

# Exploring the public's beliefs, emotions and sentiments towards the adoption of the metaverse in education: A qualitative inquiry using big data

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## Abstract

The metaverse is rapidly reshaping our understanding of education, yet identifying the public's beliefs, emotions and sentiments towards its adoption in education remains largely uncharted empirically. Grounded in the Technology Acceptance Model (TAM) and Digital Diffusion Theory (DOI), this paper aims to fill this gap using a big-data approach and machine learning to scrape comments made by social media users on recent popular posts or videos related to adopting the metaverse in education from three prominent social media platforms. The cleaning process narrowed down 11,024 comments to 4277, then analysed them using thematic, emotion and sentiment analysis techniques. The thematic analysis revealed that adopting the metaverse in education evokes a complex range of public beliefs: (1) *innovative learning methods*; (2) *accessibility and inclusion*; (3) *concerns about quality and effectiveness*; (4) *technological challenges and the digital divide*; (5) *the future of work and skills*; and (6) *privacy and security concerns*. Integrating these themes with emotion and sentiment analyses reveals a landscape of a significant portion of neutral sentiments that corroborates enthusiasm attenuated by caution. This careful consideration stresses the urgent need for a balanced approach to adopting the metaverse in education to ensure that resulting educational advancements benefit all learners equitably. As one of the first studies to offer a multidimensional

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view of the public's beliefs about metaverse education using big data, this research not only contributes to TAM and DOI but also provides critical insights that could inform policy, enhance educational practices and guide future scholarship in this emerging field.

#### KEYWORDS

beliefs and attitudes, education, metaverse, public opinion, virtual reality

### Key insights

#### What is the main issue that the paper addresses?

The paper is among the first to analyse the public's discourse regarding adopting the metaverse in education.

#### What are the main insights that the paper provides?

There is notable excitement about the metaverse's potential to revolutionise education through more innovative and accessible learning. However, concerns over education quality, technological challenges and a widened digital divide attenuate this enthusiasm. The public is cautiously optimistic, awaiting practical outcomes before embracing this technology more broadly.

## INTRODUCTION

The emergence of digital transformation has drastically changed various industries (Dwivedi et al., 2022), including the field of education. Educators and teachers have shown great interest in digital media, which encompasses interactive websites, social media, virtual reality applications and computer games (Manca et al., 2023). One particular development that has recently captured the attention of educators is the concept of the metaverse—a virtual space enabled by the convergence of virtual, augmented and mixed-reality technologies (Bengoechea & Bell, 2022; Jung et al., 2023; Krishnannair & Krishnannair, 2022; Kumar et al., 2023; Richter & Richter, 2023). This presents a new realm for educational exploration. The metaverse capabilities in creating interactive, 3D virtual environments (Dincelli & Yayla, 2022; Dwivedi et al., 2022; Mahmoud, 2023; Wu et al., 2023) can provide an enhanced learning experience that goes beyond the limitations of physical classrooms (Onu et al., 2023; Yenduri et al., 2023). In this study, we examine the public's beliefs, emotion and sentiments towards adopting the metaverse in education, a particularly relevant topic in the post-COVID era, where digital technologies are rapidly being adopted in educational contexts (Brown & Foster, 2023; Lee et al., 2022; Onu et al., 2023; Wang et al., 2022; Zubarev, 2022).

Recent literature (Alam & Mohanty, 2022; Batalla & Pedrero, 2023; Beitelmal et al., 2022; George & Wooden, 2023; Plotzky et al., 2021; Prakash et al., 2023; Shu & Gu, 2023) highlights the growing interest in the metaverse as a transformative tool in education, offering a

range of immersive, engaging and collaborative learning experiences. While some studies (Albus et al., 2021; Pellas et al., 2020; Pregowska et al., 2023) suggest that these virtual environments have the potential to foster diverse educational approaches, others caution against challenges such as accessibility, equity and quality concerns (Kye et al., 2021; Tili et al., 2022). Despite the increasing interest in the metaverse, there is still a significant gap in empirical research, particularly in terms of large-scale studies that identify the structure of the public's beliefs about adopting the metaverse in education based on naturally occurring data rather than self-reported information. This study aims to fill this gap by providing a deep analysis of the public's beliefs, emotions and sentiments using a big-data approach, which can contribute to the understanding of technology acceptance and diffusion in the context of metaverse adoption in education.

