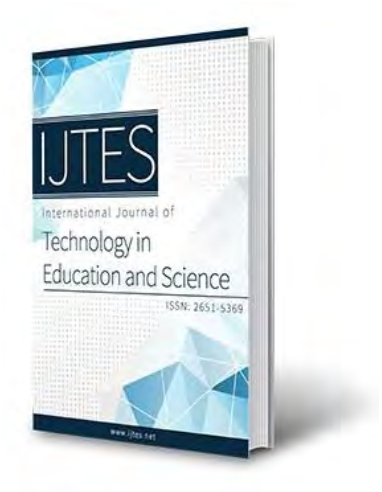

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Determinants Influencing the Adoption of Metaverse-based Learning Platforms among University Students

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Abstract

Metaverse, an amalgamation of diverse information technologies, is seen as the future of the internet and holds promise for transforming education. Leveraging metaverse media for immersive learning has the potential to reshape education practices. Despite being a novel concept, metaverse-based education has the capacity to enrich online learning experiences. The study utilized the Unified Theory of Acceptance and Use of Technology (UTAUT) model alongside the factor of personal innovativeness in IT, conducting a comprehensive survey involving 244 students from Federal University Wukari, Nigeria. Employing STATA 14, a popular variance-based structural equation modeling technique in social sciences and management, the study analyzed the structural model and conceptual measures, confirming the discriminant validity, dependability, and content of the data. The research findings highlight the importance of personal innovativeness in IT as a direct and indirect predictor of adoption intention among Generation Z students in making decisions about integrating metaverse technologies into higher education. Students demonstrating a high level of innovativeness in IT exhibit a greater willingness to engage with metaverse-based learning incorporating artificial intelligence. The results demonstrate a strong association between the identified characteristics and students' intentions to utilize educational platforms utilizing metaverse technology, contributing valuable insights to the use of technology in educational settings.

Introduction

Digital technology has revolutionized education by being increasingly used for teaching, learning, and assessment. One of the emerging technologies in this field is the metaverse. This technology is expected to have a random impact on modern school environments. It has changed the way educators and students interact, creating new business opportunities for educators and paving the way for AI-based adaptive learning systems (Kabudi et al., 2021). Due to its ability to convert physical space into virtual space and facilitate learning across various locations, times, and spaces, it is indisputable that Metaverse represents the future of academic practices. Metaverse serves as a comprehensive term encompassing all digital aspects of the future, thus rendering it particularly relevant in the field of education due to its interactive functionalities and ease of transportation (Narin, 2021).

As the utilization of the Metaverse expanded in the field of education, scholars embarked on an exploration of its applications and implications. The Metaverse has been lauded as an innovative educational trend with future-oriented potential, capable of transcending temporal and spatial barriers to revolutionize education (Zhang et al., 2022). By incorporating metaverse technology into education, the quality of online learning can be enhanced, and educational service providers can effortlessly create virtual classrooms that replicate real-life learning environments (Teng et al., 2022). Immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), Extended Reality (ER), and Mixed Reality (MR) have blurred the distinction between virtual and physical worlds, thereby generating increased interest in the metaverse (Zhang et al., 2022). The metaverse presents opportunities for enhanced creativity, personalization, and reduced risk, fostering increased student engagement, motivation, and participation, while expanding the realm of traditional learning activities (Estudante & Dietrich, 2020).

Roy et al. (2023) carried out a systematic review to comprehend the enduring impacts of the metaverse on education. The authors underscore the necessity of tackling the obstacles and constraints linked with educational metaverse, emphasizing the importance of blending the boundaries between physical and virtual classrooms while ensuring that any reported benefits are not solely attributable to novelty. Understanding the drivers behind the adoption and intention to use metaverse-based learning platforms, especially in nations beyond China, Taiwan, and the USA, is crucial.

Several academic disciplines, including engineering, technology, mathematics, natural sciences, cultural studies, social sciences, and materials science, have successfully integrated the metaverse with a problem-based learning approach, wherein students must employ their knowledge to solve problems within a virtual environment (Damar, 2021). The implementation of the metaverse in education brings forth both promises and challenges for all stakeholders involved. Therefore, it is essential to comprehend the primary drivers of adoption from the students' perspective to ensure its successful and widespread implementation in higher education.

Statement of the Problem

Over the past decade, the Metaverse has garnered significant attention, particularly within higher education. While the incorporation of immersive technology in education is still in its nascent stages, universities are commencing pilot programs that leverage immersive media to support innovative teaching and learning strategies. The rapid advancement of digital technology is instigating substantial transformations in twenty-first-century education (Siemens, 2020). The undeniable benefits of integrating digital technologies into the university education system are becoming increasingly evident.

Nevertheless, this situation poses distinctive challenges in the context of higher education in Nigeria. With a population of approximately 200 million, Nigeria is home to over 171 universities, as per the Nigerian Universities Commission (NUC, 2023). The academic achievements of university students in this setting are closely intertwined with the instructional style, lecturer personalities, and the techniques and strategies employed during the teaching process. Unfortunately, Nigerian universities face numerous obstacles in seamlessly incorporating digital technologies.

