Impact of Metaverse Technology on Student Engagement and Academic Performance: The Mediating Role of Learning Motivation

Muthmainnah[1], Ahmad Al Yakin [2], Prodhan Mahbub Ibna Seraj [3]

[1],[2] *Universitas Al Asyariah Mandar, Indonesia*

[3] *Sylhet International University, Bangladesh*

A R T I C L E   I N F O

A B S T R A C T

Metaverse technology, encompassing virtual reality (VR) and augmented reality (AR), offers immersive and interactive learning environments that can enhance student engagement. The personalized and adaptive nature of metaverse experiences has the potential to spark students' intrinsic motivation and promote active involvement in their learning. In order to evaluate the impact of metaverse technology on academic performance and level of engagement this research was aimed to assess the academic performance with mediating effect of learning motivation. We conducted an empirical research through an online survey that initially utilized to measure the collected data. Data collected from 33 educational institution located in Dubai UAE. A total of 251 respondent's data were utilized and assessed through structured equation modelling. SmartPLS 4 was used to check the model convergent validity, discriminant validity and hypothesis testing. The findings revealed student involvement can be positively impacted by the employment of metaverse technology, which in turn improves academic performance. However, it's critical to take into account potential access restrictions and the necessity for a well-rounded educational strategy that combines metaverse experiences with other teaching strategies. Future studies should focus on the precise mechanisms by which metaverse technology influences learning motivation, engagement, and performance, as this will give researchers important information for developing efficient metaverse-based educational interventions.

1. INTRODUCTION

The idea of the metaverse has received a lot of attention recently as a disruptive technology with the potential to change many facets of our life. A virtual reality environment known as the metaverse allows users to interact with other users and a computer-generated world in real time. The potential impact of the metaverse on education and student engagement is becoming more clear, despite the fact that it has historically been predominantly connected with entertainment and gaming. Student involvement is a critical element that directly influences learning results and motivation in the education sector (Hedrick et al., 2022). Traditional teaching approaches frequently fail to engage and inspire pupils, which results in disengagement and poor academic achievement. But the development of metaverse technology offers a fresh and fascinating chance to fundamentally alter student engagement and learning motivation.

The immersive aspect of the metaverse offers students a dynamic and interactive learning environment that can pique their interest and encourage engagement. Students can examine

tough ideas and situations that are otherwise challenging to picture or access using virtual simulations. For instance, astronomy students can virtually travel through the solar system to observe celestial occurrences and better comprehend astronomical principles (Nelson Laird and Kuh, 2005). Additionally, the metaverse enables cross-border, cross-cultural collaboration in learning by bringing students from various backgrounds together. Students can work together on projects, participate in online debates, and gain knowledge from professionals and instructors all across the world. This connectivity fosters information exchange and improves social interaction, making learning more interesting and rewarding. (Saeed, 2023)'s insights into digital workplaces can contribute to understanding the potential impact of metaverse technology on student engagement and academic performance.

Moreover, it is impossible to overestimate the importance of studies on how metaverse technology affects student engagement and learning motivation in the educational setting. For educators, policymakers, and researchers to make well-informed judgements about the integration of the metaverse into educational practices, they must have a clear understanding of how the metaverse might improve student engagement and motivation (Sawang et al., 2017). We can pinpoint the particular metaverse mechanisms and tactics that increase motivation and engagement through thorough research. This information can then be applied to design engaging learning environments, effective pedagogical strategies, and customized interventions that maximize the potential advantages of metaverse technology. Additionally, research on this subject can influence the creation of standards, guidelines, and best practices for the use of the metaverse in education as well as the discussion of educational technology as a whole. By pursuing research in this area, we can unleash the metaverse transformational power and open the door to a day when education is more fascinating inclusive, and effective.

1.1. Problem Statement

A projecting topic of research in the discipline of education is the effect of metaverse technology on academic performance, with learning motivation. Although immersive and interactive learning experiences are provided by metaverse

technology, it is important to comprehend how these experiences affect students' motivation, engagement, and subsequent academic success. To understand the precise mechanisms by which metaverse technology influences student engagement and learning motivation, as well as how these variables mediates the relationship between metaverse technology and academic performance, an empirical research is required. In order to fill the research gap this research will empirically collect the evidence from education sector to gauge the importance of metaverse technology to assess the academic performance. Understanding these dynamics will help educators and researchers make the best use of metaverse technology to improve students' academic results by shedding light on the factors assist in boosting academic performance.

