

A Study of Student Perceptions and Satisfaction Drivers Towards Metaverse Based Education in India

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ABSTRACT

The rapid evolution of digital technologies has reshaped the educational sector paving the way for seamless and immersive technologies fostering innovative learning environments. Traditional learning spaces are transforming into interactive and tech-enabled learning paradigms. Among these modern advancements, the Metaverse, an immersive virtual space has emerged as a next-generation platform with the potential to redefine and enhance students' interaction, active learning and collaboration in higher education. Despite the growing interest in metaverse adoption, limited empirical research has explored on its application and ability to enhance undergraduate education especially in relation to the established collaborative pedagogical approaches that operates within metaverse-based contexts. The purpose of the study is to examine students' awareness of virtual learning platforms and the Metaverse, understanding of collaborative learning, identifying the underlying dimensions of collaborative pedagogies, assessing relationship and influence of students' experiential perceptions on overall satisfaction with immersive learning at undergraduate level within the Mumbai region of India. A cross-sectional survey using structured questionnaire was conducted among 200 undergraduate students across three disciplines- science, arts and commerce. A quantitative approach was adopted using descriptive analysis, exploratory factor analysis, correlation and regression modelling. The results indicate that students have strong conceptual understanding of collaborative learning pedagogies and express openness to immersive virtual platforms. Three key factors were identified: active and gamified learning, collaborative peer-led learning and experiential and inquiry-driven learning. Usefulness, convenience, ease of interaction and immersive experience were significantly associated with, and predictive of, user satisfaction in a three-dimensional virtual learning environment. The findings underscore the significance of aligning pedagogically grounded, student-centered approaches with metaverse-based learning environments offering valuable insights for educators, developers, and policy makers aiming to implement immersive pedagogical models and aligning students' perceptions with future-ready digital strategies in higher institutions.

Keywords Collaborative Learning, Digital Platforms, Education, Metaverse, Pedagogies, User Satisfaction.

INTRODUCTION:

The digital transformation in the academic landscape of higher education especially in the post pandemic online learning era, has encouraged educational institutions to explore new and immersive technologies that supports flexible and student-centered learning environments (Dhawan, 2020; Brown & Green, 2021). The transition from traditional classroom teaching to active and participatory learning paradigms has led to the emergence of interactive and immersive learning environments, one of which is the concept of Metaverse – a multi-sensory virtual learning platform which has surfaced as a promising learning tool to facilitate active, experiential and collaborative learning (Mystakidis, 2022; Dede, 2009). The advent of immersive virtual reality (VR) and augmented reality (AR) technologies and most recently the Metaverse- has offered a unique chance to reimagine the traditional educational practices

by allowing interactive and real time collaborative learning experiences. Metaverse, a networked and shared three-dimensional (3D) virtual world has gained attention for its potential to reshape and enhance the teaching and learning particularly in collaborative learning contexts. Metaverse is termed as online virtual parallel world (Metwally et al., 2024). It is considered as an ideal model in educational sector due to its speedy communication, immersive simulation and multimedia streaming capabilities (Jagatheesaperumala et al., 2022) helping the educational technology (EdTech) companies in exploring data driven and information-based teaching and machine learning (Renz & Hilbig, 2020).

In parallel, pedagogical models in higher education have increasingly shifted towards active learning with collaborative methods such as group work, project-based learning, peer-instruction emphasizing student

participation, critical thinking and deeper understanding across disciplines (Bonwell & Eison, 1991; Prince, 2004; Freeman et al., 2004). Furthermore, Digital platforms like Learning Management Systems (LMS), Massive Open Online Courses (MOOCs) and Virtual Labs enhances learner autonomy, flexibility and motivation through personalized and interactive experiences (Bower, 2019; Wang et al., 2020). The Technology Acceptance Model (TAM) provides a theoretical framework explaining technology adoption in education with perceived usefulness and ease of use serving as key predictors in shaping students' attitudes and satisfaction towards new technologies (Davis, 1989; Venkatesh & Davis, 2000). Prior studies have demonstrated that collaborative and active learning shows a positive impact on student engagement and academic attainment (Laal & Ghodsi, 2012).

Despite these advances, the pedagogical integration of immersive technologies into active learning frameworks remains underexplored. Limited research has examined how students perceive and respond to collaborative learning pedagogies within 3D virtual spaces (Makransky & Lilleholt, 2018). Moreover, few studies exist on how student's perceptions of usefulness, convenience, ease of interaction and immersive experience shape their overall satisfaction in these environments. The mechanism linking prior exposure to digital platforms, pedagogical preferences and user's perceptions in the metaverse have not been thoroughly examined, leaving a notable gap in the current body of literature.

