

ICT Competency and Educational Technology Utilization among Nigerian Undergraduate Students: Implications for Digital Skills Development and Human Capital Advancement. (Case study of higher education institutions in Bayelsa State)

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Abstract—Grounded in human capital theory and digital competence frameworks, this study highlights the rapidly growing global need for digital literacy and ICT competency among undergraduate students. Cochran's (1977) formula for large populations informed the design of a cross-sectional survey, a digitally structured questionnaire, and its administration to undergraduate students. The study analyzed 462 responses using descriptive statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicated that ICT competency, digital skills development, and human capital advancement were rated high, while educational technology utilization was rated moderate. Pearson correlations were $r = 0.814$ between ICT competency and digital skills development, $r = 0.814$ between educational technology utilization and digital skills development, and $r = 0.801$ between digital skills development and human capital advancement. The PLS-SEM model showed that ICT competency ($\beta = 0.494$, $p < .001$) has a significant positive effect on digital skills development, educational technology utilization ($\beta = 0.431$, $p < .001$) has a significant positive effect on digital skills development, and digital skills development ($\beta = 0.622$, $p < .001$) has a significant positive effect on human capital advancement. The model explained 74.5% of the variance in digital skills development and 74.5% of the variance in human capital advancement, with a difference of 0.4%. The mediating effect analysis indicates that ICT competency ($\beta = 0.308$; 95% CI: 0.218–0.401) and educational technology utilization ($\beta = 0.266$; 95% CI: 0.197–0.341) have significant indirect effects on human capital advancement. The findings suggest that students' human capital advancement is directly related to their ability to develop digital skills through meaningful engagement with educational technology.

Index Terms—ICT Competency, Educational Technology, Digital Skills Development, Emerging Technologies, Human capital development

I. Introduction

The global accelerating pace of digital transformation has redefined the framework of world economies, labor markets, and higher education systems. Artificial intelligence, block-chain, cloud computing, robotics, big data analytics, and prolific economics platforms drive the fourth industrial revolution era by accentuating digital skills demand for graduates capable of participating productively in knowledge-based and innovation-driven economies (Schwab, 2017; World Economic Forum [WEF], 2023). Digital skills competency is now a core driver of employability, productivity, and economic competitiveness across industrial sectors (OECD, 2021; International Labor Organization [ILO], 2021); therefore, higher

educational institutions are strategically positioned as central connecting points for digital skills formation and human capital advancement.

Information and Communication Technology (ICT) competency is a multidimensional construct embracing information and data literacy, digital communication, cyber-security awareness, content creation, technical proficiency, and computational problem-solving (UNESCO, 2018; Vuorikari et al., 2022). Redecker (2020) ICT competency architecture emphasizes that digital competence embodies technical, cognitive, and socio-ethical dimensions required for effective participation in digitally mediated environments. Van Laar et al. (2020) and OECD (2021) empirical studies across the Organization for Economic Co-operation and Development (OECD) and emerging economies point out that while undergraduate students report high digital exposure, significant gaps persist in advanced digital skills competencies such as digital innovation skills, AI literacy, and data analytics.

Sub-Saharan Africa, digital transformation has experienced significant growth in internet connectivity and mobile penetration, but the region remains relatively low in digital skill readiness when compared to global standards (International Telecommunication Union [ITU], 2023; World Bank, 2021).

National Digital Economy Policy and Strategy (NDEPS 2020–2030): Nigeria is one of the largest economies in Africa and points to digital technologies as integral to its national development strategies, as stated by the National Digital Economy Policy and Strategy (NDEPS 2020–2030), which emphasizes digital literacy, emerging technologies, and human capital development as a stanchion for inclusive and continued economic growth (Federal Ministry of Communications and Digital Economy [FMCDE], 2020). Contrasting these policy ambitions, evidence suggests a persistent digital skills mismatch between labor market demands and university graduates, particularly in high- growth sectors such as cyber-security, data science, fintech, and AI-enabled services (WEF, 2023; World Bank, 2021).