Consequently, these factors undermine the efficacy of the Metaverse as an instructional tool and contribute to student hesitancy in fully engaging with it (Hamilton et al., 2021). To fully realize the transformative potential of the Metaverse in Nigerian higher education and ensure that educators and students can effectively benefit from immersive digital learning experiences, it is imperative to address these hurdles. Thus, the objective of this study is to examine the variables that influence the adoption and effective utilization of the Metaverse in Nigerian higher education.

Purpose of the Study

The aim of this research is to explore the factors influencing the adoption and effective utilization of the Metaverse in Nigerian higher education, with a particular focus on student perspectives and potential barriers to its integration.

i. To identify the factors that influence university students' acceptance of metaverse-based learning platforms in Nigeria.
ii. To examine the relationship between performance expectancy, effort expectancy, social influence, and facilitating conditions with students' acceptance of metaverse-based learning platforms.
iii. To determine the impact of adoption intention on students' acceptance of metaverse-based learning platforms.

Literature Review and Theoretical Underpinning

The concept of the metaverse pertains to a virtual realm that encompasses a shared space where individuals can engage with a computer-generated environment and interact with other users in real time. It transcends conventional virtual reality encounters by establishing a persistent and interconnected virtual world that can be accessed and experienced through a variety of devices and platforms. The metaverse is essentially a shared virtual space that is formed through the convergence of practically enhanced physical reality and physically enduring virtual space, encompassing all virtual worlds, augmented reality, and the internet (Hwang & Chien 2022). The notion of the metaverse has become somewhat ambiguous over time as various individuals have attempted to define it in their own terms, and there is no general consensus on a single definition. Nevertheless, all interpretations concur that this novel form of network will enable users to access diverse digital content without being restrained by real-world limitations or restrictions imposed by current technology or infrastructure constraints such as bandwidth limitations set by internet service providers (ISPs).

However, the progress of digital transformation has demonstrated the success of computer-mediated virtual worlds, augmented reality apps, and non-interventional games like Upland, also known as token games. According to Lee et al. (2021), the establishment of the Metaverse was intended to further facilitate digital transformation. When viewed as an ecosystem, the digital cyberspace "Big Bang" seems to be an imminent reality. This reality is ignited by technological advancements such as 5G and artificial intelligence.

Therefore, it is vital to possess a correct comprehension of these concepts, particularly now that discussions on

their application in education are commencing. The effective utilization of the Metaverse ecosystem will be made feasible through applications such as augmented reality, human-computer interaction (HCI), artificial intelligence (AI), blockchain, visual objects, robots, cloud computing, and forthcoming mobile networks. On the other hand, virtual reality (VR) is not a new concept. Its initial applications date back 40-50 years ago. However, since the 2010s, advancements in technology have made it more applicable. According to some sources, the metaverse represents the future state of the internet. Users will be able to work, meet, play, and socialize in these 3D worlds thanks to the metaverse. Certain platforms seem to incorporate elements of a metaverse, although they are not fully developed (Kim, Lee, & Choi, 2022).

Theoretical Underpinning

Numerous models have been developed to examine consumers' behavioral intentions in adopting new technology, including well-known ones such as Ajzen's Theory of Planned Behavior, Rogers' Diffusion of Innovations Theory, and Davis' Technology Acceptance Model (TAM). In order to unify these models and provide a comprehensive framework for understanding and predicting technology adoption, Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT). This theory identifies four key factors that influence individuals' utilization of technology and their behavioral intentions. One of these factors is performance expectation, which refers to an individual's belief that using technology will enhance their performance and productivity. In the context of learning with metaverse, learners are more likely to accept and continue using this technology if they believe it can help them better grasp course material and provide a more engaging learning experience.

The UTAUT model is widely used for predicting user acceptance and adoption of new technologies, including educational technology. It consists of four main components: performance expectancy, effort expectancy, social influence, and facilitating conditions. This model is particularly relevant for studying metaverse-based learning platforms, as it has been applied in previous research. Venkatesh et al. (2003) proposed the UTAUT model to determine the aim and utilization of technology through these four factors. By applying the UTAUT model, researchers aim to understand user acceptance and behavior in relation to technology usage. It is important to note that most of the major connections in the model are moderated.

Rosen (2004) investigates the impact of Personal Innovativeness in the Domain of Information Technology (PIIT) on technology acceptance and usage. PIIT refers to an individual's willingness to experiment with new information technology, a concept that has been overlooked in prior studies on technology acceptance. The inclusion of PIIT in the research model is hypothesized to enhance the understanding of individual-level adoption and usage processes. PIIT is considered as a main-effect variable to elucidate behavioral intentions, and its influence on technology acceptance and usage is analyzed using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. This study aims to advance the comprehension of technology adoption processes by incorporating the concept of PIIT into the research model.

The UTAUT provides a comprehensive understanding of the factors that influence intention and behavior change

over time. Previous studies have extensively examined students' attitudes and intentions to use various technologies in education, such as Metaverse platforms, using the UTAUT and its inspired model (Granić, 2023; Al Farsi, 2023; Zhao & Cleesuntorn, 2023; Barrett et al., 2020; Teng et al., 2022). These studies contribute to our knowledge of how models can be applied in educational contexts to assess attitudes and intentions towards the metaverse and its technologies.