Davis's (1989) Technology Acceptance Model (TAM) and Rogers's (2010) Diffusion of Innovations Theory (DOI) provide a theoretical foundation for understanding the adoption and spread of new technologies, such as the metaverse, in educational settings. TAM suggests that perceived usefulness and ease of use are key factors influencing the adoption of new technologies (Davis, 1989), while DOI examines how new ideas and technologies spread through social systems (Rogers, 2010). This study contributes to these theoretical frameworks by providing empirical evidence of the factors influencing the adoption and diffusion of this emerging technology. Indeed, by investigating the public's beliefs, emotions and sentiments towards adopting the metaverse in education using naturally occurring data, the findings can help refine and extend these theories in the context of metaverse adoption in education.

That said, several research questions guide our investigation into public opinions on the intersection of education and the metaverse. Indeed, our research attempts to answer the following questions:

1. What is the prevalent thematic structure of the public's beliefs about adopting the metaverse in education?
2. What are the public's emotions and sentiments regarding the adoption of the metaverse in education? And how can these emotions and sentiments be interpreted by the public's beliefs regarding this adoption?

Our methodology employs a qualitative big-data approach, analysing a vast corpus of social media comments through advanced machine learning techniques. Therefore, this approach enables us to thoroughly analyse themes, sentiments and emotions, providing a robust understanding of public opinions. Consequently, the significance of this study lies in its potential to inform both educational institutions and technology developers, such that, aligning the future trajectory of education in the metaverse with public expectations and ethical considerations, we ensure that it is not only in line with technological advancements but also responds to the needs and values of society.

The remainder of the paper is structured as follows. We begin with a literature review, offering a critical examination of the existing body of research on education within the metaverse, laying the foundation for our study. Following this, we detail our research methods, providing transparency and context for our analytical approach. The findings are then presented, offering a rich and detailed account of public opinions. These findings are further contextualised and explored in a discussion section. The paper culminates in a conclusion that synthesises our key contributions, highlighting the implications of our work for future research and its practical application in the intersection of education and metaverse technologies.

## LITERATURE REVIEW AND THEORETICAL UNDERPINNINGS

### Metaverse in education

The utilisation of virtual reality and virtual environments in education has a long history, dating back to the early 1990s, when trials were conducted by some American universities (Au & Lee, 2017). However, the recent surge in interest in the term 'metaverse' has been driven by advancements in technologies such as augmented reality, virtual reality and mixed reality (Nevelsteen, 2017; Park & Kim, 2022; Richter & Richter, 2023; Smart, 2022). The disruption caused by the COVID-19 pandemic (Izadi et al., 2021) has further accelerated interest in the metaverse, emphasising its potential to revolutionise interactions and engagements in virtual environments (Huang et al., 2023; Li et al., 2023; Radianti et al., 2020; Richter & Richter, 2023), particularly in creating unique and immersive educational settings (Chen et al., 2023; Zhang, 2023; Zhang et al., 2022). These developments hint at the possibility of more accessible, flexible and interactive learning experiences, along with personalised education (Arantes, 2023; Chen, 2022; Kar & Varsha, 2023; Yilmaz et al., 2023). Current applications within education include virtual classrooms, immersive collaborative spaces, interactive simulations, virtual laboratories, digital avatars and extended reality environments that merge physical and digital realms (Antonijevic et al., 2022; Dutta et al., 2022; Latorraca, 2019; Nagadeepa et al., 2023; Sinha, 2023; Wang et al., 2022; Zhang et al., 2022). These developments hint at the possibility of more accessible, flexible and interactive learning experiences, along with personalised education.