Educational technologies such as Learning Management Systems (LMS), virtual learning environments, AI-powered adaptive platforms, cloud-based collaboration tools, and open educational resources have emerged as primary transforming mechanisms for advancing ICT competency within higher education (Bond et al., 2020; Selwyn, 2022). Many universities across Nigeria and the sub-Saharan Africa region accelerated digital adoption during the COVID-19 pandemic; however, studies showed that technology adoption exists only at the functional or content-distribution level rather than enabling deeper digital skill development (Adarkwah, 2021; Mpungose, 2020). This illustrates a structural gap between technology integration, access, and impactful digital capability formation.

ITU (2023) reports that Nigerian undergraduate students demonstrate high mobile technology and social media platform engagement, yet display limited proficiency in advanced academic and professional digital tools required to function in innovation ecosystems. This discrepancy underlines the disparity between digital consumption and digital production competencies. Higher education institutions need to properly structure and integrate emerging technologies into curricula to avoid producing digitally exposed graduates who lack transformative digital capabilities to be industrially productive.

Digital skills constitute a decisive asset for national competitiveness and inclusive economic growth. Human capital theory states that education increases productivity and guarantees long-term economic returns. ICT competency is a core factor of innovation capacity, entrepreneurial development, and workforce adaptability in every growing economy (Acemoglu & Restrepo, 2019; WEF, 2023). Nigeria can improve its economic diversification objectives, youth employment, and technology-driven industrialization by strengthening undergraduate students' ICT competency (FMCDE, 2020; World Bank, 2021).

1.1 Problem Statement

Empirical research studies linking Nigerian higher education ICT competency, education technology utilization, and measurable human capital advancement remain limited despite increased investments in digital infrastructure and policy reforms. Many research studies often focus on access disparities, technology adaptation, or digital literacy independence without a panoramic framework that inclusively integrates these variables and aligns with emerging technologies (Adarkwah, 2021; Mpungose, 2020). Also, limited attention has been given to assessing whether education technologies adopted and utilized translate into structured digital skills development of undergraduate students capable of supporting innovation ecosystems and economic renaissance.

This study positions ICT competency and educational technology utilization within the widely discussed digital skills development and human capital advancement in Nigeria by empirically investigating the relationship among these constructs. The study seeks to provide evidence that informs institutional digital transformation strategies, curriculum redesign, and policy frameworks targeted at strengthening inclusive digital innovation and sustainable economic growth in Nigeria.

1.2 Objectives of the Study

This research study aims to attain the following objectives:

1. To assess ICT competency levels among undergraduate students in Nigerian higher education institutions.
2. To examine the extent and patterns of educational technology utilization among undergraduate students.
3. To determine the impact of educational technology utilization on structured digital skills development among undergraduate students.
4. To assess ICT competency and digital skills development on measurable human capital advancement indicators (e.g., employability readiness, innovation capacity, and productivity potential).

1.3 Research Questions

The following research questions guide the cross-sectional survey in line with the research objectives

1. What is the level of ICT competency among undergraduate students in Nigerian higher education institutions?
2. What are the extent and usage patterns of educational technologies among undergraduate students?
3. To what extent does educational technology utilization significantly influence the development of structured digital skills among undergraduate students?
4. How do ICT competency and digital skills development jointly influence measurable human capital advancement indicators such as employability readiness, innovation capacity, and productivity potential?

II. Literature Review

Global economies experience tremendous digital transformation and has repositioned higher education as a central driver of digital skills formation and human capacity advancement. Modern industrialization is characterized by artificial intelligence (AI), big data analytics, robotics, cloud computing, and automation, and has essentially altered skill requirements across industries (Schwab, 2017; World Economic Forum [WEF], 2023). Employers increasingly demand advanced digital competency, critical thinking skills, and the capacity to adapt to rapidly emerging and evolving technological environments from graduates (OECD, 2021). Universities are under pressure to ensure undergraduate education efficiently integrates ICT competency development programs within curricula and well-structured practice.