The Metaverse's Technological Framework

Kang (2021) has proposed a comprehensive architecture for instructional technology in the metaverse, encompassing hardware, computers, networking, virtual platforms, interchange tools and standards, payment services, content, services, and assets. Park and Kim (2022) further elaborate on the metaverse's architecture, outlining its constituent components as hardware, software, and content, as well as approaches involving user engagement, execution, and utilization.

Hwang and Chien (2022) provide valuable insights into the educational possibilities of the metaverse, emphasizing the importance of knowledgeable peers, tutees, and tutors, and highlighting its integration in AI-powered educational programs. However, the architecture of the metaverse is not defined by a single technology, but rather by a combination of various technologies that form a solid foundation for connecting the physical and virtual realms in learning activities. The proper functioning of the metaverse relies on high-speed communication networks like 5G and 6G, which enable user connectivity, scene display, feedback, and data transfer (Yang et al., 2022).To enhance the utilization of learning resources, Zhao et al. (2022) underscore the significance of computing technologies including edge, cloud, and distributed computing in processing, storing, and exchanging data within the metaverse. Analytical technologies like artificial intelligence (AI) and big data improve personalized learning experiences by allowing thorough monitoring and evaluation of learners' behaviors, emotions, and performances (Park and Jeong, 2022).

Additionally, the development of immersive learning environments with accurate simulations and intricate representations is facilitated by modeling and rendering technologies (Tlili et al., 2022). Learners' experiences in the metaverse are enriched by embodied and multimodal engagement, made possible by VR, XR, and sensors, enabling cooperative exploration and sensory feedback (Genay et al., 2021). Authentication technologies, particularly blockchain, ensure transparency, decentralization, and security in the metaverse, protecting user privacy and intellectual property (Yang et al., 2022). According to Zhao et al. (2022), wearable smart technology plays a crucial role in enabling users to seamlessly transition between digital and physical environments, thereby increasing their immersion in the metaverse. Avatars, NPC characters, learning scenes, and resources are integral elements of the metaverse's educational landscape, offering personalized and immersive learning experiences. Lifelogging captures learners' experiences and interactions within the metaverse, providing valuable insights for reflective learning and performance assessment.

Hence, learning analysis tools leverage AI and data analytics to evaluate learners' performance and inform personalized interventions. Authentication mechanisms, such as blockchain and NFTs, ensure the integrity and

traceability of learners' contributions and creations in the metaverse. The metaverse offers individualized and immersive learning experiences through the use of avatars, NPC characters, learning scenarios, and resources (Hwang and Chien, 2022).

Review of Related Literatures

Chien & Hwang (2022) assert that the Metaverse stands as one of today's most promising technologies. Nonetheless, there appears to be a dearth of educator awareness regarding its potential educational applications. The authors aim to address this gap by presenting a comprehensive elucidation of the Metaverse in their work. They delve into potential applications of the Metaverse in education and pinpoint research challenges within this realm. While doing that, they underscore the role of AI in both the Metaverse and Metaverse-based education. Their main objective is to equip scholars in computer science and educational technology with a profound understanding of the Metaverse and its prospective classroom applications. On the other hand, Akour et al. (2022) examined the factors that influence students' acceptance of the Eduverse in higher education institutions in the Gulf area. The authors delve into the feasibility of implementing an educational platform based on the Metaverse. They contend that through utilization of this Metaverse platform, learners can deeply immerse themselves in the learning journey, thereby nurturing motivation and engagement.

Al-Adwan et al. (2023) study explores how Generation Z students make adoption decisions about the usage of metaverse technologies in higher education. With a particular focus on Jordanian students, the researchers tested a model that integrates the UTUAT2 theory with Personal Innovativeness in IT by using Structural Equation Modeling (SEM) to evaluate data from 537 Generation Z Jordanian students. With the exception of social influence, every component of the model was found to have a statistically significant and favorable impact on Generation Z students' inclination to use metaverse technology in higher education. Through performance and effort expectations, the study emphasizes the significance of PIIT as a direct and indirect predictor of adoption intention. Additionally, the research offers significant implications for executives and policymakers in higher education institutions, emphasizing the importance of embracing metaverse technology to enhance student learning experiences in the wake of the Covid-19 pandemic.

According to Yang et al. (2022) study, the intentions of Chinese college students to utilize metaverse technology for basketball learning are significantly influenced by perceptions of utility, flow experience, and convenience of use. These factors directly impact attitudes toward technology as well as behavioral intention. The relationship between intention and perceived ease of use is also modified by gender, highlighting the importance of considering gender when adopting new technology. The findings emphasize the significance of user experience and perceived usefulness in influencing college students' adoption of metaverse technology, particularly in the context of sports instruction.