However, the integration of the metaverse in education also brings forth several challenges and ethical concerns. These include the technical limitations of current platforms, privacy and security risks, the necessity for enhanced digital literacy among students and faculty, the potential for overuse and addiction and unequal access to the required technology (Alfaisal et al., 2022; Prakash et al., 2023; Sunardi Hidayanto et al., 2022). Additionally, Flavián et al. (2024) highlight the challenges in virtualising events in the metaverse, such as ensuring user engagement and overcoming the digital divide, which are relevant considerations for education institutions exploring metaverse applications. Despite these hurdles, the growing interest in this domain is evident from initiatives like the development of 'metaversities' funded by Meta, aimed at establishing best practices for metaverse-enabled education (Hadi Mogavi et al., 2023; Sopher & Lescop, 2023). As this technology continues to evolve, metaverse-based learning environments have the potential to revolutionise the design and delivery of college courses (Joshi & Pramod, 2023; Lopez-Belmonte et al., 2022; Sutopo, 2022). Nonetheless, as these immersive digital spaces grow, there is a pressing need for careful consideration of the ethical implications to ensure equitable and secure learning experiences (Pathak-Shelat & Mehta, 2023; Zallio & Clarkson, 2022, 2023).

### Public attitudes and acceptance towards learning in the metaverse

Research into public attitudes towards learning in the metaverse is expanding (Alkhwaldi, 2024; Kar & Varsha, 2023), highlighting the complexity of public acceptance of the metaverse in education (Suh, 2023), yet it often lacks depth in exploring varied user experiences (Mahmoud, 2023). Indeed, while some studies (e.g., Al-Adwan et al., 2023; Hwang et al., 2023; Zhong & Zheng, 2022) have well documented the potential benefits of metaverse-based learning, such as enhanced engagement, immersion and collaboration, particularly in problem-based learning contexts, and others (e.g., Almarzouqi et al., 2022; Park et al., 2023) have acknowledged barriers like digital literacy and technological access, these studies did not deeply investigate the broader public beliefs, emotions and

sentiments towards adopting the metaverse in education. Our study addresses this gap by employing a qualitative big-data approach, analysing extensive social media data to uncover the structure of the public's beliefs and how these beliefs can be translated in terms of the triggered emotions and developing sentiments regarding adopting the metaverse in education.

Studies employing technology acceptance models have highlighted several factors influencing the adoption of metaverse technologies in education, including perceived usefulness, ease of use, enjoyment, social norms and self-efficacy (e.g., Al-Adwan et al., 2023; Almarzouqi et al., 2022; Hussain et al., 2023; Ren et al., 2022). However, these investigations often rely on limited samples and might not fully capture the complex emotional responses and societal dynamics surrounding metaverse adoption in education. To address this shortfall, our big-data approach is specifically designed to analyse the public's discourse resulting from extensive interactions across multiple social media platforms, providing a robust yet more realistic view of the public's beliefs, emotions and sentiments towards adopting the metaverse in education. Furthermore, while studies on user experiences typically capture only specific instances of interaction with metaverse platforms, focusing on both learners and instructors (e.g., Hutson, 2022; Park et al., 2023; Sopher & Lescop, 2023; Wu et al., 2024), our research enriches this perspective by drawing insights based on extended periods spanning years, offering a dynamic view of the integration process of these technologies in education.

Another strand of studies in that regard is research that largely comprises systematic and literature reviews (e.g., Ali et al., 2023; Bibri & Allam, 2022; Camilleri, 2023; Hasri et al., 2022). These reviews serve a critical role in aggregating and synthesising existing research to outline the theoretical and practical advancements in the use of immersive technologies in educational settings. However, while these reviews provide a detailed overview of the state of the art, they inherently lack new empirical data that reflects the real-time evolution of public beliefs, emotions and sentiment towards adopting metaverse-based learning. This gap highlights the need for research methodologies that move beyond traditional reviews and small-scale studies to capture a broader, more dynamic range of user interactions and responses.

Addressing this need, our research employs a big-data approach, significantly expanding the methodological scope by analysing public discourse across three major social media platforms rather than restricting the study to a single platform like Twitter, as done by Krittanawong et al. (2023), who explored the public discourse on the metaverse but focusing on its implications for mental health. This approach not only diversifies the demographic and psychographic profiles of the participants but also captures a wide array of naturally occurring public expressions and interactions regarding the metaverse. Doing so provides a more detailed exploration of how various populations perceive and react to integrating metaverse technologies in educational contexts. The novelty of this research lies in its ability to uncover complex patterns of beliefs, emotions and sentiments that are often diluted in structured survey settings or limited by the demographic skew of a single platform. Hence, this study not only fills a crucial gap in the existing literature by offering real-world insights into public opinion but also sets a foundation for future educational strategies and technological deployments in the metaverse, aligning them more closely with user expectations and societal trends.