2. THEORETICAL FRAMEWORK

2.1. Metaverse Technology

The concept of the metaverse, a virtual reality environment where users can communicate with other participants and a computer-generated world, has received a lot of interest lately. Metaverse technology has developed as a promising field with significant ramifications for numerous industries, including entertainment, gaming, social media, and commerce, as the technological landscape changes (RAHMAN et al., 2023). In order to build a persistent, shareable, and immersive digital realm, metaverse technology combines virtual reality (VR), augmented reality (AR), blockchain, artificial intelligence (AI), and other cutting-edge technologies. Users have access to a variety of activities through it, including gaming, socializing, attending virtual events, conducting business, and exploring virtual worlds.

2.2. Learning Motivation

Learning and academic success depend heavily on motivation. It is crucial for educators and researchers to comprehend what motivates people to engage in learning activities and persevere in the face of difficulties. The process of learning and academic success depend heavily on motivation. It motivates people to participate in educational activities, put forth effort, and persevere in the face of difficulties. For educators, researchers, and learners themselves, it is essential to comprehend

the idea of learning motivation (Lin et al., 2017). The term "learning motivation" refers to the internal and environmental elements that affect people's desire, zeal, and openness to learning (Ainley, 2006). It includes all of the different cognitive, affective, and behavioral processes that influence people's interest in and effort put forth in educational endeavors. Understanding the nature of learning motivation, its theoretical underpinnings, and the variables that influence it can help us improve motivation and maximize learning experiences.

2.3. Student Engagement

A complex concept that has received a lot of attention in educational research and practice is student involvement. It speaks to the extent of students' involvement, interest, and active participation in their educational activities and learning process. As stated by (Pangsapa et al., 2023), Academic success, wellbeing, and educational outcomes are all influenced by student engagement, which is a crucial component of the learning process. Teachers can create stimulating learning environments that encourage students' active involvement, emotional investment, and cognitive development by understanding the aspects of student engagement, using suitable measurement methodologies, and putting effective ideas into practice.

2.4. Academic Performance

Academic performance, which represents the academic accomplishments and results of students in diverse learning environments, is a vital component of education. It is essential for educators, decision-makers, and researchers to comprehend the elements that affect student success. Moreover, it is stated by (Lee and Kwon, 2022), academic performance is a subtle and complicated concept that is influenced by several social, familial, academic, and individual aspects. It is crucial to comprehend these factors and how they affect academic achievement if one is to improve educational outcomes. Teaching quality, motivation, parental participation, and school climate are just a few of the variables that educators and policymakers should take into account when designing interventions and supportive environments that encourage

improved academic performance.

3. LITERATURE REVIEW

3.1. Metaverse Technology Influence Student Engagement

Metaverse technology, with its immersive and interactive virtual reality environments, holds significant potential to transform student engagement in educational settings. This literature review aims to explore the influence of metaverse technology on student engagement, examining its impact on various dimensions of engagement, the underlying mechanisms, and potential implications for educational practice. According to (Hedrick et al., 2022), students can explore virtual settings, interact with items, and take part in simulations or virtual experiments because of metaverse technology. These immersive learning opportunities can improve students' critical thinking, problem-solving, and cognitive engagement. A study explored (Alawadhi et al., 2022), learning experiences that are personalized and adaptable are possible as a result of metaverse technology. (Saeed et al., 2019) and (de Carvalho et al., 2022)shed light on the practices and challenges of nomadic knowledge sharing, offering insights that can inform the understanding of how metaverse technology may impact student engagement and academic performance through enhanced knowledge sharing practices.

By addressing their particular requirements and learning preferences, students can receive customized feedback, individualized training, and adaptable content in virtual environments, which promotes engagement. According to (Yang et al., 2022), through the use of metaverse technology, students can communicate with professors and their peers virtually. Students' emotional investment and sense of belonging are increased by this social involvement, which encourages collaboration, teamwork, and knowledge sharing. In addition, students' attention and interest can be captured by the novelty and excitement of metaverse technology, increasing engagement. The metaverse interactive and aesthetically pleasing features can arouse interest and generate a positive emotional reaction, which can result in long-lasting engagement. Based on various prior studies we have developed a hypothesis as follow:

H1: Metaverse Technology significantly influence

Student Engagement.