Misirlis and Munawar (2023) support the perspective of Yang et al (2022) by asserting that the utilization of metaverse technology for educational purposes requires practical knowledge acquisition. They propose a structural model of acceptance for MetaEducation, which aims to provide guidance to university stakeholders on

successfully integrating new technologies into academic environments. The study reveals a significant lack of substantial association between perceived ease of use and attitude, as well as between perceived usefulness and attitude. However, self-efficacy and subjective norms have favorable effects on attitude and perceived usefulness. This suggests that students are hesitant to use MetaEducation technology due to their unfamiliarity with its features and advantages. The overall findings of the study highlight the need for targeted interventions to address knowledge gaps and enhance university students' adoption of metaverse technology.

Songkram et al. (2023) support the aforementioned perspective by asserting that attitude is the primary factor influencing students' recognition and acceptance of digital learning platforms. Their study on students' behavioral intentions toward these platforms reveals that perceived ease of use and perceived usefulness come after attitude in terms of importance. The study underscores the critical role of attitudes in shaping students' adoption of digital learning technology. It was conducted within the context of Thai education and utilized structural equation modeling with a large sample size. The study also finds that students' understanding and acceptance of these platforms are influenced by peripheral variables such as enabling conditions, subjective norms, and technological self-efficacy.

Similarly, Wang et al. (2023) conduct a comprehensive analysis of the factors influencing university students' intention to adopt the metaverse in the context of the 4th industrial revolution and the COVID-19 pandemic in China. By combining the C-TAM-TPB model and IDT theory, the study identifies several important factors that influence adoption intention, including attitude, compatibility, perceived utility, relative benefits, and subjective norm. Notably, perceived behavioral control does not have a significant impact on adoption intention. The subjective norm is found to be the most influential component, while compatibility has the least influence. Additionally, the association between relative advantage and adoption intention is negatively moderated by perceived risk. Importantly, there is no significant difference in adoption intention based on gender and experience levels.

Hence, the research conducted by Al-Adwan et al. (2023) delves into the critical factors that influence the utilization of metaverse technology in the classroom by college students. The study employs an expanded Technology Acceptance Model (TAM) to comprehensively understand the behavioral objectives of students in this context by incorporating technological, individual, and enabling/inhibiting elements. Through the utilization of partial least squares structural equation modeling (PLS-SEM) analysis on empirical data collected from 574 students in Jordanian universities, the researchers identify perceived usefulness, personal innovativeness in IT, and perceived enjoyment as key factors that enable the use of metaverse technology. Additionally, they recognize perceived cyber risk as a significant inhibitor. Interestingly, the study reveals that adoption intentions are not greatly influenced by perceived ease of use.

Furthermore, Chahal and Rani (2022) explore the crucial domain of e-learning adoption among students in Indian higher education. Their research aims to comprehensively understand the factors that impact students' behavioral intentions and actual usage of e-learning platforms. They accomplish this by integrating the Technology Acceptance Model (TAM) with three external variables: personal innovativeness, social factors, and self-efficacy.

The quantitative analysis, which involved 570 respondents, yields significant findings that validate the proposed model and clarify the direct and indirect influences of external factors on TAM components. These findings have substantial implications for stakeholders in higher education and offer valuable insights for enhancing the effectiveness of e-learning programs in India.

However, Bubou and Job (2020) present a different perspective. Their study examines the crucial roles played by individual innovativeness and e-learning self-efficacy in predicting the preparedness of first- and second-year students at the National Open University of Nigeria (NOUN) Yenagoa Study Center for e-learning. Conducted in an African open and remote education setting, the research investigates whether a significant relationship exists between these variables and students' preparedness for e-learning using a quantitative approach. The findings reveal a strong positive correlation between individuals' creative capacity and their readiness for online learning, indicating that students who possess innovative tendencies are better equipped for such learning environments. Similarly, the study uncovers noteworthy associations between preparedness and e-learning self-efficacy, underscoring the importance of students' confidence in their ability to navigate e-learning environments proficiently.

In their study, Lee, Nguyen, and Yang (2023) investigate the factors influencing the adoption of Metaverse platforms among Generation MZ in Vietnam. The researchers incorporated the Extended Unified Theory of Acceptance and Use of Technology, along with introducing a "switching cost" variable. Through the analysis of data from 520 participants, including 230 from Generation Y and 290 from Generation Z, the study found that effort expectancy, performance expectancy, facilitating conditions, hedonic motivation, and value price positively influence the intention to adopt Metaverse platforms. While social influence had no significant impact on the overall dataset, it did affect the intention of Generation Y positively. Conversely, the study emphasizes that switching costs act as a barrier to the adoption of Metaverse platforms. The research also highlights substantial differences between Generation Y and Generation Z in terms of the factors influencing adoption, providing valuable insights for industry leaders looking to capitalize on the opportunities presented by Metaverse platforms for sustainable growth in the online sector.

Teng et al. (2022) conducted a study to examine the factors influencing the intention to use metaverse educational application platforms, utilizing an expanded UTAUT model. Their findings reveal that personalized learning, situational teaching, perceived usefulness, and perceived ease of use are significant determinants of usage intention. It is essential to establish a comprehensive assessment framework for metaverse-based learning platforms, incorporating indicators that may require modification or addition in alignment with metaverse application. Additionally, there is a necessity to discover novel applications and case studies across various disciplines and sectors within the metaverse, considering that learning experiences may vary significantly from traditional methods.