In summary, while previous research provides foundational insights into the initial reception and potential advantages of metaverse learning, it often overlooks the full spectrum of public beliefs, emotions and sentiments over the long term. Our study uniquely fills these critical gaps by employing a sophisticated big-data approach, thus making significant contributions to academic discussions and practical implementations in the evolving field of educational technology.

## Metaverse education: Integrating theory and emerging trends

The study is grounded in Davis's (1989) TAM, which posits that an individual's intention to adopt a new technology is primarily determined by their perceived usefulness and ease of use of the technology. TAM offers a foundational framework for understanding the motivations and acceptance of new technologies (Fülöp et al., 2023; Khan et al., 2021), and hence is relevant to empirical investigations on adopting the metaverse in education. TAM can help uncover the public's beliefs about the potential benefits and challenges of using this technology for learning (Al-Adwan, 2020). Therefore, by focusing on factors such as the perceived effectiveness of metaverse-based education, ease of use and perceived enjoyment of immersive experiences, TAM can provide critical insights into what drives or inhibits public adoption of the metaverse in education. This leads us to argue that this approach is instrumental in informing educational providers about key aspects that make metaverse learning experiences more compelling and acceptable to potential learners, such that studying public beliefs through this lens equips providers with essential information on how to design and refine metaverse educational offerings to meet learner expectations effectively.

Complementing TAM, Rogers's (2010) DOI provides a broader perspective on how new ideas, such as the metaverse in education, spread through society. This theory highlights the importance of understanding the stages of public awareness, interest, evaluation, trial and adoption of this novel form of virtual education (Almaiah et al., 2022; Menzli et al., 2022). In the context of qualitative research, examining these stages through social media discourse can offer deep insights into public sentiments and emotional responses related to each stage (Al-Razgan et al., 2021; Bolici et al., 2020). This leads us to argue that analysing the diffusion patterns of the metaverse in education can help reveal crucial insights into the current public perceptions and the likely course of its adoption, especially given the emerging stage of the metaverse in education.

We expect that the thematic, sentiment and emotion analyses of public discourse and beliefs about adopting the metaverse in education will add a rich, qualitative dimension to the study, uncovering the perceived benefits, risks, emotions and meanings associated with this emerging innovation. Notably, while quantitative models like TAM provide structured insights, these qualitative analyses offer a more detailed exploration of learner perspectives (e.g., Al-Adwan et al., 2023; Ren et al., 2022), capturing the emotional and psychological cues behind the acceptance and rejection of the implementation of innovative technologies (e.g., De Cicco et al., 2022) like the metaverse. As such, integrating TAM, DOI and these qualitative methods can offer a framework to address existing knowledge gaps and derive valuable conclusions for theory, practice and society regarding an innovation poised to disrupt the education sector.

## METHODS

### Data collection

Our research adopted a big-data methodology to explore societal perceptions of education in the metaverse. Ethical approval for this study was granted by the Institutional Review Board (IRB) at St. John's University, which deemed informed consent unnecessary due to the public nature of the online comments. Nonetheless, we ensured ethical integrity by anonymising the data and eliminating any personal identifiers. We collected textual data in the form of user comments from three major social media platforms: Reddit, TikTok and YouTube, spanning from 2020 to 2023, a period aligned with significant technological developments and increased interest in the metaverse. These platforms were chosen for their



varied demographics and unique user interactions, providing a deeper insight into public sentiment (e.g., Mahmoud, 2024; Proferes et al., 2021; Wiley et al., 2023). To scrape comments from Reddit, we utilised the Python Reddit API Wrapper (PRAW), a Python package that provides a simple interface to access Reddit's API. After obtaining the necessary API credentials, we retrieved comments from specific posts by referencing their subreddit and post ID. For TikTok, given the platform's restricted API access, we opted for the third-party Python library TikTokApi. Finally, for YouTube, we employed Google's official YouTube Data API using the `googleapiclient.discovery` module to build a service object that interacts with the API. This allowed us to request comment threads associated with particular video IDs, extracting each comment's textual content efficiently. In each case, we adhered to the respective platform's API usage policies and rate limits, ensuring ethical compliance in data gathering.