As higher education increasingly adopts immersive and student-driven learning technologies, it is essential to understand how students engage with these tools not just technologically but pedagogically also. While some global studies highlight the advantages of integrating metaverse based learning, there is very limited empirical research that contextualizes these benefits in the Indian education system. In India, where educational institutions are rapidly adopting the online learning and virtual platforms, the practical application of metaverse and its ability to enhance undergraduate education remains relatively unexplored (KPMG, 2023; UNESCO, 2022). This current research is crucial for assessing not only students' awareness and preparedness but also the practical educational value of implementing the immersive learning systems in the real-world scenarios. Grounded in the Technology Acceptance Model (Davis, 1989), and Constructivist Learning Theory (Vygotsky, 1978; Kolb, 1984), this study covers three key objectives:

- ✓ To explore students' awareness of digital learning platforms, their online learning experiences, prior exposure of 3D virtual world and their understanding of Metaverse.
- ✓ To examine students' general understanding and familiarity of collaborative learning, and identify underlying key pedagogical dimensions using exploratory factor analysis (EFA).

- ✓ To assess students' perceptions of Metaverse-based collaborative learning environments and to evaluate how perceived usefulness, perceived convenience, perceived ease of interaction, perceived immersive experience relate to and predict user satisfaction.

This research contributes to the existing literature in several ways. First, it extends the TAM model by including three additional variables – interaction ease, immersive experience and satisfaction which are relevant to the immersive learning contexts (Makransky & Mayer, 2022). Simultaneously, Constructivist Learning Theory supports the pedagogical framework of this study. By integrating these two established theories, the current research not only examines how undergraduate students adopt immersive technologies but also how they engage with and benefit from collaborative learning pedagogies. Second, it identifies latent factors within broad range of collaborative learning pedagogies using exploratory factor analysis (EFA) enriching measurement and instructional design. Third, it empirically models how experiential perceptions influence students' satisfaction for learning in virtual settings. Finally, the current study provides timely and practical insights into the technological and pedagogical factors that influence student's engagement for active learning in future-ready virtual learning environments. The findings of the study provide actionable insights for the educators, instructional designers, platform developers and policy makers seeking to incorporate innovative tools into their curriculum offering a deeper understanding of how emerging technologies can transform the future of education in India (FICCI & EY, 2022; NITI Aayog, 2021).

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The Metaverse, as an interactive and immersive 3D virtual learning environment has gained significant importance in the educational field in recent times particularly focusing on theoretical aspects and its potential to transform the digital learning. Advanced technologies like AR, VR and Metaverse have gained attention in improving collaborative experiences in higher education (Kshetri et al., 2022). Investment in Metaverse technology is expected to reach more than 13 trillion by 2030 as indicated in some reports (Morris, 2022) and a new learning environment combining four kinds of metaverses-augmented reality, life logging, virtual reality and a mirror world is created by metaverse (Salloum et al., 2023). The evolution of metaverse in education is bringing about encouragement as it promises to transform conventional learning (Patil, 2022). While majority of the research studies on metaverse and immersive learning technologies focuses on K-12 education of developed countries (Jarmon et al., 2011), it remains limited in terms of the performance of these technologies in a developing country like India especially at the undergraduate education and the overall student's experiences within this environment.

Recent developments in online education have extended the use of digital learning platforms such as MOOCs, Institutional e-portals and LMSs, with global research studies highlighting the influence of accessibility, digital literacy and institutional support on students' awareness to these platforms (Al-Fraihat et al., 2020; Dhawan, 2020). Furthermore, existing research studies on digital learning platforms by Johnson et al. (2014) and Garrison et al. (2000) has primarily focused on traditional online VR/AR tools rather than interactive 3D virtual spaces like Metaverse. In the Indian undergraduate context, research shows that while most of the students are familiar with the digital platforms like Zoom, Google Classroom and Coursera, their usage remains at surface-level with minimal exposure to interactive, immersive and collaborative learning (Kumar & Bansal, 2022). Further, specific focus on collaborative learning using metaverse and its integration especially at the undergraduate (UG) level in India remains largely unexplored.

Studies by Kervin et al. (2020) shows how video game engines like Minecraft and Roblox help students in engaging with teamwork and collaboration in virtual spaces. Furthermore, Garcia and Hooper (2019) argued that these gaming and interactive platforms helps the users in developing immersive literacy. However, students' prior exposure with 3D virtual environments varies widely across geographical regions and institutions (Warburton, 2009; Park & Kim, 2022). While global research studies explore students' perceptions of the metaverse based education (Lee et al., 2023), it largely covers tech-savvy and postgraduate students with limited exposure to Indian undergraduate students. Globally, collaborative learning has been recognized as a key pedagogical approach in constructivist education, fostering critical thinking, problem solving and communication through approaches like peer instruction, project- based and team- based learning (Laal & Ghodsi, 2012). However, in India, especially at the UG level, the educators rely on

traditional classroom models with limited exposure to structured pedagogical frameworks (Saxena & Prasad, 2021). Constructs such as perceived usefulness and ease of use which are key variables to the models like the Technology Acceptance Model (Davis, 1989) and Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) are rarely examined in the context of metaverse platforms in Indian higher education. Most Indian studies focus on basic e-learning satisfaction excluding immersive and collaborative aspects.

