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Exploring the Adoption of the Metaverse System among Elementary Students

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ABSTRACT

The metaverse is an envisioned realm offering immersive digital spaces, bolstering highly interactive environments within educational contexts. This digital dimension amplifies synchronous communication, uniting a vast number of users as they share their unique experiences. This research aims to scrutinize the perceptions of elementary students towards the metaverse system (MS). Our proposed model underwent validation through the Partial Least Squares Structural Equation Modelling (PLS-SEM) technique. Data, sourced from 287 students of Dubai National School, revealed that the primary predictor of students' intent to engage with the MS is personal innovativeness. This is followed closely by perceived usefulness and then perceived ease of use. The findings of this research provide deeper insights into the driving factors behind the adoption of MS among young learners.

1. Introduction

The Due to time and location restrictions, as well as the difficult job of adequately encouraging each student, traditional classroom learning may not always be relevant and engaging to students [1]. Because the vast bulk of the globe's 900 million uneducated adults, 130 million unschooled children, and many more dissatisfied school leavers whom conventional formal learning structures have only been capable of reaching to a very minor level in Arab countries, there is a supplemental, urgent necessity of accessible educational activities in these nations [2,3]. Additionally, it is impossible to assist each student in a traditional classroom given their varied traits [3,4].

Several academic institutions are adopting distance learning, commonly referred to as "e-learning," which combines traditional courses with online learning alternatives to reduce expenses [5]. The development of information and communication technologies (ICTs) has quickly altered the globe and transformed traditional classroom instruction into Technology Enhanced Learning (TEL) frameworks. To improve education quality and allow stakeholders to participate in teaching and learning programs at their educational institutions, academic institutions are integrating these technologies. Depending on blended learning models, these technologies can be integrated into the

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classrooms or employed to grant remote participation to a novel teaching landscape depending on the suggested distance learning model. It will be intriguing to explore how the expanded usage of distance learning will impact enrolment and admission rates for students in Arab schools. Due to the fact that metaverse system (MS) has been developed recently to solve problems in the virtual environments, few studies have focused on its adoption and acceptance by users in the developed countries, hence, computer scientists and researchers aimed to rapidly develop the aspects of the virtual environment [6]. The evolution of the internet, combined with the pervasive reach of social media platforms, has democratized access to advanced digital tools. This accessibility to both hardware and software paves the way for the creation and enhancement of content, especially in the realm of three-dimensional (3D) virtual environments. These advancements are captured in research by scholars such as [6,7]. The concept of the "metaverse" was introduced by [8], drawing inspiration from his science fiction narrative. He visualized it as an engulfing 3D virtual space, offering an immersive experience to its users. With time, the metaverse has evolved and now plays a pivotal role in the way humans communicate and interact, essentially serving as a bridge between the virtual and the real. At its core, the metaverse is an augmented reflection of our physical reality, blending the tangible and the virtual. It allows users to navigate through digital replicas of the real world and even explore imagined realms that don't exist in our physical world. These virtual spaces serve various purposes, providing both a mirror to our reality and a window into endless digital possibilities. This merging of real and digital universes provides users with a comprehensive, multi-dimensional experience, as supported by studies from [6,9].

The present study has the aim of examining the factors that have an impact on the adoption of the MS among elementary students by finding out the degree to which the adoption of MS is affected by perceived ease of use and perceived usefulness. In addition, it also aims to determine how perceived usefulness and perceived ease of use affect personal innovativeness. Therefore, the current study focused on filling the gap by formulating a conceptual model that concentrates on the critical aspect of students' perception towards the MS.