As a result, on Reddit, we gathered 3533 comments from subreddits like *r/education* and *r/metaverse*. On TikTok, we harvested 6926 comments from posts with keywords like 'virtual reality', 'vr', 'metaverse' and 'education'. From YouTube, 565 comments were collected from widely viewed videos, selected for their relevance and high view counts, using search terms related to metaverse and education. The initial dataset totalled 11,024 comments. Our keyword and hashtag selection was based on a content analysis of trending topics on education in the metaverse and exhaustive searches on these platforms. The dataset was refined to 4277 comments suitable for qualitative analysis after preprocessing and cleaning, which involved removing duplicates, filtering non-English comments and discarding irrelevant content like spam using Python coding (as detailed in Appendices S1 and S2).

## Analysis of data: Thematic analysis

For the thematic analysis, we used NVivo 12, a highly regarded software for managing complex qualitative data (e.g., Fotheringham et al., 2021; Maher et al., 2022). The analysis process was thorough and involved generating initial codes, which were then grouped into broader themes. NVivo was also employed for inter-coder reliability assessment. The aim was to deeply understand public beliefs about the use of the metaverse in education. The analysis involved several meticulous stages, including dual coding and multiple iterations, to ensure validity and reliability. A subset of 300 comments was initially analysed to identify themes, which informed a coding framework grounded in preliminary findings and relevant literature. Two independent researchers performed the coding, thereby reducing bias and enhancing reliability (Saldaña, 2021). The initial open coding phase involved creating codes from the raw data, capturing key themes and patterns in public beliefs about education in the metaverse. These codes were later organised into a shared codebook, constantly updated throughout the study (Hack-Polay et al., 2022; Thomas, 2016). Data saturation was confirmed when no new themes emerged from the analysis, ensuring rigorous and valid findings (Guest et al., 2012). Axial and selective coding followed, clustering initial codes into broader categories and then refining these into overarching themes (Corbin & Strauss, 2015). Inter-coder reliability was measured using Cohen's kappa coefficient, and any coding disagreements were resolved through discussion. The final Cohen's kappa score ( $\kappa = 0.841$ ) indicated substantial coder agreement (Cohen, 2016; Landis & Koch, 1977). Additionally, a third coder's validation added further rigour to the coding framework (Mahmoud, 2024). The themes were then interpreted in light of existing literature, providing a basis for future research (Boyatzis, 1998; Elo et al., 2014; Fereday & Muir-Cochrane, 2016).

## Analysis of data: Sentiment and emotion analysis

For sentiment analysis, the refined dataset was examined using the Sentiment Intensity Analyser (SIA) with the VADER lexicon (Hutto & Gilbert, 2014) from Python's NLTK, effective for social media texts (Banik, 2023; Hossain & Rahman, 2022). Each comment received a compound score to determine its sentiment polarity, classifying comments as 'Positive', 'Negative' or 'Neutral' categories based on predefined thresholds ( $>0.05$  for Positive;  $<-0.05$  for Negative; between these ranges for Neutral). Emotion analysis utilised a predefined list of emotion words based on established emotion theories, mainly Plutchik's Wheel of Emotions (Plutchik, 1980). The comments were tokenised and compared against this lexicon. The frequencies of each emotion were calculated to gauge the overall emotional tone of the discussions. The findings were visualised using Matplotlib, including a bar chart for emotion frequencies, a pie chart for sentiment distribution and a word cloud for a qualitative overview of the data.

## RESULTS

### Thematic analysis

#### Innovative learning methods

The first theme identified from the comments, *innovative learning methods*, reflects a widespread excitement among users about the potential of the metaverse to revolutionise education through advanced technology. Many comments illustrate a keen interest in the immersive learning experiences that virtual reality (VR) and augmented reality (AR) technologies could provide. One user gushed, '*The idea of attending lectures in a VR environment sounds thrilling!*', highlighting the appeal of novel and interactive educational settings. This sentiment was echoed by another commenter who envisioned practical applications, stating, '*Imagine doing lab experiments virtually, no risk and all the learning*'. These comments highlight a strong belief in the metaverse's ability to offer safe yet realistic, practical learning experiences.