Despite growing global interest in Metaverse-based learning, there exists a significant research gap in understanding how Indian undergraduate students perceive and interact with such environments. Most existing research literature is theoretical or exploratory lacking empirical and context -specific research on the practical application of metaverse based collaborative learning in Indian higher education system. This study bridges these gaps by examining the digital learning readiness, prior-exposure to 3D virtual world, familiarity with collaborative pedagogies and multi-dimensional perceptions in the context of Metaverse-based collaborative learning at the UG level in emerging markets like India filling the regional gap.

The following alternative hypotheses were designed in alignment with the core research objectives:

- H1: There is a significant positive relationship between perceived usefulness, perceived convenience, perceived ease of interaction, perceived immersive experience, and perceived user satisfaction in Metaverse-based collaborative learning.
- H2: Perceived usefulness, perceived convenience, perceived ease of interaction, perceived immersive experience significantly predict perceived user satisfaction in Metaverse-based collaborative learning environments.

The proposed research framework created by the authors (2025) is shown in Figure 1.

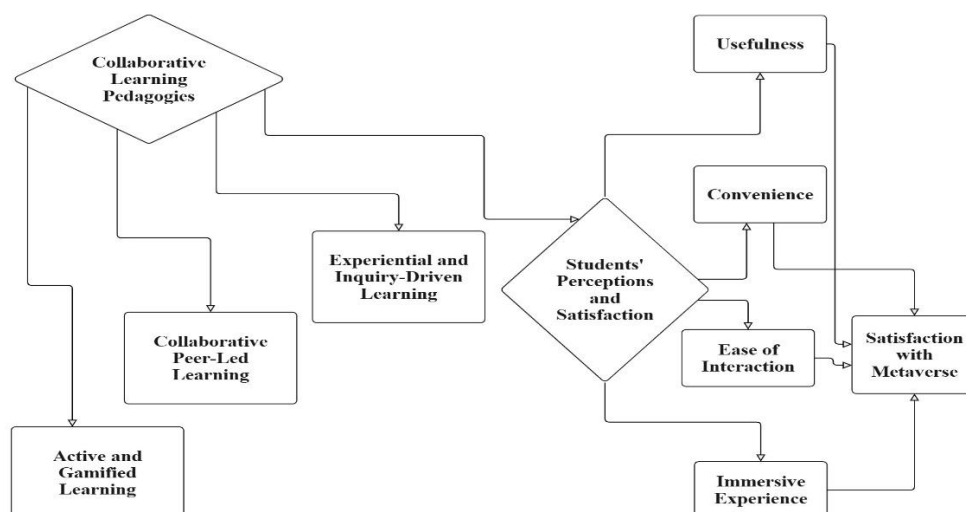


Figure 1 Proposed Conceptual Model (Authors, 2025).

RESEARCH METHODS

The purpose of this section is to outline the methodology adopted to address and achieve the above stated research objectives.

Participants and Procedure

The research study employs a descriptive, quantitative and cross-sectional research approach through hybrid survey. The sample consisted of undergraduate students from higher education institutions specifically those who are enrolled in three-year bachelor's degree programs (first year, second year and third year) across different academic disciplines (arts/humanities, science and commerce streams) of all gender identities within the Mumbai region of India. This area was selected due to its technological readiness and educational diversity making it an ideal place to examine immersive collaborative learning experiences. Research data was collected through structured questionnaire using purposive convenience sampling. Responses were collected from students aiming balanced representation across all three streams with an almost equal distribution: arts 30% (60 students), science 35% (70 students) and commerce 35% (70 students). The research was carried out keeping into consideration the academic ethical standards. Informed consent was obtained from the respondents. After removing the extreme outliers, a total of 200 undergraduate students participated in the survey which was administered through both online mode (via Google forms) and offline mode (via printed questionnaire). The online form was shared using WhatsApp/email/Facebook/others and the printed form was distributed directly to the students. The gender distribution showed a relative balanced approach with 52.5% of the total respondents identified as male samples, 44% of total sample population as females and 3.5% falls within others category. With respect to age distribution, the largest portion belong to 18-20 years age group comprising of 47.5% of the total sample, 30% were in the age group of 21-22 years, 12.5% of total sample were above 22 years and the rest 10% were below 18 years describing early entrants at first year level.