3.2. Metaverse Technology Influence Learning Motivation

Learning experiences that are immersive and interactive now have new possibilities due to the development of metaverse technology. According to (Salloum et al., 2023), using metaverse technology, students can actively participate in realistic simulations, problem-solving situations, and virtual experiments, fostering chances for experiential learning. Students' curiosity, excitement, and enjoyment can be sparked by these immersive experiences, improving their intrinsic motivation to study. Learning through the use of metaverse technology gives students more control and freedom. Students can choose their own learning routes, explore virtual settings at their own speed, and carry out self-directed activities. This independence may encourage pride in one's work and intrinsic motivation. As highlighted by (Lee and Hwang, 2022), learning settings that support autonomy can be facilitated by metaverse technology. It adheres to the tenets of self-determination theory by providing options, enabling self-paced learning, and encouraging learners' voice and agency. Environments that enable autonomy increase intrinsic drive, engagement, and enjoyment. Through virtual worlds, avatars, and communication capabilities, metaverse technology facilitates social engagement and collaboration between students. The sense of relatedness, social belonging, and cooperative learning that might result from these social interactions can have a good effect on the motivation to learn. Based on prior studies we have developed a hypothesis as follow:

H2: Metaverse Technology significantly influence Motivation Learning.

3.3. Metaverse Technology Influence Student Engagement through Learning Motivation

The integration of metaverse technology in educational settings has opened up new possibilities for transforming student engagement. As directed in one study by (Sawang et al., 2017), students are actively engaged in virtual settings thanks to the immersive and engaging learning experiences provided by metaverse technology. Students can participate more cognitively and experientially by taking part in simulations, virtual experiments, and problem-solving activities. According to (OXFORD and SHEARIN, 1994), experiences of learning can be personalized and self-directed with the help of metaverse technology. Students are able to move around virtual spaces, pick their own learning routes, and partake in activities that suit their interests and preferences. This independence and personalization help students to become more engaged.

As discussed by (Seashore Louis, 2020), the use of metaverse technology can increase students' intrinsic motivation by delivering engaging and valuable learning. The immersive quality of the metaverse combined with interactive challenges and simulations encourages interest, enjoyment, and curiosity, all of which have a good impact on student engagement. According to (Hepplestone et al., 2011), the metaverse's autonomy and personalization are consistent with self-determination theory. Metaverse technology increases students' intrinsic motivation and engagement by giving them options, control over their education, and chances to show their knowledge. As stated by (Nelson Laird and Kuh, 2005), metaverse technology has the potential to significantly influence student engagement, with learning motivation playing a crucial mediating role. By understanding how metaverse technology enhances intrinsic motivation, self-determination, and competence, educators can design effective instructional strategies and virtual learning environments that optimize student engagement. Continued research is needed to further explore the dynamics of this relationship and identify best practices for leveraging metaverse technology to enhance both motivation and engagement in educational settings. Based on the prior studies we have developed a hypothesis as follow:

H3: Metaverse Technology significantly influence Student Engagement with mediating role of Learning motivation.

3.4. Learning Motivation Influence Student Engagement

Learning motivation is a key aspect in determining students' degree of engagement, which is essential for academic achievement. (Heiberger and Harper, 2008) suggested a strong positive relationship between learning motivation and student

engagement. Students who are intrinsically motivated, driven by their internal interest and enjoyment of learning, tend to exhibit higher levels of engagement. Furthermore, external factors such as teacher support, classroom climate, and the presence of challenging tasks can also influence students' motivation and subsequent engagement.

According to (Nelson Laird and Kuh, 2005), student involvement is a multifaceted concept that includes students' active participation, zeal, and interest in their education. On the other side, motivation refers to the internal and external forces that propel people to start and maintain particular behaviors, including learning. It is critical for educators and researchers who want to improve student learning outcomes to comprehend the connection between learning motivation and student engagement. (Sawang et al., 2017) also highlighted the role of instructional practices in fostering learning motivation and student engagement. Providing students with meaningful and relevant learning experiences, offering choice and autonomy, setting clear expectations, and providing timely feedback are some instructional strategies that can enhance motivation and engagement. Based on the prior studies we have developed a hypothesis as follow:

H4: Learning Motivation significantly influence Student Engagement

3.5. Student Engagement Influence Academic Performance

As highlighted by (Collings and Mellahi, 2009), the level of participation, dedication, and investment that students have in their educational experiences is referred to as student engagement. On the other

hand, academic performance includes academic accomplishment, learning results, and overall educational success. For educators and researchers looking to improve instructional strategies and student outcomes, an understanding of how student involvement affects performance is essential. Various studies have confirmed that it is commonly acknowledged that predicting and supporting positive student outcomes depends on student participation. It is linked to greater academic success, higher retention rates, and better overall educational experiences (Abaidoo, 2018). The results in different studies evaluation consistently show a favorable correlation between student engagement and academic achievement. Grades, test results, and general learning outcomes all show that engaged students are more likely to exhibit better levels of academic accomplishment.