2.1 ICT Competency: Conceptual Foundations

The term ICT competency is an embrace of a multidimensional set of knowledge, skills, attitudes, and ethical considerations required for efficient and effective participation in digital societies. UNESCO (2018), ICT Competency Framework for Teachers, focuses on technological literacy, knowledge deepening, and knowledge creation as progressive levels of digital capability. The European Digital Competence Framework (DigComp 2.2) lists information and literacy, communication and collaboration, digital content creation, digital safety, and problem-solving as core ICT competence areas (Vuorikari et al., 2022). By combining these ICT competency frameworks, undergraduate students can be well positioned for academic success and workforce readiness. Existing empirical research reveal that undergraduate students perceive themselves has digital ICT competence, but they are deficient in higher-order ICT competencies such as data analytics, digital content production, cyber-security awareness, and computational thinking (Van Laar et al., 2020). This disparity reveals the difference between digital familiarity and digital proficiency. Higher education institutions need to assess undergraduate ICT competency to apply digital tools critically and innovatively, not merely by their ability to access digital devices.

2.2 Educational Technology Utilization in Higher Education

Higher education institutions' ability to effectively and efficiently integrate Educational technology and utilized it features is cardinal to undergraduate students obtaining structured digital skills. Educational technologies such as Learning Management Systems (LMS), virtual classrooms, AI-powered adaptive platforms, cloud-based collaboration tools, and simulation technologies, when deployed by institutions, enhance instructional delivery (Bond et al., 2020).

Mpungose (2020) noted that the COVID-19 pandemic accelerated emergency global digital adoption, such as remote teaching and reshaping online and blended learning perceptions. Availability of digital tools in an institution does not translate into transformative learning outcomes because digital technology integration in higher education systems often remains superficial, emphasizing primarily on administrative efficiency and content dissemination rather than deeper pedagogical innovation (Selwyn, 2022). Technology use must be strategically embedded in curricula to promote higher-order cognitive and digital skills (OECD, 2021). Educational technology utilization must be intentionally designed to intensify active digital production and avoid the risk of reinforcing passive consumption.

Technology Acceptance Model (TAM) theory provides a technological adoption perception for identifying its usefulness and ease of use as key factors for technology utilization (Redecker, 2020). Constructivist learning theory states that structured digital skill acquisition is possible through active engagement, collaborative problem-solving, and authentic learning experiences. Therefore, employing instructors conversant with adopted educational technology tools in higher education institutions and proper utilization can mediate its impact on undergraduate digital skill formation.

2.3 Digital Skills Development and Emerging Technologies

Digital skill development can be grouped into basic, intermediate, and advanced competencies. Van Laar et al. (2020) define basic skills (device operational knowledge and internet navigation), Intermediate skills (document creation, data management, and data communication abilities), and advanced skills (AI literacy, Data analytics, coding, and digital innovation). To be economically competitive in the Fourth Industrial Revolution, obtaining digital skills that are connected to emerging technologies is essential (WEF, 2023).

Nigeria, being a developing economy, has made significant efforts towards accelerating her digital infrastructure and digital literacy. The National Digital Economy Policy and Strategy (NDEPS 2020–2030) emphasizes emerging technologies and advanced digital skills as critical drivers of inclusive economic

growth (FMCDE, 2020). However, empirical research studies have unveiled persistent disparities in institutional capacity, functional readiness, and advanced skill integration within undergraduate programs (Adarkwah, 2021; World Bank, 2021). This implies that many undergraduate students remain digitally connected but inadequately prepare for advance technology-intensive labor markets.

2.4 ICT Competency and Human Capital Advancement

ICT competency constitutes a strategic component of human capital formation. Becker's (1993) human capital theory posits that individual productive capacities are enhanced by education, leading to economic returns at both micro and macro levels. Growing technological change has reshaped labor market demands, requiring workers to adapt to new tasks rather than merely performing routine functions (Acemoglu and Restrepo, 2019). Therefore, structured and advanced digital skills are essential to participating in the global economy and not supplementary. World Bank (2021) stressed that countries with strong digital skills ecosystems are considered to be advantageously positioned to attract investment, foster innovation, and enhance industrial productivity.

