rank of Age*

H_{03}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on institution type.

The level of students' readiness to acquire relevant skills through technology-driven education, considering their institution type, was also tested using the Kruskal-Wallis Test. The result is shown in Table 7.

Table 7: *Independent-Samples Kruskal-Wallis Test Summary*

Test	Value
Total N	570
Test Statistic	10.852[a]
Degree Of Freedom	2
Asymptotic Sig. (2-sided test)	.004

a. The test statistic is adjusted for ties.

Table 7 indicates that the statistical significance of students' readiness for technology-enhanced education was significant based on students' institution type (H=10.852, df=-2; p=0.004). Therefore, the null hypothesis stating that there is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on institution type is rejected. These results imply that there is a significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on their types of institution. Considering the significant difference recorded, a post hoc analysis was also conducted to determine where the mean difference lies in the group using pairwise comparison. The statistical analysis is shown in Table 9.

Table 9: *Pairwise comparisons of institution type*

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
State-Private	-43.638	30.802	-1.417	.157	.470
State-Federal	65.790	20.191	3.258	.001	.003
Private-Federal	22.152	25.733	.861	.389	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

The result in Table 9 shows that each row tests the null hypothesis that the sample 1 and sample 2 distributions are the same. Premised on the level of significance of 0.05, which has been adjusted by the Bonferroni correction for multiple tests, the result shows that the differences lie within public institutions. This is also evident from Figure 7, which shows that the mean difference exists between state and federal institutions. These results imply that students in public institutions (state and federal) indicated readiness to acquire relevant skills through technology-driven education.

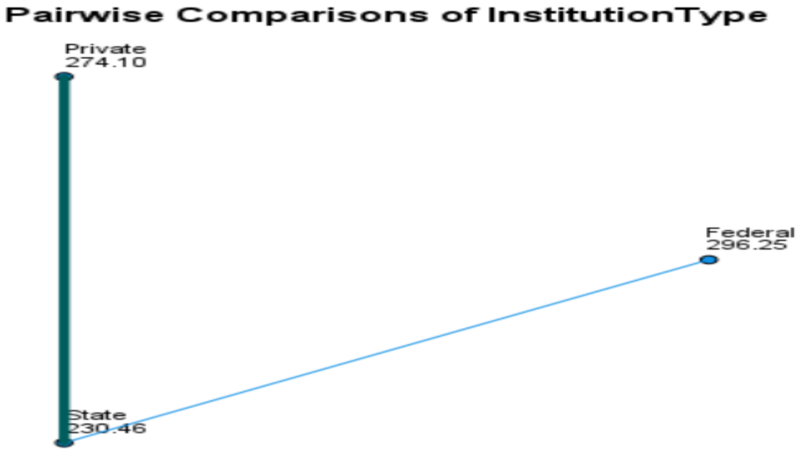

Figure 7: *Mean ranks of students' level of readiness and pairwise comparison (institution type). Each node shows the sample average rank of Institution Type*

H_{04}: There is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on the level of study**.**

Lastly, the level of students' readiness to acquire relevant skills through technology-driven education, considering their level of study, was tested using the Kruskal-Wallis Test. The result is shown in Table 10 and Figure 8.

Table 10: *Kruskal-Wallis H Test Summary*

	Level of Readiness
Kruskal-Wallis H	45.058
df	2
Asymp. Sig.	.001

a. Kruskal Wallis Test
b. Grouping Variable: Study Level

Table 10 indicates that the statistical significance of students' readiness for technology-enhanced education was significant based on students' study level (H=45.058, df=2; p=0.001). Therefore, the null hypothesis, which states that there is no significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on their study levels, is rejected. These results imply that there is a significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on their study levels. Since a significant difference was also recorded with the study level variable, a post hoc analysis was conducted to determine where the mean difference lies in the groups using pairwise comparison. The statistical analysis is shown in Table 11 and Figure 8.