Additionally, they are more likely to keep at their studies, turn in assignments on time, and engage in class activities. According to (Das and Padmavathy, 2021), academic performance has been found to be influenced by a number of aspects of student engagement, including behavioral, emotional, and cognitive engagement. Moreover, students' participation and interest in academic activities, such as attending courses and finishing homework, is referred to as behavioral engagement. While cognitive engagement indicates students' active thinking, critical analysis, and in-depth topic knowledge, emotional engagement is related to students' affective responses and positive attitudes towards learning. Based on the prior studies we have developed a hypothesis as follow:

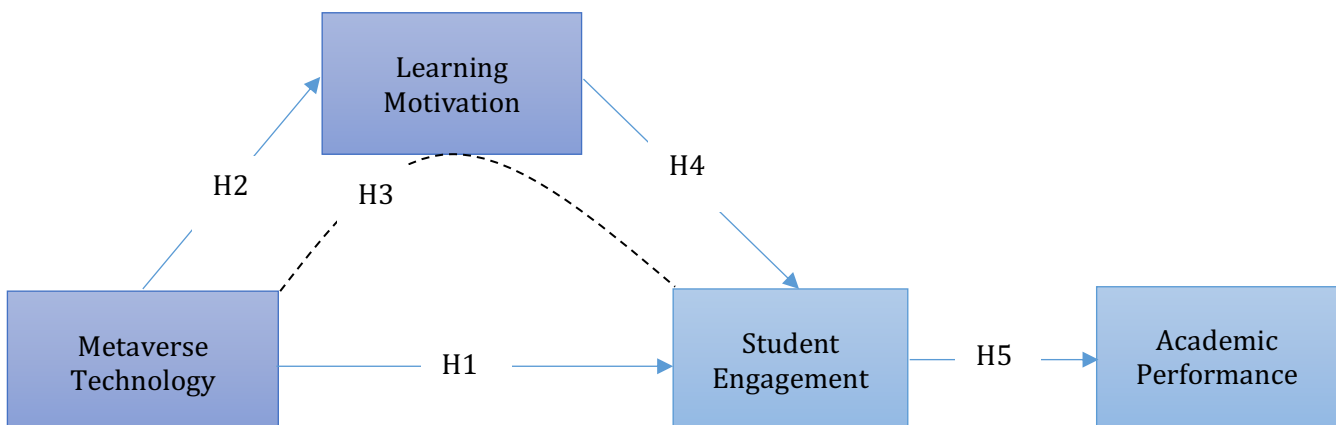**H5**: Student Engagement significantly influence Academic Performance.

3.6. Research Model

Figure 1: Conceptual Research Model

3.7. Hypothesis Development

H1: Metaverse Technology significantly influence Student Engagement

H2: Metaverse Technology significantly influence Learning Motivation

H3: Metaverse Technology significantly influence Student Engagement with mediating role of Learning Motivation

H4: Learning Motivation significantly influence Student Engagement

H5: Student Engagement significantly influence Academic Performance

4. METHODOLOGY

Considering this quantitative research approach is popular and acknowledged in the study of metaverse technology and the evaluation of the intricate relationships between variables and constructs, a survey methodology was used to evaluate the conceptual model to measure the metaverse technology and its impact on student engagement and performance through learning motivation in the educational sector UAE. Top 33 educational institutes located in Dubai UAE were made up the target population sample for this research. As a sort of social interaction where students shared their personal experience of using metaverse technology and its outcomes to their learning level as well as the teaching and staff also approached to administer the learning outcomes and lesson delivery to the students using web based, technology based classes.

The survey questionnaire consisted of four construct containing 22 items developed by authors. The items were used to measure each construct separately. All items of the four construct was anchored on the five-point scale from 5=strongly agree to 1=strongly disagree. There were 251 participants in total for the final data analysis, of which 50.9% of the male participants (N=128) and 49% of the female participants (N=123).