Instrument and Measures

A structured questionnaire divided into four sections was used to collect the data including multiple choice (close-ended) and Likert-scale questions for standardized responses and quantitative measurements. The first section of the survey instrument gathered demographic details of respondents as it builds foundational context for the study. The second section was based on identifying students' digital awareness, prior exposure to 3D virtual world and metaverse familiarity. The third section focused on general understanding of collaborative learning, diverse pedagogies, academic performance and learning experience. The effectiveness of pedagogies was ranked using a 7-point Likert rating scale. Prior to the fourth and the final section, a freely accessible short you-tube video link (printed quick response - QR code or direct web link address) was embedded to provide a common baseline of information about metaverse virtual world before responding with the upcoming questions. The fourth section specifically focused on students' perceptions towards metaverse-based learning in collaboration under five constructs: perceived usefulness, perceived convenience, perceived ease of interaction, perceived immersive experience and perceived user satisfaction using a 5-point Likert scale. In addition, an open-ended question for sharing suggestions was included at the end of the instrument to capture deeper insights beyond the structured responses.

Data Analysis

Data collected for research was analyzed by applying various descriptive and statistical tests. The descriptive data was analyzed using percentages and frequency distribution table. Further, an exploratory factor analysis (EFA) was employed on the 12 pedagogical items to identify the underlying distinct pedagogical factors. For this purpose, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were performed to measure the sampling adequacy and degree of intercorrelation. Principal Component Analysis (PCA) was performed to reduce dimensionality of pedagogical variables and for identifying meaningful factors followed by Varimax rotation to optimize and enhance the interpretability of these factors for clarity. Further, Pearson's correlation coefficients (r) were calculated to assess the strength of relationships between students' perceptions in metaverse-based collaborative learning. Multiple regression analysis was conducted to determine the predictive power of usefulness, convenience, ease of interaction and immersive experience on students' satisfaction. Before performing inferential analysis, Cronbach's alpha (α) was used to assess the internal consistency of the survey measurement tool.

RESULTS

The findings are detailed sequentially with supporting evidence from descriptive and inferential analysis adopted in the study.

Descriptive Analysis (Objective 1)

Descriptive statistics reveals that 92.5% of students have either used or open to use digital platforms indicating broad digital awareness and exposure among students of Generation Z. While most of the students (73.5%) found online learning beneficial and useful, a notable portion of the students (26.5%) expressed dissatisfaction towards e-learning. Regarding transition to online education, over 65% of the students adapted to online learning, whereas 20% still preferred conventional methods and 15% lacked transition to e-learning. A significant majority (61.5%) of students believe that exposure to 3D virtual gaming engines helped in conceptual understanding of metaverse underlining its potential as an effective pedagogical learning tool. Majority of students (82.5%) identified Roblox and Minecraft as a known 3D gaming

platform. Most students (70%) demonstrated moderate to high level of understanding of metaverse reflecting a wide conceptual exposure and preparedness towards emerging immersive technologies. While 87.5% of the students believed metaverse is used for visual and hybrid learning, 75% saw value with gamification and skill-based learning and 52.5% associated it with delightful learning environment demonstrating positive student's inclination and growing interest in using metaverse-based platforms for purpose-driven education.

Descriptive Statistics and EFA (Objective 2)

To identify the dimensions of collaborative pedagogies, an EFA was employed. A reliability test using Cronbach's alpha (α) was conducted to measure the internal consistency of the 12 pedagogical survey items in the instrument. Reliability means consistency, stability, predictability and accuracy of the results which can be measured using Cronbach's alpha (Muchinsky, 2003). The 12-item scale achieved a Cronbach's alpha value of 0.912 indicating excellent internal consistency of the items (George & Mallery, 2003) and as such no items should be dropped from the analysis. Each item in the scale is well-aligned and are highly correlated.

To validate the suitability of data for factor analysis, the KMO measure of sampling adequacy and Bartlett's Test of Sphericity ($\chi^2 = 1842.661$, $p < 0.001$) were calculated as presented in Table 1.

Table 1 KMO and Bartlett's Test Results

Tests		Values
Kaiser-Meyer-Olkin (KMO) sample adequacy measure		0.823
Bartlett's Test of Sphericity	Approx. Chi square (χ^2)	1842.661
	Df	66
	Sig. (p-value)	0.000

The result value of KMO (0.823), which falls into the meritorious range (Kaiser, 1974) indicates that the sample size is adequate supporting the application of EFA (Field, 2018). Additionally, Bartlett's Test of Sphericity ($\chi^2 = 1842.661$, Df = 66) with a high significant p-value of 0.000 shows that the variables are correlated and suitable justifying factorability (Hair et al., 2019). For factor extraction, PCA with Varimax Rotation was applied as shown in Table 2.