Table 11: Pairwise comparisons of students' study level

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Undergraduate-Postgraduate Masters	-74.317	22.539	-3.297	.001	.003
Undergraduate-Postgraduate PhD	-180.838	29.617	-6.106	.000	.000
PostgraduateMasters-Postgraduate PhD	-106.520	35.660	-2.987	.003	.008

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

The result in Table 12 shows that each row tests the null hypothesis that the distributions of sample 1 and sample 2 are the same. Based on a significance level of 0.05, which has been adjusted using the Bonferroni correction for multiple tests, the results indicate that the differences are present across all levels. This is also evident from Figure 8, which illustrates that a mean difference exists between undergraduate and postgraduate levels of study. This result implies that undergraduate and postgraduate (master's and PhD) students indicated a readiness to acquire relevant skills through technology-driven education.

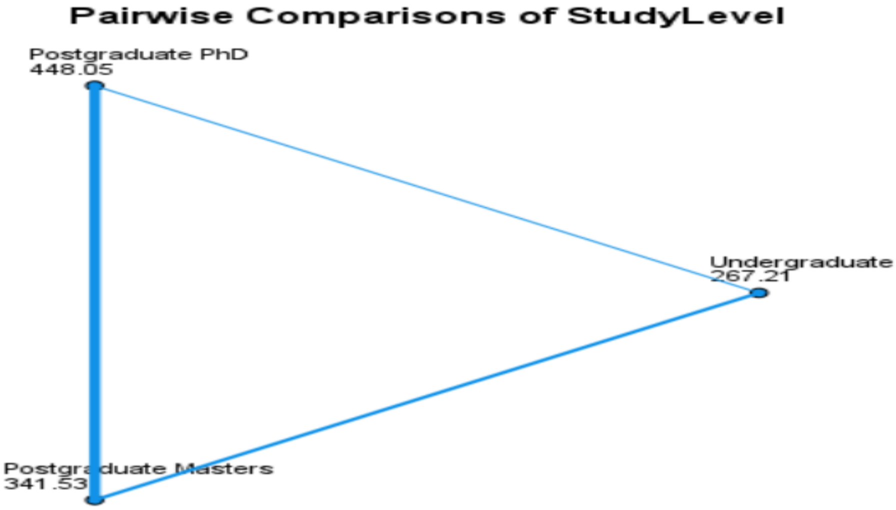

Figure 8: *Mean ranks of students' readiness (study level).*
Each node shows the sample average rank of institution type

5. Discussion of Findings

The results show that students were somewhat or largely ready for some of the skills required for technology-driven education, such as using educational apps for studying, engaging with immersive tech tools while learning, acquiring knowledge about the Internet of Things (IoT) as part of their learning trajectories for Fourth Industrial Revolution (4IR) compliance, embracing numerous technological innovations while learning, and engaging in lifelong learning as a 4IR requirement. Additionally, they are acquiring knowledge in modern educational technology facilities for learning, as demanded by 4IR, enhancing their capabilities for learning using learning management systems, and gaining skills in creativity and complex problem-solving required in the 4IR era, among others.

This finding departs from Nwagwu (2020), which revealed uncertainty regarding students' readiness for technology-driven education in terms of understanding e-learning and possessing sufficient IT/web skills required to drive e-learning. Similarly, the study by Panagiotopoulos and Karanikola (2020) also noted a lackadaisical attitude towards the use of technology, with concerns about workload and inequalities in the social gap. However, the students' readiness discovered in this study could be attributed to the increase in free e-learning resources in the 4IR era (Shirk, 2020). Given the evolving demands of 4IR, students should leverage emerging technologies to enhance learning.

The results also indicate that most students in Nigerian universities report a moderate level of readiness for Education 4.0, which aligns with the findings of Pahugot et al. (2022). Panagiotopoulos and Karanikola (2020) stressed that technology-enhanced education brings about transformation in education systems, where the learning process becomes more personalised, flexible, and integrated with digital tools. However, readiness to embrace these technologies remains essential. The moderate level of readiness suggests that while students are somewhat prepared for the demands of technology-enhanced education, significant gaps in terms of infrastructure may be a major deterrent (Pahugot et al., 2022). Hence, a high level of readiness is required for the effective use of new technologies to meet the ever-changing requirements of the 4IR. Ensuring this would also lead to higher engagement with the shifting educational paradigm.