Researchers have displayed a keen interest in exploring the potential application of the metaverse in diverse educational contexts. However, there is a need for additional studies that examine the adoption of the metaverse by learners in Nigerian universities using the UTAUT paradigm. According to our analysis, there are only a limited

number of empirical studies focusing on the utilization of the metaverse in educational settings in Nigeria. Drawing insights from previous research on the metaverse in education, it can be concluded that this technology holds significant potential for transforming the educational landscape. One noteworthy application of metaverse technology is in the realm of audiovisual education, which enhances learning outcomes by providing experiential and simulated learning opportunities, surpassing the limitations of traditional textual and visual materials. By integrating direct experiences or simulations into the learning process, the effectiveness and structure of learning can be greatly improved.

Research Hypotheses and Conceptual Model

The research model utilized the UTAUT, which consisted of five variables: performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FCs) and a dimension on personal innovativeness in IT was added to examine its effects along with the original UTAUT determinants. All five independent factors predicted the adoption intentions, which served as the dependent variable. There is comparable predictive importance among the five independent variables (IV) for adoption intentions (dependent variables (DV).

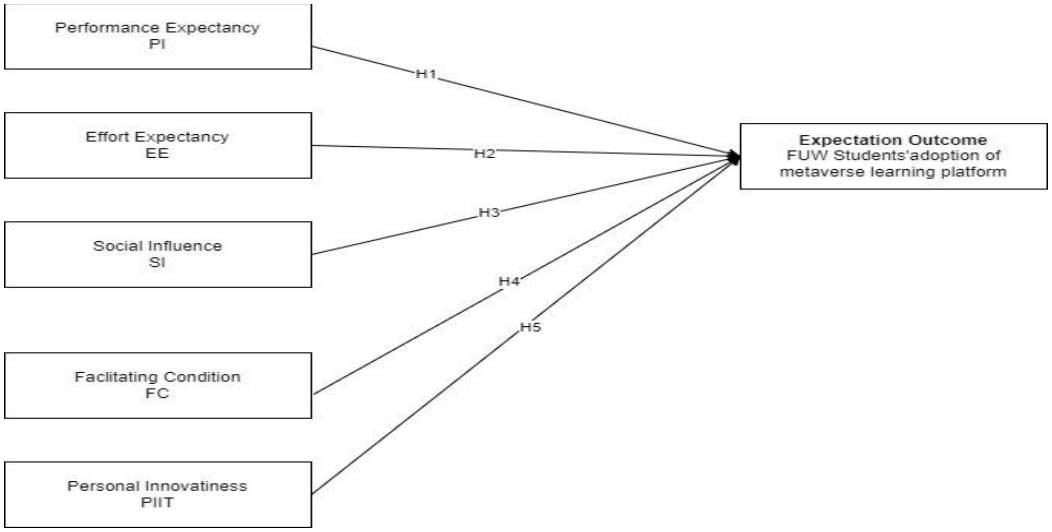

Figure 1. Conceptual Research Model

Based on the model as depicted in figure 1, the hypotheses articulated are as follows:

H1: Performance Expectancy (PE) significantly influences students' intentions to adopt MLP in Federal University Wuakri

H2: Effort Expectancy (EE) has a significant effect on the students' intentions to adopt MLP in Federal University Wukari.

H3: Social Influence (SI) significantly influences students' intentions to adopt MLP in Federal University Wukari.

H4: Facilitating Condition (FC) positively influences students' intentions to adopt MLP in Federal University Wukari.

H5: Personal Innovativeness in IT (PIIT) significantly impacts students' intentions to adopt MLP in Federal University Wukari learning platforms

Method

This study employed quantitative research methods to explore the factors influencing the acceptance of metaverse-based learning platforms by university students. The research aimed to provide statistical evidence applicable for future studies and validate the proposed theoretical framework. The study sought to improve the understanding of the determinants affecting students' intentions to use metaverse-based learning platforms.

The research population comprised undergraduate students from the faculties of computing and information systems, engineering, and pure and applied science at Federal University Wukari, Nigeria, totaling 2,067 students. A systematic sampling approach, involving a 10% sampling fraction, was utilized, in line with Airasan's (2003) recommendations in educational research. Data collection was done through an online survey distributed strategically across different faculties using various social media platforms and sampling techniques such as snowball sampling to ensure diversity and enhance participation rates. The survey instrument included the UTAUT questionnaire with five variables and utilized a five-point Likert scale for survey items. After screening for incomplete responses, 244 usable responses were analyzed using structural equation modeling with STATA 14 software to assess the research hypotheses and confirmatory factor analysis for discriminant validity, reliability, and data substance.

Additionally, a Common Method Bias test (CMB) was performed as part of the CFA analysis to identify any potential measurement bias. Once the validity and CMB requirements were confirmed, the proposed theories were tested using structural equation modeling (SEM), specifically path analysis. The model was estimated using the Maximum Likelihood Method (MLM) to maximize the explained variance of the latent dependent components and ensure accuracy in standard error, dependability, and beta computation.