2. Literature Reviews

In previous research endeavours, scholars have delved deep into the potential of the metaverse within the educational landscape, exploring a diverse array of experiences. Notable works by [10-13] underscore this focus. A distinct study by [14] pivoted around the importance of Augmented Reality (AR) within the educational context. This research stressed the need for educators to harness AR within classrooms, creating immersive mobile AR experiences using metaverse AR tools. However, an intriguing observation from the study suggested that students' heightened engagement stemmed more from the content presented by the teachers rather than the allure of the AR tool itself. This observation then sparked a pertinent inquiry: Were educators and students given comprehensive insights into AR's role within the metaverse? A clear understanding of AR's contribution to the metaverse might have reshaped the classroom dynamics and experiences. Sim *et al.,* [15] embarked on a different route, examining the integration of a MS in education. Their research zoomed in on how such a system provides seamless access to both real-time (synchronous) and time-lapsed (asynchronous) information. Their exploration spanned various educational experiences in the virtual realm, from interactive teacher-student sessions and resourceful library explorations to virtual museum visits and meetings. For this study, a quasi-experimental methodology was employed on a cohort of students, followed by a survey that aimed to gauge student satisfaction within the virtual learning environment. Although the overarching goal was to devise teaching methods harnessing emerging tech, the study's scope was confined to math teachings at the University of Cundinamarca.

Consequently, it raises an intriguing thought: Would the perceptions of students vary if the study extended to other theoretical subjects? Different subjects might elicit varying degrees of student satisfaction and perceptual experiences within the virtual domain.

The effectiveness of the metaverse is often rooted in its interactive capabilities and the ability to deliver a personalized user experience, as underscored by [10]. Recognizing the potential of these facets, scholars have explored their applications within the educational sphere [16]. In a study spearheaded by [16], the intricacies of a unified resource allocation mechanism within a virtual education environment were dissected. A salient outcome was the observation that virtual platforms can alleviate several challenges. Not only do they reduce associated costs, but they also provide clarity, thereby addressing user apprehensions and uncertainties. The versatility of the metaverse shines through in its applicability across diverse educational domains. For instance, subjects like mathematics, engineering, and STEM education have immensely benefited from the immersive environment the metaverse offers. One striking example is the realm of aviation training. In such a setting, learners have the opportunity to interact with virtual aircraft, providing an experience that mirrors real-life, thus amplifying the educational and training quality. Such rich interactions with virtual entities further refine the experiences within mixed realities. Conversely, when examining STEM education, the metaverse brings forth its strength in connectivity. This enhanced connectivity allows for more apt demonstrations of applications, as highlighted by [17,18]. The versatility of the metaverse across these varied disciplines underpins a universal sentiment: its potent link to motivation. Immersion within the metaverse environment tends to positively influence the motivation levels of students and trainers alike. Engaging with the metaverse isn't just a novel teaching tool; it has evolved into a highly favoured mode of interaction that aligns with the aspirations of both educators and learners, as echoed by [19].

While the metaverse is increasingly recognized for its potential in educational contexts, there remains a paucity of studies investigating elementary students' perceptions towards such immersive digital platforms. Specifically, the underlying factors driving young learners' inclination to engage with the metaverse remain largely unexplored. This research, centred on a model validated through the PLS-SEM technique and data from Dubai National School students, seeks to bridge this gap. By identifying personal innovativeness, perceived usefulness, and perceived ease of use as key determinants, this study offers a novel perspective into the motivations behind metaverse adoption among younger demographics.

3. Research Framework and Hypotheses

Usually, as part of the innovation theory, technology users are classified as individuals who are highly innovative and desire active information to develop further innovational ideas. These individuals can manage uncertainty levels and develop positive intentions towards acceptance. Hence, personal innovativeness would establish positive perception towards innovation technology. It has also been stated that the strongest influence over the cognitive interpretations of an individual towards information technology are factors associated with personal innovativeness that have been assessed as symbolizing the risk taking abilities which may seem to be the development after the new technology is used [20].

According to the technology acceptance model (TAM), technological personal innovation is mostly influenced by perceived usefulness and the perceived ease of use of the technology [21]. The two aspects quite crucial within the model are perceived ease of use and perceived usefulness. Perceived ease of use refers to the degree of belief present within the user that the mentioned technology would increase the performance level for specific reasons. The perceived usefulness

refers to the degree where the user considers that if the specific technology is applied, it would not require much effort [22,23] carried out a research where a strong association was found amongst behavioural intention and perceived usefulness and perceived ease of use. Hence, the conceptual model that has been proposed indicates that personal innovativeness significantly influences that perceived usefulness and perceived ease of use and it establishes the basic relevance towards the MS adoption [24,25]. Hence, keeping the earlier assumptions in mind, the hypotheses developed are:

H1: Personal innovativeness has a positive effect on perceived ease of use of the MS.
H2: Personal innovativeness has a positive effect on perceived usefulness of the MS.
H3: Perceived ease of use has a positive effect on the intention to use the MS.
H4: Perceived usefulness has a positive effect on the intention to use the MS.