Table 2 Principal Component Analysis (PCA) Results

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	6.185	51.545	51.545	6.185	51.545	51.545	3.737	31.140	31.140
2	1.838	15.320	66.865	1.838	15.320	66.865	2.910	24.252	55.391
3	1.335	11.122	77.986	1.335	11.122	77.986	2.711	22.595	77.986
4	.557	4.640	82.627						
5	.388	3.237	85.864						
6	.344	2.864	88.727						
7	.330	2.750	91.478						
8	.277	2.310	93.788						
9	.268	2.233	96.021						
10	.235	1.959	97.980						
11	.177	1.471	99.451						
12	.066	.549	100.000						
Extraction Method: Principal Component Analysis.									

Using PCA, three components with eigenvalues greater than 1 were retained based on kaiser criterion, cumulatively explaining 77.99% of the total variance (Kaiser, 1960). This high cumulative percentage indicates that majority of the data variability can be effectively captured by these three components (Hair et al., 2019). Upon Varimax rotation, the total variance is evenly distributed across these three components. The drop-off after the third factor is sharp indicating that the first three components collectively represent the most meaningful structure in the dataset (Cattell, 1966). The results also support the Scree plot method where the curve shows a sharp decline after the first component forming an "elbow" at the third component suggesting that further components do not contribute to explaining the total variance as presented in Figure 2.

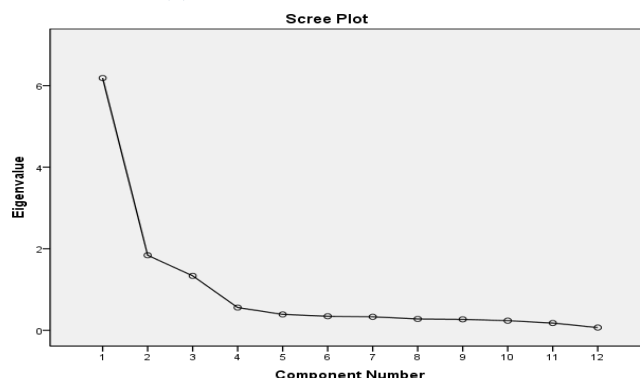


Figure 2 Scree Plot for Extracted Components

The Rotated Component Matrix was used to identify the underlying components of related teaching learning methods. EFA revealed three distinct underlying factors that meaningfully group the 12 different teaching learning pedagogies based on their factor loadings: Active and Gamified Learning (Component 1), Collaborative Peer-Led Learning (Component 2) and Experiential and Inquiry driven Learning (Component 3), consistent with modern pedagogical frameworks (Kolb, 1984; Prince, 2004; Hmelo-Silver et al., 2007). The results are summarized in Table 3.

Table 3 Rotated Component Matrix Results

Rotated Component Matrixa			
	Component		
	1	2	3
Project-Based Learning Rating	.648		
Problem-Solving Learning Rating	.644		
Blended Learning Rating	.571		
Peer Teaching & Mentoring Rating		.857	
Discussion & Debate-Based Learning Rating		.849	
Case-Based Learning Rating		.871	
Inquiry-Based Learning Rating			.870
Experiential Learning Rating			.899
Flipped Classroom Learning Rating			.867
Gamified Learning Rating	.884		
Think-Pair-Share Rating	.881		
Cross-Disciplinary Collaboration Rating	.870		
Extraction Method: Principal Component Analysis.			
Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 4 iterations.			

According to the descriptive data, most of the students associate collaborative learning with participatory and group-based pedagogical practices such as group work (63.5%), project oriented (64.5%), case-based (64%) and collective learning (65.5%). Only 20% of the students recognised it with traditional lecture method, suggesting that substantial proportion of students understand collaborative learning as an active and peer-driven process. More than 58% of the respondents demonstrated high levels of familiarity with diverse collaborative pedagogies. Specifically, experiential learning (63.5%), cross-disciplinary collaboration (63.5%) and flipped classroom learning (63.0%), were the most widely recognized learning approaches. Majority of the students (64%) indicated that collaborative learning significantly enhances their learning experiences and outcomes. A significant number of students (71.5%) use online tools for collaborative learning either regularly or for specific project work. Students widely recognised the multifaceted benefits of collaborative learning across cognitive, affective, and interpersonal skill development.