Further illustrating this theme, users pointed out the potential for VR to make distance learning more engaging and interactive. One comment, '*VR classrooms could make distance learning much more engaging*', suggests a vision of virtual learning spaces that could enhance student involvement and combat the isolation often associated with online education. Similarly, the use of AR in education was seen as a means to bring dynamic and context-rich content into the learning process, as one user highlighted: '*Augmented reality could bring historical events to life in history classes*'. This perspective reflects an aspiration for technology to enrich and diversify educational content, making abstract or historical information more tangible and relatable. Collectively, these comments paint a picture of a future where education leverages the metaverse's innovative technologies to create more captivating, effective and immersive learning environments.

#### Accessibility and inclusion

The second prominent theme emerging from the analysis of users' comments is *accessibility and inclusion*, reflecting a strong public belief in the metaverse's potential to democratise education. Many users discussed how education in the metaverse could transcend geographical barriers and provide equal learning opportunities to a diverse range of students.



One user pointed out, '*Education in the metaverse could reach people in remote areas*', highlighting the potential for virtual platforms to bridge distances and bring educational resources to underserved communities. Similarly, another commenter noted, '*It's great for those who can't attend campus due to disabilities*', emphasising the inclusivity aspect of metaverse education, particularly for students with physical limitations.

Further emphasising this theme, users expressed the view that the metaverse could foster a global educational community, transcending national and cultural boundaries. One comment, '*This could make higher education more accessible globally*', captures the sentiment that the metaverse could facilitate a more interconnected and diverse educational experience. Additionally, users see the metaverse as a platform for cultural exchange and mutual learning, as reflected in the statement, '*The metaverse could offer a platform for diverse cultural exchanges*'. These insights indicate a collective anticipation that the metaverse could not only make education more accessible but also more inclusive by providing a global stage for learners from various backgrounds to interact, exchange ideas and enrich their educational experiences. This theme underlines a hopeful vision of the metaverse as a tool for creating a more equitable and inclusive educational landscape.

### Concerns about quality and effectiveness

The third major theme that emerged from the comments is centred around *concerns about the quality and effectiveness* of education in the metaverse. This theme captures a sense of scepticism and apprehension among users regarding the efficacy of virtual learning environments compared to traditional educational settings. One user articulately voiced this concern, stating, '*Can virtual education really replace the classroom experience?*'. This comment reflects a common worry about whether the richness of in-person learning can be effectively replicated in a digital format. Another user expressed a similar sentiment, questioning the overall quality of virtual education: '*I'm skeptical about the quality of education in a VR setting*'. Such comments reveal a pervasive uncertainty about the ability of metaverse platforms to maintain educational standards and deliver an engaging learning experience.

In addition to doubts about educational quality, there were concerns about the loss of critical aspects of the traditional educational experience in a virtual setting. One user pondered, '*How will they ensure academic rigour in a virtual environment?*', highlighting worries about maintaining academic standards and the integrity of the learning process. Furthermore, the social and interpersonal elements of education were a point of concern, as one commenter noted: '*There's more to college than just lectures, what about the social aspects?*'. This remark brings to light the multifaceted nature of education, where social interaction and campus life play a vital role in the overall educational experience. Together, these comments underscore a significant apprehension among the public regarding the potential limitations of metaverse education in replicating the depth, quality and social dimensions of traditional education settings.

### Technological challenges and digital divide

The fourth theme extracted from the users' comments pertains to *technological challenges and the digital divide*, highlighting concerns about the practical and equitable implementation of education in the metaverse. Users expressed concerns regarding the accessibility of necessary technology and the potential for a widened educational gap due to technological disparities. One user succinctly captured this concern, stating, '*Not everyone has access to high-quality VR equipment*'. This comment points to the issue of unequal access to the

advanced technologies required for a full metaverse experience, which could exclude economically disadvantaged students. Another comment, '*What about the technical issues and glitches in VR?*', raises concerns about the reliability and smooth operation of VR technologies, which are crucial for ensuring a seamless educational experience.