A total of 244 participants took part in the study. Among them, 152 (62.6%) identified as male, while 91 (37.4%) identified as female. In terms of age distribution, 96 (39.5%) fell within the 15–20 years range, 109 (44.9%) were between 21–25 years old, and 38 (15.6%) were aged 26–31 years. The participants were enrolled in the following faculties: Computing and Information Systems with 85 (35.0%) participants, Engineering with 71 (29.2%), and Pure and Applied Science, with 87 (35.8%).

Results

The results obtained from the questionnaire were analyzed using factor analysis and mean item score (MIS). After conducting an initial analysis to assess validity and reliability, the component factors were extracted through descriptive factor analysis (utilizing the mean item score and ranking) and exploratory factor analysis. An exploratory factor analysis (EFA) was conducted on survey data to identify the underlying relationships between variables influencing the adoption of the Metaverse at Federal University Wukari, Nigeria. The analysis focused on student perspectives and potential obstacles to the integration of the Metaverse. EFA, a statistical approach, allowed for the determination of the structural factors without imposing any predetermined structure on the results. Prior to the analysis, the adequacy and reliability of the data were assessed using Cronbach's alpha coefficients.

The results, presented in Table 1, indicate that the university's adoption of the Metaverse is supported by Cronbach's alpha coefficients of 0.828 and 0.833, respectively. The fact that these coefficients exceed 0.7 suggests a high level of reliability.

Tabe1. Cronbach's Alpha Test

Cronbach's alpha	No of items
0.828	28

The averages, standard deviations, and correlations for the important variables are shown in Table 2. Moderate correlations between the independent variables are indicated by Pearson's r correlation coefficients.

Table 2. Correlations and Descriptive Statistics

Variable	M	SD	PE	EE	SI	FC	PIIT	BI
PE	4.25	0.561	1					
EE	4.08	0.583	0.6869**	1				
SI	3.82	0.732	0.6055**	0.6808**	1			
FC	3.81	0.745	0.4733**	0.5826**	0.6537**	1		
PIIT	4.49	0.565	0.5224**	0.4857**	0.3407**	0.4916**	1	
AI	3.83	0.723	0.5310**	0.6269**	0.8622**	0.8010**	0.4054**	1

Note **p<0.01

Furthermore, in order to evaluate the authenticity of our underlying constructs and the resilience of our framework in terms of distinguishing validity and content, the criterion for content validity is substantiated by the standardized factor loadings that surpass 0.50 as illustrated in Table 3. Moreover, the table exhibits Cronbach's alpha values exceeding 0.70, indicating the internal consistency and reliability of the scales. Lastly, the values for Average Variance Extracted (AVE), which measures the extent to which random measurement error is accounted for by the latent variable, ranged from 0.55 for enabling conditions to 0.87 for performance expectancy, both of which exceed the 0.50 criterion.

Table 3. Robustness Checks

Construct	Items	Mean	St. Dev	Factor loading	CA	AVE
Performance expectancy	PE1	4.27	0.73	0.67	0.88	0.87
	PE2	4.16	0.66	0.59		
	PE3	4.27	0.73	0.67		
	PE4	4.23	0.59	0.72		
	PE5	4.30	0.64	0.70		
Effort expectancy	EE1	4.12	0.63	0.72	0.87	0.80
	EE2	4.06	0.71	0.66		
	EE3	4.06	0.77	0.67		

Construct	Items	Mean	St. Dev	Factor loading	CA	AVE
	EE4	4.27	0.59	0.73		
	EE5	3.89	0.87	0.65	0.86	0.59
Social Influence,	SI1	3.82	0.85	0.70		
	SI2	3.77	0.80	0.71		
	SI3	3.67	1.08	0.65		
	SI4	3.89	0.877	0.61		
	SI5	4.06	0.83	0.72		
Facilitating Conditions	FC1	3.65	1.05	0.63	0.87	0.55
	FC2	3.91	0.91	0.54		
	FC3	3.54	1.05	0.79		
	FC4	3.83	0.88	0.69		
	FC5	4.11	0.73	0.63		
Personal innovativeness in IT	PIIT1	4.46	0.66	0.58	0.90	0.79
	PIIT2	4.55	0.62	0.51		
	PIIT3	4.47	0.67	0.57		
	PIIT4	4.44	0.65	0.61		
	PIIT5	4.51	0.61	0.72		
Adoption Intentions	AI1	3.794239	0.95	0.72	0.85	0.70
	AI2	4.057613	0.83	0.61		
	AI3	4.057613	0.83	0.63		

From the outcomes presented in Table 3, it can be deduced that the measurements of PE, EE, SI, FC, PIIT, and IU exhibit reliability. This deduction is derived from the fact that the Cronbach's alpha values of all the variables exceed 0.7, signifying strong reliability for the validated constructs in this investigation. Each factor's composite reliability score is also above 0.80, which is remarkably high for the proposed model. Consequently, the proposed model satisfies construct reliability. Additionally, Average Variance Extracted (AVE) remains the preferred measure for assessing convergent validity. Convergent validity is confirmed when AVE values surpass the suggested minimum criterion of 0.5. Since all AVE values exceeded this threshold, it can be concluded that the structural model fulfills the requirements for convergent validity.