Drawing upon the hypotheses derived from the expanded TAM model regarding Metaverse adoption among students, we have developed the research model illustrated in Figure 1.

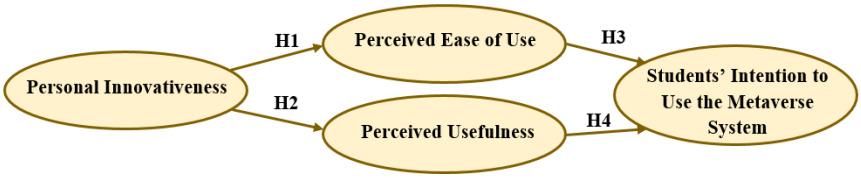

Fig. 1. Research Model for MS

4. Research Methodology

Online surveys were organized in the fall semester (2023/2024) to collect the data from the elementary students of UAE for the period of September 05th 2023 - October 05th, 2023. Ethical clearance has been sought from the target school. The purpose of the study, along with the survey link, were emailed to the targeted students. In order to increase the response rate, the survey link was shared on the applicable Facebook and WhatsApp groups of the schools as well. The choice of the voluntary participation was provided to the audience. A total of 300 questionnaires were sent out, and 287 questionnaires filled by the respondents were received back, indicating a 95.6% response rate. Among the filled questionnaires, 13 were omitted because of the incomplete answers. Hence, 287 appropriately filled questionnaires were taken as valid responses. According to [26], the total number of 287 effective questionnaires are an acceptable sample size for an investigation, as the approximate sample size for a population of 1100 is 285 respondents. The sample size of 287 is quite larger than the trivial criteria. As supported by [27], for this sample size, the Structural Equation Simulation (SEM) can be used, and therefore, SEM was applied to verify the hypotheses. Primarily, the hypotheses were formed based on the theories, but some alterations were made in the consideration of Metaverse framework. SEM, the SmartPLS Version (3.2.7), was used to test the measurement model. In addition, the final path model was also employed for deeper evaluations.

To validate the hypothesis, a survey instrument was applied. For measuring the four constructs in the questionnaire, the survey integrated 11 items. In Table 1, the sources of these constructs are reported. To improve the applicability, the investigators modified and altered the questions from the past studies.

Table 1
Measurement Items

Constructs	Items	Definition	Instrument	Sources
Personal Innovativeness	PI1	Personal innovativeness has been regarded as the willingness degree	MS may be applied within the research.	[28]
	PI2	which users would accept technology. It is the readiness of the users to make use as well as accept this new	It is believed that the new technology, like MS, can be applied.	
	PI3	technology. The readiness concept would be included as part of the personal innovativeness since it is used as the external factor for measurement of the technology acceptance of the users.	Based on the innovative features, MS can be used.	
Perceived Ease of Use	PEOU1	The degree to which the user believes that innovation is effortless.	MS seems to be quite effortless.	[29]
	PEOU2		Since MS is easy, it may be applied for various educational reasons.	
	PEOU3		For particular areas, it may be difficult to apply MS.	
Perceived Usefulness	PU1	The degree of the user belief that various benefits are provided by	For forums and live lectures, MS seems to be quite useful.	[29]
	PU2	innovation.	I believe MS is beneficial for live lectures and discussions.	
	PU3		I feel MS brings numerous benefits to my academic pursuits.	
Users' Intention to Use the MS	UMS1	Intention to use technology has been stated as the preference of the users	For education, MS would definitely be applied.	[30,31]
	UMS2	for acceptance or rejection of the specific techniques to make sure technology is continuously used.	MS would be applied for limited educational reasons.	