Hypothesis Testing (Objective 3)

Cronbach's Alpha was used to assess the internal consistency and reliability of all five constructs: Perceived Usefulness (PU), Perceived Convenience (PC), Perceived Ease of Interaction (PEOI), Perceived Immersive Experience (PIE), and Perceived User Satisfaction (PUS). The reliability measurement results are summarized in Table 4.

Table 4 Item-Level Reliability Measurement Results

Constructs	Items	Mean	SD	Inter-item correlations	(α) value
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PU	Metaverse-based collaborative learning could help to understand difficult topics more easily.	4.00	0.64	0.76	0.86
	Metaverse-based collaborative learning would be useful for hands-on and practical learning like experiments or simulations.	4.03	0.65	0.76	
PC	Using the metaverse platform for collaborative/group learning would be easy.	4.00	0.65	0.72	0.83
	Using the metaverse tools for collaborative/group learning would not require extra help or training.	3.98	0.63	0.72	
PEOI	Interacting with teachers and classmates in a metaverse-based classroom would be easy	4.02	0.63	0.73	0.85
	Sharing the ideas and information with others using metaverse-based classroom would be easy	4.01	0.64	0.73	
PIE	Learning in metaverse-based classroom would be highly engaging and immersive.	4.00	0.65	0.74	0.83
	Studying in a metaverse-based classroom would be highly enjoyable	4.01	0.63	0.74	
PUS	Learning in a metaverse-based classroom compared to a traditional classroom would be satisfactory.	4.01	0.64	0.74	0.82
	Using a metaverse-based classroom over a traditional classroom for future learning activities would be preferable.	4.02	0.65	0.74	

Each construct was measured using only two items and as such “Cronbach’s Alpha if item deleted” is not reported. Each construct exhibited good internal consistency with alpha value (α) above 0.80. The high inter-item correlations (all > 0.70) further supported the acceptable internal reliability of items within each construct (Eisinga et al., 2013).

Further, correlation analysis (r) was performed to examine the degree and direction of the linear relationship between all five main constructs. The following Table 5 summarizes the correlation coefficients between the main constructs.

Table 5 Correlation Coefficients Matrix

Main Constructs	PU	PC	PEOI	PIE	PUS
Perceived Usefulness (PU)	1.00	0.84**	0.85**	0.84**	0.85**
Perceived Convenience (PC)	0.84**	1.00	0.85**	0.84**	0.84**
Perceived Ease of Interaction (PEOI)	0.85**	0.85**	1.00	0.86**	0.85**
Perceived Immersive Experience (PIE)	0.84**	0.84**	0.86**	1.00	0.84**
Perceived User Satisfaction (PUS)	0.85**	0.84**	0.85**	0.84**	1.00
Note: $p < 0.01$ (2-tailed); ** indicates correlation is statistically significant.					

The correlation matrix results reveals that all constructs are positively correlated ($r = 0.84$ to 0.86) and statistically significant ($p < .01$), thus supporting the alternative Hypothesis 1. The results show that significant positive correlation exists between students’ perceptions and satisfaction.

A multiple linear regression analysis was conducted to examine the predictive influence of usefulness, convenience, ease of interaction and immersive experience on students’ satisfaction level in metaverse contexts. Following Table 6 explains the regression coefficients model.

Table 6 Regression Coefficients Results

Predictors	Standardized coefficients (β)	Standard error	t-statistic	p-value (Sig. level)	95% Confidence Interval (CI)	
					Lower bound	Upper bound
PU	0.2713	0.0640	4.24	< .001	0.15	0.40
PC	0.2169	0.0650	3.34	= .001	0.09	0.35
PEOI	0.2145	0.0728	2.95	= .004	0.07	0.36
PIE	0.1897	0.0663	2.86	= .005	0.06	0.32

Intercept (PUS)	0.4430	0.1291	3.43	= .001	0.19	0.70
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The regression model was statistically significant indicating that all four predictors positively and significantly influence student satisfaction with usefulness having the strongest predictive power, supporting the alternative Hypothesis 2. The model explains 79% of the variance ($R^2 = 0.79$) in user satisfaction demonstrating an excellent model fit. The results suggests that students' experiential perceptions of collaborative immersive learning are significantly related to and predictive of their satisfaction supporting both H1 and H2.

DISCUSSION

The present study investigated various key variables including different pedagogical and technological dimensions of shared virtual learning spaces.