ITU (2023) noted that digital transformation presents opportunities that foster rapid development in Sub-Saharan Africa. However advance skills deficits and unequal access to quality digital education stand as potential constraints in its development and to enjoying global economic competitiveness. In Nigeria, digital skills mismatch has led to youth unemployment, and it rings the bell for urgent alignment of higher education outputs with emerging technology sectors. Obtaining digital skills that align with emerging technologies is a global campaign for undergraduate students, yet several existing research studies often isolate ICT access, technology adoption, and digital literacy in their studies without integrating these constructs within a unified framework connecting educational technology utilization to measurable human capital outcomes (Bond et al., 2020; Mpungose, 2020).

Many studies have been centered on digital divide issues or students' perceptions of online learning, but there is limited empirical evidence to assess educational technology utilization that enhances structured digital competence, translating undergraduate students into employability readiness, innovation capacity, and productivity capability.

III. Methodology

This study adopts a quantitative cross-sectional survey design. Data are collected electronically and analyzed using descriptive statistics (mean, standard deviation, Pearson Correlation, multiple regression analysis, and regression coefficients), and Partial Least Squares Structural Equation Modelling (PLS-SEM) to examine the research variables (ICT Competency, Educational Technology Utilization, Digital Skills Development, and Human Capital Development). The mediating construct is digital skills development, and the exogenous constructs are ICT competency and educational technology utilization, while the endogenous construct is human capital advancement. Hence, the variables are referred to as:

ICT Competency = ICT

Digital Skills Development = DSD

Educational Technology Utilization = ETU

Human Capital Advancement = HCA

The structural Model Equations are:

$$DSD = \beta_0 + \beta_1 ICT + \beta_2 ETU + \varsigma_1 \dots \dots \dots eq(1)$$

$$HCA = \beta_3 ICT + \beta_4 ETU + \beta_5 DSD + \varsigma_2 \dots \dots \dots eq(2)$$

Where:

β_1 , β_2 , β_3 , β_4 are path coefficients, and β_5 represents the effect of digital skills development on human capital advancement. ζ_1 and ζ_2 are structural error terms. The first structural equation estimates the determinants of digital skills development, and the second equation estimates human capital advancement. It also examined the direct and indirect paths from ICT and ETU to HCA. Hence, the SEM hypothesized model of this study is:

1. ICT Competency $\rightarrow$ Digital Skill Development (DSD) $\rightarrow$ Human Capacity Advancement (HCA)
2. Educational Technology Utilization (ETU) $\rightarrow$ Digital Skill Development (DSD) $\rightarrow$ Human Capacity Advancement (HCA)

IV. Results

462 undergraduate students across higher education institutions in Bayelsa State, Nigeria responded to the digital survey. Figure 1 presents the demographic characteristics of the respondents from the digital survey. It shows that male, university, and 300-level students responded more to the survey. Furthermore, access to digital devices showed a widespread dependence on smartphones among the students.