5. DATA ANALYSIS

The data was investigated by examining its reliability, composite reliability, and average variance extract under the measurement model. The relationships between constructs were examined on the basis of SEM through collected data. The present study used SMART-PLS for data analysis through measurement model and structural equation modelling techniques.

Table 1: Convergent Validity, Discriminant Validity (CA, CR, AVE)

Variables	Cronbach's Alpha	CR	AVE	MT	LM	SE	AP
Metaverse Technology	0.883	0.832	0.517	-			
Learning Motivation	0.854	0.838	0.590	0.54	-		
Student Engagement	0.890	0.892	0.665	0.72	0.70	-	
Academic Performance	0.871	0.844	0.776	0.63	0.51	0.69	-

MT=Metaverse Technology, LM=Learning motivation, SE=Student Engagement, AP=Academic Performance, CA=Cronbach's Alpha, CR=Composite Reliability, AVE=Average Variance Extracted.

In order to be accepted statistically and reliably for the data collection tool (Hair et al., 2010), values for Cronbach alpha, composite reliability, and average extracted (AVE) must all remain higher than 0.7, whereas values for AVE must remain higher than 0.5. The findings in the above table 1 shows all the values meet the benchmark value evidencing an accepted and reliable model. We also took discriminant validity into account in addition to internal reliability and convergent validity. By assessing the level of correlation between model constructs, discriminant validity illustrates how distinct the constructs are from those of other structures. The average correlations between the heterotrait-heteromethod and the average HTMT are used to determine HTMT using the

bootstrapping routine. To confirm discriminant validity between conceptions, the HTMT value should be less than 0.90 or 0.85. No construct had a value higher than 0.90, as shown in Table 1, showing adequate discriminant validity.

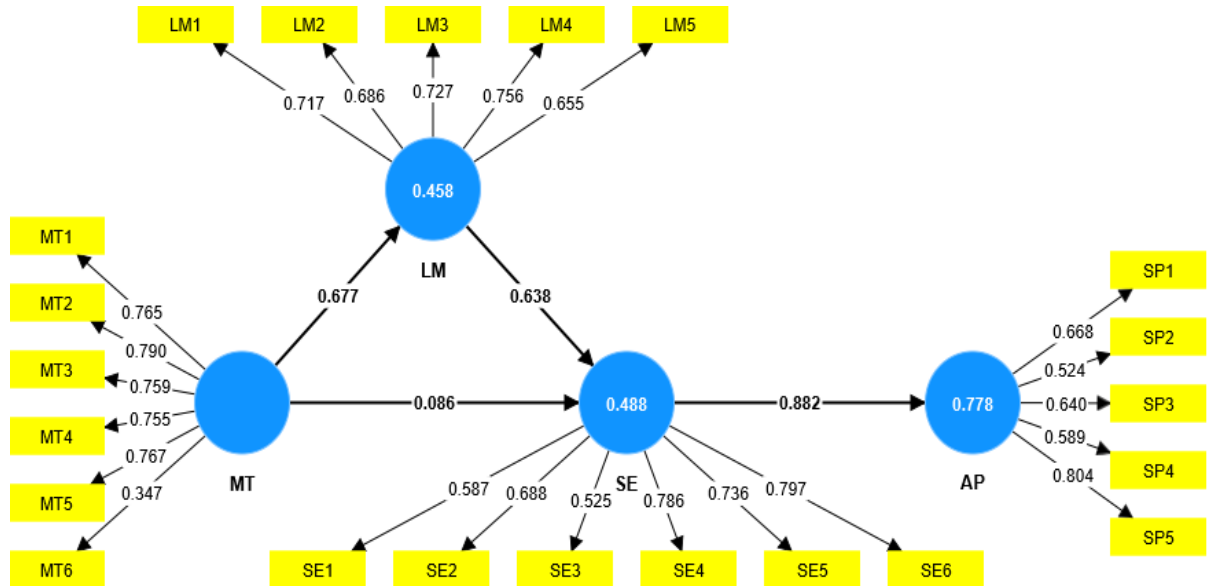### 5.1. Structural Equation Model

Figure 2: Measurement Model Assessment

5.2. Hypothesis Testing

The evaluation of the direction, power, and significance level of the path coefficients (betas) were the elements employed to examine the research hypotheses in this research. The minimum individual R^2 level should be higher than the least standard value of 0.10 (10%), according to (Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, 2017). The R^2 criteria measures how strongly an independent variable affects a dependent variable; the three values of 0.19, 0.33, and 0.67, respectively, represent low, moderate, and high R^2 levels. Furthermore, bootstrap use to assess the significance of the connections, t-statistics were used. According to Fig. 2, all routes are statistically significant (Garson, 2012) if the T-statistic is more than 1.96 at the 95% confidence level. T-statistics above 1.65, 99% above 2.57, and 99.90% above 3.29 are acceptable at the 90% confidence level.