Digital Learning and Metaverse

The descriptive analysis confirms that the current generation students have a high level of awareness and functional knowledge of virtual platforms and tools which may facilitate ease of integration of advanced tools into the existing learning framework. This aligns with the post pandemic digital adoption and transition observed in the recent educational sector (Bower, 2019; Wang et al., 2020). Furthermore, a significant segment reported difficulty with e-learning highlighting the ongoing challenge of promoting students' involvement in virtual classrooms (Martin & Bolliger, 2018). Over 20% of the students reported preference for traditional teaching methods supporting the need for hybrid pedagogical designs (Garrison & Vaughan, 2008). Few students lacked transition to remote education indicating the continued presence of traditional classroom learning. The findings also highlights that gamified platforms can serve as an effective analog for immersive learning aligning it with the finding of prior research which identifies video game technologies as a preliminary step towards metaverse adoption in social interactions and education (Dionisio et al., 2013). A significant proportion of students are likely to possess intermediate or advanced understanding of metaverse showing potential readiness to explore the immersive virtual platforms, consistent with the research emphasizing increased digital literacy among Generation Z (Mystakidis, 2022). The study indicates that greater online learning platform awareness is associated with deeper understanding of metaverse in higher education which aligns with the prior research studies where student with high digital exposure exhibited better metaverse concept clarity (Johnson et al., 2021) and a strong link was reported between students' digital awareness and readiness (Gupta and Sharma, 2022). The exploratory finding suggests that Generation Z learners are not only digitally literate but also demonstrate readiness for immersive learning spaces, validating the relevance of immersive pedagogical design (Makransky & Lilleholt, 2018).

Collaborative Learning and Pedagogies

The descriptive finding reveals high digital adoption for collaborative tasks reflecting a contemporary educational shift towards participatory pedagogies and student-centered approaches to learning, especially accelerated in the post-pandemic era. Students' familiarity with broad range of pedagogies indicates the

increasing institutional integration of active and blended learning in virtual or hybrid environments as noted by Bonwell and Eison (1991) and Hmelo-Silver et al. (2007). The study supports the idea of adopting engagement-based pedagogies which can lead to improved students' academic outcomes aligned with the prior studies that highlights the importance of collaborative learning in improving academic outcomes (Gokhale, 1995; Dillenbourg, 1999). The fact findings reinforce the multifaceted benefits of collaborative learning across cognitive and socio-affective domains. This supports prior research emphasizing the importance of collaborative learning environments for enhancing interpersonal skills (OECD, 2018; Hmelo-Silver, 2004). The study results indicate collaborative learning as a pedagogically effective, multidimensional and digitally supported strategy in higher education. The high Cronbach's alpha of 0.912, KMO value of 0.823 and a highly significant Bartlett's Test of Sphericity ($p < .001$) confirms the reliability and suitability of data for factor analysis, thereby establishing a strong statistical foundation for dimensionality reduction techniques like PCA. EFA identified a three-factor model explaining 78% of the total variance which is notably high in educational and social science research (Hair et al., 2019). Active and Gamified Learning approaches promotes meaningful collaboration, peer engagement and shared problem-solving skills. This factor underscores the importance of participatory and technology-oriented pedagogies in enhancing deeper understanding, learning motivation and knowledge retention (Prince, 2004; Hamari et al., 2014). Grounded in constructivist learning theories, this construct shifts students from passive recipients to active constructor of knowledge through reflection and experiences (Bonwell & Eison, 1991). Collaborative Peer-Led Learning highlights peer to peer learning, social interaction and real-world problem analysis. Prior research demonstrates that such collaborative and interpersonal methods enhance real world application of knowledge, higher-order cognitive and critical thinking skills (Gillies, 2006; Topping, 2005) aligning with social constructivist frameworks (Vygotsky, 1978). Experiential and Inquiry Driven Learning focus on autonomy, reflection, experimentation and application of concepts aligning with constructivist and experiential frameworks (Kolb, 1984; Bishop & Verleger, 2013). These components highlight the significance of hands-on experiences and practical skills (Hmelo-Silver et al., 2007) aligning with earlier studies which suggests that learning happens through collaboration and social interaction (Vygotsky, 1978; Johnson & Johnson, 2009). These integrated factors combine the social, experiential and cognitive dimensions of learning supporting the

argument that a balanced mix of innovative teaching learning strategies is essential for meaningful education in digitally mediated environments. With the integration of these pedagogical approaches, the educators can create dynamic learning eco-systems that enhances students' academic satisfaction and achievements.

Cognitive and Experiential Perceptions

Cronbach's alpha confirms that all constructs exhibit high internal reliability and consistency ($\alpha > 0.8$). The correlation analysis results offer robust empirical support for H1, with all five constructs showing statistically significant and positive correlations with each other. This correlation strength signifies a high degree of interconnectedness across students' perceptions. The findings validate the extended TAM model, which links usefulness and usability with satisfaction (Davis, 1989; Venkatesh & Davis, 2000). Further, the regression analysis (H2) confirmed that each of the independent variables significantly predict students' satisfaction, with perceived usefulness having the strongest predictive influence ($\beta = 0.27$, $p < .001$), highlighting that learning efficacy practical relevance are critical in immersive learning settings. Similarly, ease of interaction and convenience proved to be a robust predictor, indicating the significance of communication and usage ease in blended settings. Moreover, Immersive experience also showed strong contribution affirming realism and user engagement as core component of effective e-learning. The regression model supports H2, reinforcing the past research emphasizing the role of presence, interactivity and immersion in enhancing e-learning (Makransky & Lilleholt, 2018). Collectively, these fact-findings contributes to high instrument reliability, strengthening the construct validity and relevance in the proposed research framework.