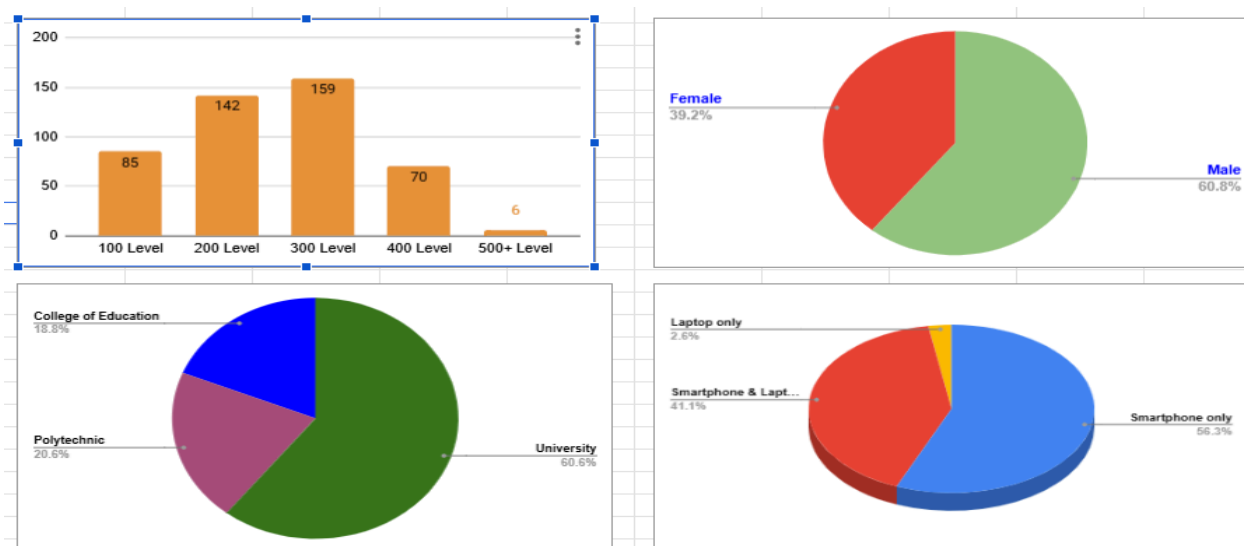


Figure 1: Demographic Characteristics of Survey Respondents

Table 1 shows the mean and standard deviation analysis of the four research variables investigated in the study.

Table 1: Mean and Standard Deviation Analysis

Variable	Mean	Std. Deviation	Interpretation
ICT Competency (ICT)	3.29	0.82	High
Educational Technology Utilization (ETU)	3.18	0.86	Moderate
Digital Skills Development (DSD)	3.36	0.88	High
Human Capital Advancement (HCA)	3.41	0.84	High

Table 2 shows the strength and relationships among the study variables.

Table 2: Pearson Correlation Analysis

Variables	ICT	ETU	DSD	HCA
ICT Competency (ICT)	1.000	0.753	0.814	0.759
Educational Technology Utilization (ETU)	0.753	1.000	0.801	0.739
Digital Skills Development (DSD)	0.814	0.801	1.000	0.850
Human Capital Advancement (HCA)	0.759	0.739	0.850	1.000

Table 3 examines the predictive effects of ICT competency, educational technology utilization, and digital skills development on human capital advancement.

Table 3: Multiple Regression Analysis

Statistic	Value
R ²	0.740
Adjusted R ²	0.739
F-value	435.6
Significance	p < .001

Table 4 demonstrates the individual predictor variables' contributions toward human capital advancement.

Table 4: Regression Coefficients

Predictor	Beta (β)	t-value	p-value	Decision
ICT □ HCA	0.160	3.810	< .001	Significant
ETU □ HCA	0.121	2.726	.007	Significant
DSD □ HCA	0.616	13.318	< .001	Significant

4.1 Partial Least Squares Structural Equation Modelling (PLS-SEM)

Table 5 measures the model composite reliability, average variance extracted, and Cronbach's alpha indicators.

Table 5: Reliability and Convergent Validity

Construct	No. of Items	Cronbach's α	Composite Reliability	AVE	Decision
ICT	12	0.939	0.947	0.600	Reliable/Valid
ETU	8	0.864	0.894	0.515	Reliable/Valid

DSD	9	0.929	0.941	0.639	Reliable/Valid
HCA	9	0.941	0.950	0.680	Reliable/Valid

Table 6 determines the estimated structural model predictive relationships among the variables.

Table 6: Structural Path Coefficients

Structural Path	β	t-value	p-value	Decision
ICT $\rightarrow$ DSD	0.494	14.00	< .001	Significant
ETU $\rightarrow$ DSD	0.431	12.22	< .001	Significant
DSD $\rightarrow$ HCA	0.622	13.21	< .001	Significant
ICT $\rightarrow$ HCA	0.164	3.85	< .001	Significant
ETU $\rightarrow$ HCA	0.119	2.91	.004	Significant

Table 7 examines the coefficient of determination (R^2) of the endogenous construct of the SEM model.

Table 7: Coefficient of Determination (R^2): Variance

Endogenous Construct	R^2	Interpretation
DSD	0.745	Substantial
HCA	0.741	Substantial

Table 8 presents the effect of predictor variables on the endogenous variables

Table 8: Effect size (f^2)

Predictor	Endogenous variable	f^2	Effect
ICT	DSD	0.427	Large
ETU	DSD	0.325	Large
ICT	HCA	0.032	Small
ETU	HCA	0.018	Small
DSD	HCA	0.381	Large

Table 9 estimates the indirect and mediating effect of the model by utilizing the product of the relevant path coefficients and through 5,000 bootstrap resamples.