Table 4. Path Coefficients Estimates

Hypothesis	Correlation	Path Coefficients	t- Statistics	P-values	Decision
H1	PE > AI	0.257	3.877	0.000	Supported
H2	EE > AI	0.269	4.132	0.00	Supported
H3	SI > AI	0.465	10.996	0.000	Supported
H4	FC > AI	0.071	1.065	0.287	Not Supported
H5	PIIT > AI	0.165	3.208	0.001	Supported

The findings from the hypothesis testing are presented in Table 4, indicating that H4 was deemed statistically

insignificant, while hypotheses H1, H2, H3, and H5 were statistically significant at the 0.01 probability level. Consequently, this investigation supports hypotheses H1, H2, H3, and H5 in terms of significant and favorable effects, but not H4. Path coefficients (β) reveal the relationships within a structural model organization. The impact of performance expectancy, effort expectancy (EE), social influence (SI), and personal innovativeness in IT (PIIT) on users' intentions to accept metaverse is shown by their respective path coefficients of 0.257, 0.269, 0.465, and 0.165.

Furthermore, the overall effect size of the structural model, as indicated by R^2, falls into one of three categories: "high" ($R^2 > 0.5$), "moderate" ($R^2 > 0.30$), or "weak" ($R^2 > 0.1$). Table 5 reveals that the intention to utilize a Metaverse-based learning platform (BI) has a remarkably high R-squared (R^2) value of 0.843, suggesting that the five components (PE, EE, SI, FC, and PIIT) together account for approximately 84% of the variance. Similarly, the modified R-squared demonstrates that the additional predictors contribute insignificantly to the increased explanatory values.

Table 5. Magnitude of the Coefficients of Determination R-squared (R^2)

	R-Square	**R-Square Adjusted**
AI	0.8436	0.8386

Discussion

The present investigation has conducted an extensive evaluation of the essential components necessary for the intention to adopt the metaverse. To achieve this, the UTAUT model was employed, with a specific focus on a developing nation. The study implemented thorough testing to examine the constructs across all proposed associations, thereby enhancing the distinctiveness and rigor of the findings. Through the meticulous design of the methodological approach, the researchers of this study were able to conduct a comprehensive and rigorous investigation of the factors influencing the intention to adopt the metaverse in the context of higher education, particularly within the unique socio-economic landscape of a developing country. The outcomes revealed that the key variables influencing adoption intention were performance expectancy (PE), effort expectancy (EE), and social influence (SI).

The study's scope included the development of theories to investigate the relationships among the components of the model. The assertion of hypothesis "H1: Performance expectancy influences students' adoption intentions to use the metaverse" was justified by a particular reasoning. Correspondingly, Chiao et al. (2018) observed in their examination of a virtual reality tour guiding system within the context of the technological acceptance model that adoption intention is impacted by performance expectancy. This finding is corroborated by Khalil et al. (2023), who have also illustrated that performance expectancy plays a crucial role in influencing adoption intention. The research revealed that various factors such as effort expectancy, performance expectancy, enabling circumstances, hedonic motivation, and value pricing have a significant influence on the inclination to utilize the Metaverse platform (Lee et al., 2023).

The validation of the second hypothesis in the study pertains to the influence of effort expectancy on students' adoption intentions to utilize the metaverse. This aligns with Khalil et al.'s (2023) research in higher education, indicating a positive correlation between effort expectancy and adoption intention. In contrast, Aranyossy (2022) did not observe a significant impact of effort expectancy on adoption intention in a study on online theater environments due to the basic nature of the sample online setting.

Likewise, the results of this study offer backing for the third research hypothesis, which posits that students' adoption intentions concerning the metaverse are shaped by social influence. Chiao et al. (2018) similarly discovered a positive link between social influence and adoption intention, highlighting the impact of peers' technology adoption on individuals' decisions. Teng et al.'s (2022) investigation into students' usage of educational metaverse environments further illustrated how social influence affects usage intention, emphasizing the importance of peer recommendations and social circles in this context. However, Aranyossy (2022) conducted an analysis of online theater environments during the epidemic utilizing the UTAUT2 model, discovering that social influence had no noticeable impact. It is anticipated that students, especially those from Generation Z, will view metaverse-based educational platforms as more user-friendly and intuitive compared to their peers. Due to being proficient in utilizing modern technology such as VR/AR gear, the majority of Generation Z students, being digital natives, often encourage their peers to effortlessly use and navigate metaverse-based educational platforms. These results are consistent with previous studies in the instructional technology field (Wang et al., 2021). Through the examination of responses related to social influence and the validation of the hypothesis that social influence influences students' intentions to adopt metaverse use, it was evident that social influence indeed holds a significant influence.

The fourth hypothesis of this research, "H4: Facilitating conditions influence students' intentions to adopt metaverse use," was disproven. This outcome is in line with the emphasis placed by Yang et al. (2022) on the importance of considering facilitating conditions in their examination of metaverse application in basketball training. In contrast, Sunardi et al. (2022) discovered that facilitating conditions did not have a significant impact on adoption intentions when studying augmented reality in video conferencing systems. Conversely, Mustafa et al. (2022) identified conducive conditions as a vital factor in the adoption of 5G technology in their study on influencing factors. It is important to acknowledge that not all students have access to the required hardware or stable internet connections for a fully immersive Metaverse experience.