Furthermore, this study revealed a significant difference in the level of students' readiness to acquire relevant skills through technology-driven education based on gender, institution type, age, and level of study. The significance recorded within male and female student categories was in favour of males. While this finding aligns with that of Oladele et al. (2021), it departs from Ayanwale et al. (2024), which revealed a significant difference in favour of the female gender; however, this study focused on lecturers rather than students. Mourdoukoutas (2017) stressed that women are fifty percent less likely to use the internet than males. In seeking a solution to this, a number of organisations are actively working to entice women into the digital ecosystem, such as the MTN Group, which is championing the Women in Digital Business Challenge (MTN, 2024); the United Nations Conference on Trade and Development (UNCTAD), which is promoting the E-Trade for Women initiative (UNCTAD, 2024); and the International Telecommunication Union (ITU), through the Enhanced Integration Framework and EQUALS Global Partnership (ITU, 2024), among others. These initiatives should be extended to students within the university community as a grassroots approach to problem-solving.

Similarly, a significance was recorded with respect to students' readiness for technology-enhanced education based on participants' age categories, favouring the older students. This finding departs from that of Oladele et al. (2024), whose study revealed no significant differences, with most of the study participants within the Gen Z age category having a deep affinity for technology. This finding intersects with the study by Ayanwale et al. (2024), which recorded a significant difference in teachers' readiness for technology-driven education. However, this is not unexpected, as these participants are considered digital migrants given their status as an older generation (Machaba & Bedada, 2022). This finding may be due to the high proliferation of technology, which has led to the incorporation of more emerging technologies into classroom teaching and learning (Ayanwale, 2024; Sosa et al., 2018). As such, making these devices available at affordable costs is a sure path to improving the readiness of digital immigrants for technological advancement and integration in education.

In terms of institution type (e.g., public, state, or private institutions), the results suggest that students' readiness to embrace a technology-enhanced educational landscape varies across comparison levels, with state and federal institutions accounting for the significance reported. This may be related to the readily available government funding for institutions in this category

(Akpoghome & Nwano, 2020). This outcome is also not unexpected, as despite the financial constraints facing higher education institutions in Nigeria, government-owned institutions benefit from government funding, which facilitates the provision of resources in the technology-driven education landscape (Odediji, 2023; Ogundipe, 2021). However, crowdfunding should be leveraged to avoid over-dependence on progressively diminishing government funding.

The significance recorded based on students' level of study, which favoured postgraduate students, suggests that university undergraduates may be more or less ready for technology-enhanced education than postgraduates, who are typically older students at the same or different types of institutions. Considering that the postgraduate age group is mostly composed of digital immigrants, this result is a clear departure from studies that indicate digital natives are more likely to effectively use technology to inform their educational choices (Wang et al., 2013). Therefore, this finding points to some progress towards having all students actively engaged in effective technology use. It is important to ensure that digital natives remain engaged to achieve a comprehensive technological integration, leaving no one behind as the world confronts the realities of the Fourth Industrial Revolution within the education sector in Nigeria.

6. Conclusion and Recommendations

Based on the findings of this study, it can be concluded that while students were somewhat and largely ready for some of the skills required for technology-driven education, most students exhibited a moderate level of readiness influenced by factors such as institution type, age, gender, and level of study. Therefore, it can be deduced that while students are positively inclined towards the skills needed for technology-driven education (TDE) in the context of the current Fourth Industrial Revolution (4IR) realities, they demonstrate moderate readiness for technology-enhanced education, with group dynamics playing a crucial role in improving this readiness. Consequently, providing students with opportunities for technical upskilling is essential. This is critical for the successful implementation of technology-enhanced education in Nigerian universities. This can be achieved through investments in technology, training for both students and educators, and the formulation of policies that foster digital learning environments conducive to global competitiveness.

Moreover, the limited resources characterising developing countries necessitate the adoption of infrastructural crowdfunding to avoid over-dependence on government funding for effective implementation of technology-driven education across all institution types in Nigeria. While there are concerted efforts to bridge the gender gap in technology use among the working population, these initiatives should also be extended to the university community to reach students as a grassroots approach to problem-solving. Doing so would help ensure that all students are equally prepared to acquire the skills required in the evolving landscape of technology-driven education. Nigerian universities must establish inter-university and inter-regional collaborations to provide targeted support that meets the distinct needs of various student groups. This study serves as an investigation into potential research opportunities for a nationwide study and for other regions in Africa.

7. Declarations

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Conflict Of Interest: The author declares no conflict of interest.

Data Availability: Due to ethical considerations, the data cannot be made publicly available, but it is available from the corresponding author upon reasonable request.

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