Table 9: Indirect/Mediation Effects

Mediation Path	Indirect β	95% Bootstrap CI	Decision
ICT $\square$ DSD $\square$ HCA	0.308	0.218 – 0.401	Significant
ETU $\square$ DSD $\square$ HCA	0.266	0.197 – 0.341	Significant

The ICT competency mediation effect is: ICT $\square$ DSD $\square$ HCA. The two relevant path coefficients from table 6 are:

$$\text{ICT} \square \text{DSD} = \beta = 0.494$$

$$\text{DSD} \square \text{HCA} = \beta = 0.622$$

Therefore,

$$\text{Indirect effect} = \beta_{\text{ICT} \rightarrow \text{DSD}} \times \beta_{\text{DSD} \rightarrow \text{HCA}}$$

$$0.494 \times 0.622 \approx 0.308$$

The Educational Technology Mediation effect is: ETU $\square$ DSD $\square$ HCA. The two relevant path coefficients from Table 6 are:

$$\text{ETU} \square \text{DSD}: \beta = 0.431$$

$$\text{DSD} \square \text{HCA}: \beta = 0.622$$

Therefore,

$$\text{Indirect effect} = \beta_{\text{ETU} \rightarrow \text{DSD}} \times \beta_{\text{DSD} \rightarrow \text{HCA}}$$

$$0.431 \times 0.622 \approx 0.268$$

Hence, from the SEM model

$$\text{Total effect} = \text{direct effect} + \text{indirect effect}$$

ICT competency structural paths are:

$$\text{ICT} \square \text{HCA (direct effect)} = 0.164$$

$$\text{ICT} \square \text{DSD} = 0.494$$

$$\text{DSD} \square \text{HCA} = 0.62$$

$$\text{Total effect} = 0.164 \times 0.308 \approx 0.471$$

Education Technology Utilization structural paths are:

$$\text{ETU} \square \text{HCA (direct effect)} = 0.119$$

$$\text{ETU} \square \text{DSD} = 0.431$$

$$\text{DSD} \square \text{HCA} = 0.622$$

$$\text{Total effect} = 0.119 \times 0.268 \approx 0.387$$

Table 10 shows the direct and indirect effects of the SEM model

Effect	Direct Effect	Indirect Effect	Total Effect
ICT $\square$ DSD $\square$ HCA	0.164	0.307	0.471
ETU $\square$ DSD $\square$ HCA	0.119	0.268	0.387

Table 11 shows the predictor variance inflation factor (VIF) values of the model analysis.

$$VIF = \frac{1}{1-R^2} \dots\dots\dots \text{eq. (3)}$$

Table 11: Multicollinearity Evaluation

Structural Equation	Predictor	VIF
DSD	ICT	2.236
DSD	ETU	2.236
HCA	ICT	3.192
HCA	ETU	2.963
HCA	DSD	3.922

4.2. SEM Model Evaluation

Structural model equations are evaluated as follows:

Eq. (1) Predicting Digital Skills Development.

$$DSD = 0.494ICT + 0.431ETU + \varsigma_1$$

This implies that ICT Competency and Educational Technology Utilization directly predict Digital Skills Development.

Eq. (2) Predicting Human Capital Advancement

$$HCA = 0.164ICT + 0.119ETU + 0.622DSD + \varsigma_2$$

This means that ICT Educational Technology Utilization and Digital Skills Development directly predict approximately 74.1% of the variance in Human Capital Advancement.