5. Research Findings

The software of Smart-PLS formulated by [32] in 2005 is frequently used for performing the PLS-SEM. With its introduction, the system was readily employed by researchers as it was accessible and was free-of-cost with an appropriate user-interface and complex reporting options [33]. The measurement model gives an explanation of the indicators and latent constructs considered in the study and reveal the relationship between them. The convergent validity and discriminate validity are evaluated for the assessment of measurement model [34]. The convergent validity is the degree of relevance between theoretically comparable constructs whereas the discriminant validity indicates the degree of variance between the model constructs.

It was proposed by [35] to determine value of the construct reliability (with the help of composite reliability (CR), and Cronbach's alpha (CA)) and to determine the value of validity (with the help of convergent and discriminant validity) and then, to use both these obtained values for evaluating the measurement model. The CA values determined for evaluating construct reliability were found in the range of 0.749 to 0.780 which surpass the threshold CA value of 0.7 as can be seen in the Table 2 [36]. Likewise, the values obtained for CR were between 0.857 and 0.870 beyond the recommended CR value of 0.7 [37]. The convergent validity can be measured by the analysis of average variance extracted (AVE) and factor loading [38]. The contents of Table 2 showed each of the factors loading value higher than the recommended value of 0.7. Besides this, Table 2 tabulates all the AVE values which were greater than the 0.5 threshold value. The AVE values ranged from 0.667 to 0.758. These outcomes can be helpful in establishing the convergent validity for every construct.

Table 2
Convergent validity results

Constructs	Items	Factor Loading	CA	CR	AVE
Personal Innovativeness	PI1	0.825	0.749	0.857	0.667
	PI2	0.761			
	PI3	0.860			
Students' Intention to Use the MS	UMS1	0.873	0.780	0.862	0.758
	UMS2	0.868			
Perceived Ease of Use	PEOU1	0.862	0.775	0.870	0.691
	PEOU2	0.779			
	PEOU3	0.851			
Perceived Usefulness	PU1	0.804	0.759	0.860	0.672
	PU2	0.812			
	PU3	0.844			

The "Heterotrait-Monotrait ratio (HTMT)" of correlations was recommended for discriminant validity by [39]. The HTMT values should fall below 0.85. All values are confirmed based on the references presented in Table 3, validating the discriminant validity.

Table 3
Heterotrait-Monotrait Ratio (HTMT)

	PEOU	PU	PI	UMS
PEOU				
PU	0.698			
PI	0.785	0.493		
UMS	0.844	0.712	0.751	

The researchers determined the interdependence and association among the theoretical constructs of the structural model by making use of the structural equation model through the Smart PLS that offered application of maximum likelihood estimation to the observed data [40-43]. These methods allowed the testing of the proposed hypotheses. Figure 2 clearly show percentage of discrepancy in students' intention to use the MS, moderate predictive power of the model (accounting to about 51%) [34].