Table 2: Hypothesis Testing

Hypothesis	Paths	β	R^2	t-value	p-value	CI 2.5%	CI 95%	Supported
H1	MT→SE	0.086	0.488	4.12	0.000	0.383	0.611	Yes
H2	MT→LM	0.677	0.458	11.51	0.000	0.385	0.623	Yes
H3	MT→LM→SE	0.671		4.93	0.009	0.241	0.754	Partial Mediation
H4	LM→SE	0.638		3.28	0.002	0.310	0.692	Yes
H5	SE→AP	0.882	0.778	8.70	0.000	0.217	0.843	Yes

MT=Metaverse Technology, LM=Learning motivation, SE=Student Engagement, AP=Academic Performance

Significance level at P>0.05

6. DISCUSSION

This research was done in order to fill gaps in prior

research. First, we looked into how metaverse technology impacts academic performance with mediating role of learning motivation. Regarding metaverse technology, the findings demonstrated that metaverse technology have a significant impact on student engagement (B= 0.086, t = 4.12, p 0.000). H1 is supporting in our statistical analysis. The metaverse technology has significant impact on learning motivation with findings (B=0.677, t=11.51, p 0.000) supporting the H2 of the model. The indirect effect of metaverse technology has significant impact on student engagement with mediating effect of learning motivation depicted as significant (B=0.671, t=4.93, p 0.009) supporting H3 with partial mediation. The influence of learning management has significant impact on student engagement with (B=0.638, t=3.28, p 0.002) supporting the H4 of the model. Lastly, the student engagement has proven as significant with academic performance (B=0.882, t=8.70, p 0.000) supporting the H5 of the model.

The empirical findings of our research are consistent with the prior studies (Pangsapa et al., 2023). Similarly, the ability of metaverse technology to offer students incredibly immersive and engaging learning experiences is one possible advantage. The metaverse use of virtual reality (VR) and augmented reality (AR) can increase student engagement by building believable and fun simulations that let them explore and engage with difficult ideas in a practical way. These engaging activities have the power to pique students' curiosity and intrinsic drive, which will subsequently boost engagement and improve performance. Additionally, metaverse technology can open up possibilities for individualized and flexible learning experiences. The findings revealed that students are able to interact with learning materials that are specifically suited to their requirements and preferences through the customization of virtual worlds and interactive content. This customization can increase students' autonomy and sense of control, two elements that are known to have a beneficial impact on motivation and engagement. Students may be more inclined to put forth effort and maintain focus as a result, which will likely result in better results.

Consequently, the potential for revolutionizing educational experiences lies in the impact of metaverse technology on academic performance and student engagement, as mediated by learning motivation. Although the immersive and interactive features of metaverse technology might increase motivation and engagement, it is important to carefully address access disparities, the harmony of virtual and real-world learning experiences, and the particular methods of mediation. By carefully considering these elements, educators and researchers can use metaverse technology to build engaging and productive learning environments that boost academic performance.

7. CONCLUSION

In conclusion, the impact of metaverse technology on student engagement, academic performance, and learning motivation in the education sector is substantial. Empirical findings of this research caught a significant relationship among variables. However, the immersive and interactive nature of the metaverse provides students with dynamic learning experiences, fostering curiosity and active participation. Whereas, collaborative features enable global connections, promoting social interaction and knowledge sharing. Moreover, personalized learning capabilities cater to individual needs, enhancing motivation and driving student success. The gamification elements inherent in the metaverse create intrinsic motivation, turning learning into an enjoyable experience. By conducting research and understanding the specific mechanisms underlying the metaverse impact, educators and policymakers can harness its potential to revolutionize education. By embracing metaverse technology, we can create a future where students are deeply engaged, motivated to learn, and equipped with the skills necessary for success in the digital age.

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