The fifth hypothesis presented in this study focuses on personal innovativeness in the field of Information Technology. Hypothesis H5 suggests that the inclination of students to adopt the metaverse is impacted by their level of innovativeness in IT, a notion that was corroborated by the research. This assertion is consistent with the findings of various studies (Akour et al., 2022; Chahal & Rani, 2022; Bubou & Job, 2022; Wang et al., 2021) demonstrating that individuals with a high degree of innovativeness are more open to new technologies and perceive their adoption as less daunting. The results of the study also align with the discovery by Al-Adwan et al. (2023) that the significance of Personal Innovativeness in IT (PIIT) acts as both a direct and indirect predictor of adoption intentions among Generation Z students in making decisions about the utilization of metaverse technologies within higher education. The incorporation of PIIT in the research framework functions as a primary

factor to clarify behavioral intentions, and its impact on the acceptance and usage of technology is examined through the Unified Theory of Acceptance and Use of Technology (UTAUT) framework (Rosen, 2004).

Consequently, students who exhibit high levels of personal innovativeness in IT are incentivized to engage with educational environments based on the metaverse. These students have the opportunity to improve their skills and confidence in utilizing IT, including the metaverse, by exploring novel technologies and experimenting with their capabilities. Furthermore, students who possess a high degree of innovativeness perceive new educational technologies like the metaverse as less complicated to utilize due to their technological proficiency, which positively influences their attitudes towards adopting such technologies.

Conclusions

The aim of this study was to investigate the factors influencing students' intentions to use learning platforms based in the Metaverse. To achieve this, a new conceptual framework was developed using the Unified Theory of Acceptance and Use of Technology (UTAUT) model, incorporating five independent variables. These variables included personal innovativeness in IT, performance expectancy (PE), effort expectancy (EE), social influence (SI), and enabling conditions (FCs) from the UTAUT model. A comprehensive survey was conducted among 244 students from different faculties at Federal University Wukari, Nigeria, including computing and information systems, engineering, and pure and applied science. The findings revealed that characteristics showing statistical significance had a positive impact on students' intention to use Metaverse-based learning platforms. The study also explored the adoption intentions of students using metaverse technology in the classroom and aimed to gather comprehensive data on students' acceptance and awareness of the technology. One key finding was that individuals with high levels of personal innovativeness in IT were more inclined to adopt metaverse-based learning platforms. These students were more open to using new technologies and had greater technical competency, which influenced their perceptions and ease of use of such platforms. The study recommended further research on the social dimensions of metaverse technology, particularly considering the opinions and perspectives of Generation Z university students, who were the main respondents in this study. However, the study found that the average response to the performance expectancy variable was high, indicating that students believed the metaverse setting enhanced their learning.

Implications

The contributions of the research are as follows: Firstly, it presents an adjusted UTAUT model for exploring metaverse adoption in higher education, incorporating Personal Innovativeness in Information Technology (PIIT) factor to address UTAUT's shortcoming in terms of inability to explain behavioral intentions and its lack of consideration to individual characteristics. Secondly, it validates UTAUT's relevance and enriches our comprehension of metaverse adoption in higher education, particularly within the educational landscape of Nigeria. This study enhances the existing body of knowledge on metaverse technology, focusing on its application in education. The proposed model accounts for 83.9% of the variability in metaverse adoption intentions, providing a useful framework for realizing virtual reality's educational potential. It stresses the significance of

accounting for cultural, socio-economic, and institutional aspects when implementing technology in educational environments.

Additionally, the practical implications underscore the importance of incorporating metaverse technology in higher education post-Covid-19 to enhance student learning experiences. Social influence, particularly among Generation Z students who appreciate user-friendly metaverse platforms, is a key factor. The research emphasizes the necessity of adapting traditional teaching methods to align with students' preferences for innovative learning approaches. Learners with high Personal Innovativeness in Information Technology (PIIT) tend to seek personalized, self-directed learning experiences, suggesting that educators should tailor metaverse-based learning to meet these needs. Furthermore, this study serves as a pivotal point in the ongoing discourse on technology adoption in Nigeria, offering detailed insights and evidence-based recommendations tailored to the unique cultural context.

Recommendations

Based on the findings of this study, the following recommendations are made**:**

1. For the enhancement of the generalizability of results, future research ought to utilize varied and random samples, guaranteeing relevance across diverse demographics, educational environments, and cultural backgrounds.
2. Subsequent studies should contemplate the application of additional theoretical frameworks to acquire a thorough comprehension of the elements that impact the acceptance and utilization of the metaverse in educational practices. The collaboration among scholars from different fields can enhance the exploration of the metaverse in education, amalgamating complementary skills and viewpoints.
3. Longitudinal studies can offer valuable insights into the lasting impacts and viability of teaching methodologies based on the metaverse. Future inquiries should prioritize the actual execution and assessment of teaching interventions based on the metaverse in authentic educational settings. By integrating these recommendations, academics can progress our insight into the role of the metaverse in education and contribute to empirically-grounded methodologies for immersive technologies in the educational domain.

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