V. Discussion

Table 1 mean and standard deviation demonstrate that undergraduate students exhibit a relatively high level of ICT competency and digital skills development, while education technology utilization recorded a moderate level, indicating that available digital learning resources and platforms may not yet be optimally utilized by students. In addition, human capital advancement indicators, including employability readiness and innovation capacity, were rated relatively high among the respondents. Table 2 revealed that ICT competency had a strong positive relationship with digital skills development ($r=0.814$), which implies that a student's advancement in ICT competency significantly enhances his/her digital skills development. Educational technology utilization also demonstrated a strong positive relationship with digital skills development ($r = 0.801$), suggesting that effective engagement with educational technologies contributes substantially to digital capability enhancement. Furthermore, digital skills development exhibited the strongest positive relationship with human capital advancement ($r = 0.850$), implying that digital skills significantly influence employability readiness, innovation potential, and productivity capacity. Overall, the findings indicate strong positive interrelationships among all the study variables.

Table 3 regression model accounted for ($R^2 = 0.74$) of the total variance in human capital advancement, demonstrating a strong predictive capacity; ICT competency, educational technology utilization, and digital skills development collectively exert significant influence on human capital advancement indicators. The β values in Table 4 show the significant influence of the predictor variables on human capital advancement. This suggests that digital skills development serves as a critical pathway through which ICT competency and educational technology utilization contribute to measurable workforce and economic advancement outcomes.

Cronbach's alpha value (0.864 - 0.941) and composite reliability value (0.894 - 0.950) demonstrate strong internal consistency across the four variable constructs and confirm satisfaction of the construct reliability. The average variance extracted value (0.515-0.680) shows satisfaction of the convergent validity of the SEM model. Table 6 provides strong empirical support that higher ICT competency leads to greater digital skills development ($\beta = 0.494$, $p < .001$) and that educational technology utilization exerts a strong positive effect on digital skills development ($\beta = 0.431$, $p < .001$). This implies that students' meaningful engagement with educational technologies contributes significantly to students' acquisition of digital skills. Also, digital skills are a major determinant of human capital advancement, directly leading to employability, innovation capacity, entrepreneurship, and productivity readiness ($\beta = 0.622$, $p < .001$).

Table 8 indicates that ICT competency and educational technology utilization have large effects on students' digital skills development, and digital skills development has a large effect on human capital advancement. This analysis strongly supports the SEM hypothesized model that digital skills development is the critical mechanism through which technology related capabilities are translated into human capital outcomes. The indirect effect value ($\beta = 0.308$) and bootstrap confidence interval (0.218-0.401) of the ICT competency mediating effect support that digital skills development significantly mediates the relationship between ICT competency and human capital advancement. Furthermore, the educational technology utilization mediating effect, with an indirect effect value ($\beta = 0.266$) and bootstrap confidence interval value (0.197–0.341), indicates that skills development significantly mediates the relationship between educational technology utilization and human capital advancement.

Table 11 shows VIF values (2.236 – 3.922), indicating that multicollinearity was not a serious concern in the structural model and that the estimated path coefficients were not substantially distorted by excessive inter-correlation among the predictor constructs. The SEM model equation (1) result demonstrates that ICT competency and Educational Technology Utilization are positively connected with Digital skills development of standardized path coefficients of 0.496 and 0.431, respectively. These predictors accounted for 74.5% of the variance in Digital Skills Development ($R^2 = 0.745$). Equation (2), ICT Competency ($\beta=0.164$), Educational Technology Utilization ($\beta=0.119$), and Digital Skills Development ($\beta=0.622$) have a positive structural relationship with Human Capital Advancement. The results established that Digital skills development proves to be the strongest direct effect on Human Capital Advancement. Hence, the structural relationship of the three predictors therefore supports the proposition that ICT competency and education utilization contribute to human capital advancement substantially through the development of students' digital skills.

VI. Findings of the study

The principal findings of this study are:

1. The descriptive results showed that undergraduate students possess a strong ICT competency level, which implies they have developed the basic and applied digital skills needed to engage in educational technology-mediated learning environments. These skills are relevant to learning, problem-solving, innovation, and future professional activities. However, students' educational technology utilization was rated moderate. This finding suggests a potential gap between competency and utilization. Implying that having digital technology use ability may not necessarily mean that students exploit available educational platforms and digital learning resources to their full potential.
2. The correlation findings prove that ICT competency, educational technology utilization, digital skills development, and human capital advancement are positively interconnected. This implies that students' ICT capability and educational technology engagement are important foundations for

digital skills development. Digital skills development substantially translates these capabilities into human capital outcomes.