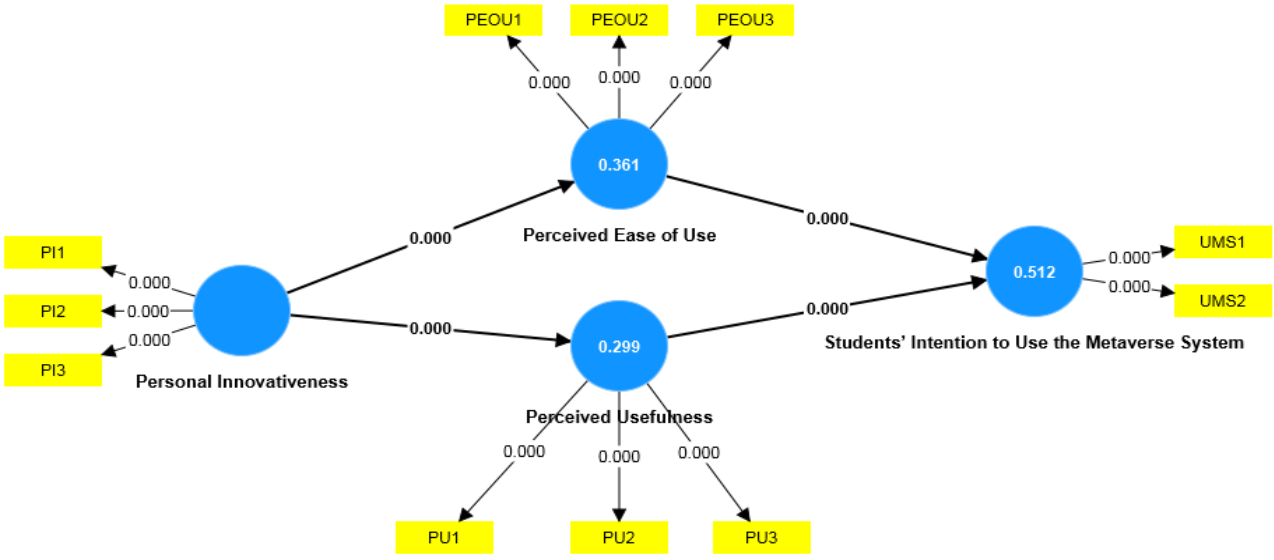

Fig. 2. Path coefficient of the model (significant at p** < = 0.01, p* < 0.05)

The beta (*β*) values, *t*-values, and *p*-values obtained for every research hypothesis through the PLS-SEM technique were recorded in Table 4. The results of the data analysis indicated that the research hypotheses (H1, H2, H3, and H4) were supported. The results showed that PI significantly influenced PEOU (β= 0.374, P<0.001) and PU (β= 0.440, P<0.01) supporting hypothesis H1 and H2 respectively. Furthermore, UMS was significantly influenced by two exogenous factors: PEOU (β= 0.601, P < P<0.001), and PU (β= 0.547, P<0.001) which support hypotheses H3, and H4.

Table 4
Results of structural model

H	Relationship	Path	*t*-value	*p*-value	Direction	Decision
H1	PI → PEOU	0.374	4.764	0.000	Positive	Supported**
H2	PI → PU	0.440	5.247	0.000	Positive	Supported**
H3	PEOU → UMS	0.601	9.755	0.000	Positive	Supported**
H4	PU → UMS	0.547	9.699	0.000	Positive	Supported**

6. Discussions

The adoption of metaverse system by students depends on personal based-characteristics like personal innovativeness. This means that higher personal innovativeness in students implies more willingness to innovational technology adoption and hence more eagerness for adoption of metaverse system. Or, we can also say that positive intentions to use metaverse system can be seen in students inclined towards the use of innovational technology since they tend to deal positively with unexpected events in the course of technology adoption. The earlier researches also exhibited same outcomes where students' perception was found to be a direct consequence of perceived usefulness as adoption of new technology seems fascinating to the new generation [44,45]. Earlier research also highlighted a significant effect of students' perceived usefulness on behavioural intention towards the adoption of innovational technology. Future research is suggested to investigate the factors like playfulness and others which are likely to influence students' adoption of technology. The uncertainty and innovativeness associated with technology adoption is also highly likely to affect students' perceptions [46,47]. One more factor of perceived ease of use has been named by this study as significant for students' perception and intention regarding technology adoption. Perceived ease of use is highly correlated with personal innovativeness suggesting that any innovational technology perceived as easy-to-use and easy-to-understand is willingly adopted by students [48,49] because convenience of use and high functionality are demanded by the students of all ages. A previous study performed by [50] showed that technology adoption is significantly dependent on perceived ease of use and perceived usefulness but this effect varies with character of the community adopting the technology. The study conducted by [51] showed that lack of collectivism value orientation leads to insignificant association between innovation and technology adoption. This study showed results different from the earlier ones since the nature of community was not the same in both studies. This study involves the Gulf population that loves innovation and technology and is always eager to adopt novel technologies. Hence, the gulf population is characterized with higher level of technology adoption. Many limitations were observed in this research. The most evident limitation was associated with the imperfection of the conceptual model in terms of using only one variable of personal innovativeness with no attention to other vital factors. The subsequent limitation is relevant to the fact that only the constructs of perceived ease of use and perceived usefulness were used to represent the technology acceptance model construct so as to allow simpler measurements and better investigation of factors that influence personal innovativeness. The second limitation is the participation of limited number of students. It is advised

that this limitation can be removed by using Internet and social media for distribution of survey as it allows the access of greater number of students. The last limitation is associated with the fact that despite the vast scope of applying metaverse, the study has only applied it to study the effect of metaverse system in the educational sector.

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