Implications

The findings of the study have several implications. From a theoretical viewpoint, this study develops an empirically tested three-factor model of diverse pedagogies that captures cognitive, socio-affective and experiential dimensions of learning, reinforcing constructivist models. The identification of this model through EFA within the collaborative immersive learning, provides a proposed empirical framework to examine how undergraduate students conceptualize and engage with diverse instructional approaches in digitally mediated environments. These insights illustrate how active, collaborative, and inquiry-driven methods enhance students' engagement and academic outcomes. Further, the study extends the TAM model by incorporating experiential dimensions (interaction ease and immersion), thereby offering a holistic understanding of satisfaction level among students in digital learning ecosystems. By conceptualising satisfaction through four distinct perceptions in immersive learning contexts, this research adds empirical evidence to the integrated framework merging pedagogical and technological aspects.

According to the findings, since majority of students have strong conceptual understanding of metaverse, Indian universities and educational boards should integrate immersive learning tools and activities into their curricula at the early stages of education for easy adaptability and comprehension of metaverse. For this purpose, institutions should organise workshops and orientation programs to build experiential familiarity among students. The results highlight the need to adopt blended instructional approach for improving student engagement and learning outcomes. Academic educators should be trained to employ experiential, active and collaborative learning to effectively engage students within online environments. The study also emphasizes that improving convenience, usefulness, interactivity and immersive quality of metaverse-based learning will strongly enhance students' level of satisfaction. For practical application, the EdTech developers and instructional designers should focus on designing pedagogically grounded, user friendly, interactive and immersive interfaces. Platform developers should prioritize learner-centered approaches such as interaction, gamification and collaboration to align with students' learning preferences and expectations. Institutional funding agencies should consider funding for real-time collaborative platforms such as virtual labs, Artificial Intelligence (AI) enabled classrooms and gamified platforms to enhance effectiveness of teaching and students' readiness for modern education. These fact-finding results will help the educators, policy makers, and EdTech developers to design engagement and skill -based learning environments for future-ready education.

Limitations and Future Research Directions

Despite the current study provides empirically validated contributions, it has certain limitations. First, the research was limited to exploring various dimensions of metaverse-based learning in collaborative manner. Future studies should compare the effectiveness of immersive learning across diverse instructional modalities and academic disciplines. Second, the current research is cross-sectional in nature providing only a temporal snapshot at a certain point in time limiting understanding of long-term effects. Thus, longitudinal research studies are needed to assess the development patterns of student perceptions and satisfaction over time in metaverse based education. Third, since the study employs only quantitative methods, overlooking the diverse students' perspectives and institutional settings, further research can incorporate qualitative, observational or mixed-method approaches. Lastly, the sample was confined to undergraduate students from three streams only, which restricts generalizability of findings across varied academic disciplines, regions, educational levels, and cultural contexts. Future research studies could expand to include diverse fields, postgraduate learners, different socio-economic and geographical backgrounds to provide a more holistic understanding of metaverse-based education.

CONCLUSION

The current study offers a novel contribution and substantiates its research findings with empirical evidence gathered from undergraduate students across Mumbai region of India. The descriptive analysis affirms that students in today's world are well aware of virtual platforms used for learning. Prior digital exposure and familiarity with innovative teaching methods enhances students' readiness for immersive digital spaces. The research study highlights the key role of collaborative learning pedagogies in influencing students' outcomes. The findings suggest that integrating student-centered pedagogical methods with shared virtual platforms leads to better students' achievement, richer experiences and satisfaction at undergraduate level. This pedagogical intersection with technology innovation can play a vital role in shaping the next generation learners. The empirically tested positive correlation and predictive relationship of users' perceptions (usefulness, usability, interaction ease and immersion) offer valuable insights for enhancing satisfaction among students in a three-dimensional environment. These insights bridge the existing research gap, thereby opening new domain for theory building and practical relevance in AI-enabled learning environments.

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Ethical Considerations

The research was carried out keeping into consideration the academic ethical standards.

Consent to participate

Informed consent was obtained from participants. Voluntary participation approach was adopted. Confidentiality of information was maintained.

Declaration of conflicting interest

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