3. Findings from the SEM model suggest that human capital advancement of students is directly related to his ability to develop digital skill through meaningful educational technology engagement that can strengthen productivity, employability, and innovation.

VII. Conclusion

This study examined the relationship between four variables (ICT, ETU, DSD, and HCA) among undergraduate students in higher education institutions in Bayelsa State, Nigeria. 462 students responded to the online cross-sectional survey, and the researchers analyzed their responses using descriptive statistics and Partial Least Squares Structural Equation Modelling (PLS-SEM). The findings revealed that students have high levels of ICT competency and digital skills development but moderate use of educational technologies, suggesting a gap between students' effective use of their digital capabilities and their engagement with educational technologies. Among the study constructs, digital skills development emerges as the strongest predictor of human capital advancement. PLS-SEM model results confirm the significant direct and indirect effects of digital skills development serves as the mediating pathway by which ICT competency and educational technology utilization contribute to HCA. These findings indicate that educational technology value extends beyond students' digital tools access, but students' ability to develop and practically apply digital capabilities is essential to human capital outcomes. It is therefore imperatively important that higher education institutions systematically redesign curricula that prioritize digital capacity development, digital transformation, and the integration of emerging educational technologies, and provide sustainable policies that enforce their use in the teaching and learning process. To build graduates within Nigeria's digitally evolving economy who are employable, innovative, and productive requires such interventions are essential for human capital advancement.

VIII. Recommendations

The following is recommended based on the findings of the study:

1. Integrate structured ICT competency and digital skills development into undergraduate curricula
2. Invest substantially in digital infrastructure and digital skills development programs.
3. Provide policies that strengthen educational technology usage in the teaching and learning process.
4. Provide ICT policies that prioritize digital transformation frameworks capable of enhancing graduates' human capital advancement.

References

- [1] Acemoglu, D., & Restrepo, P. (2019). Automation and new tasks: How technology displaces and reinstates labor. *Journal of Economic Perspectives*, 33(2), 3–30. <https://doi.org/10.1257/jep.33.2.3>
- [2] Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?" ICT in Ghana post-Covid-19. *Education and Information Technologies*, 26, 1665–1685.
- [3] Becker, G. S. (1993). *Human capital* (3rd ed.). University of Chicago Press.
- [4] Bond, M., Bedenlier, S., Marin, V., & Händel, M. (2020). Emergency remote teaching in higher education. *International Journal of Educational Technology in Higher Education*, 17(44).
- [5] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340.
- [6] Federal Ministry of Communications and Digital Economy (FMCDE). (2020). *National digital economy policy and strategy (2020–2030)*. Government of Nigeria.
- [7] International Labour Organization (ILO). (2021). *Global employment trends for youth 2021*. ILO.

- [8] International Telecommunication Union (ITU). (2023). *Measuring digital development: Facts and figures 2023*. ITU Publications.
- [9] Mpungose, C. B. (2020). Emergent transition from face-to-face to online learning in South African universities. *Humanities and Social Sciences Communications*, 7(113).
- [10] OECD. (2021). *21st-century readers: Developing literacy skills in a digital world*. OECD Publishing.
- [11] Redecker, C. (2020). *European framework for the digital competence of educators (DigCompEdu)*. Publications Office of the European Union.
- [12] Schwab, K. (2017). *The fourth industrial revolution*. Crown Business.
- [13] Selwyn, N. (2022). *Education and technology: Key issues and debates* (3rd ed.). Bloomsbury.
- [14] UNESCO. (2018). *ICT competency framework for teachers (Version 3)*. UNESCO.
- [15] van Laar, E., van Deursen, A., van Dijk, J., & de Haan, J. (2020). Determinants of 21st-century digital skills. *Computers in Human Behavior*, 72, 577–588.
- [16] Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The digital competence framework for citizens*. Publications Office of the European Union.
- [17] World Bank. (2021). *Digital economy for Africa initiative: Nigeria country diagnostic*. World Bank.
- [18] World Economic Forum (WEF). (2023). *The future of jobs report 2023*. WEF.