Furthermore, the comments reveal an awareness of the broader implications of a digital divide in education. One user highlighted, '*There's a digital divide; this could widen the gap in education*', emphasising the risk of exacerbating existing inequalities in access to quality education. This perspective is shared by another commenter who underscored the financial aspect, remarking, '*We need to consider the cost of VR technology for students*'. These comments reflect a deep-seated concern that while the metaverse has the potential to revolutionise education, it also poses significant challenges in ensuring that these advancements are accessible and beneficial to all students, regardless of their socioeconomic background. The theme of *technological challenges and the digital divide* thus emphasises a critical need for thoughtful and inclusive planning to ensure that the promise of metaverse education does not inadvertently deepen educational inequities.

## Future of work and skills

One of the key themes that emerged prominently from the analysis of users' comments is the *future of work and skills*, reflecting a forward-looking perspective on how education in the metaverse could align with evolving job markets and skill requirements. Users believed that metaverse education could play a pivotal role in preparing students for the demands of future workplaces, especially in technology-driven sectors. One user insightfully noted, '*Metaverse education could better prepare students for future tech jobs*', highlighting the potential of virtual learning environments to equip students with relevant digital skills. Another commenter echoed this sentiment, emphasising the importance of current educational systems adapting to the digital age: '*We need education systems that match the future of work*'.

Additionally, there was a recognition of the need for education to evolve in response to the changing nature of work, which increasingly values digital literacy and virtual collaboration skills. One user remarked, '*This could be a way to develop skills relevant to the digital age*', underscoring the role of metaverse education in fostering competencies crucial for modern work environments. Furthermore, the importance of training students in virtual collaboration and digital tool proficiency was highlighted, with one commenter stating, '*It's important to train students in virtual collaboration and digital tools*'. These observations reflect a broader understanding that as workplaces become more digital and interconnected, the skills imparted by education must evolve accordingly. This theme captures a collective anticipation that the metaverse can serve as a dynamic platform for preparing students not only academically but also in terms of the practical skills needed for future career success.

## Privacy and security concerns

The sixth and final theme identified from the users' comments focuses on *privacy and security concerns* related to education in the metaverse. This theme reflects a significant level of apprehension among users about the potential risks to privacy and data security in virtual learning environments. One user voiced a common concern, asking, '*What about data privacy in a virtual education platform?*'. This question points to the complexities of managing and protecting personal and sensitive information in a fully digital educational setting. Similarly, another user emphasised the importance of cybersecurity, stating, '*Cybersecurity*

will be a major concern in metaverse classrooms'. This comment acknowledges the challenges of ensuring secure and safe online spaces for students and educators alike.

In addition to general privacy concerns, users also highlighted the need for robust policies and measures to protect user data within the metaverse. One user asked, 'How will student information be protected in the metaverse?', suggesting a need for clear guidelines and protocols to safeguard personal data. Another concern, as one commenter noted, is the establishment of stringent privacy policies: 'There need to be strict policies to safeguard privacy in virtual classes'. The comments provided collectively stress the significance of taking a proactive approach towards addressing privacy and security concerns as the education sector ventures into the metaverse. The emphasis on these concerns reflects a broader understanding that while the metaverse offers exciting educational possibilities, it also brings new challenges in terms of ensuring the privacy and security of all participants in this burgeoning digital landscape.

Each of the identified themes is represented in [Table 1](#), displaying both the number of comments and their respective percentage frequency.

## Emotion and sentiment analysis

The sentiment analysis of user comments on education in the metaverse, as depicted in [Figure 1](#), shows that a majority of the sentiments are neutral (50.9%), suggesting a cautious or measured outlook among users. The significant proportion of neutral sentiment could imply that while many are open to the idea of education in the metaverse, they may still be seeking more information or are unsure about its implementation and impact. The positive sentiments account for a substantial 36.3%, indicating a strong sense of optimism and a positive attitude towards the potential integration of the metaverse into educational settings. On the other hand, the negative sentiments are relatively low, at 12.9%, reflecting some concerns or doubts but not overwhelmingly so.

The word cloud analysis ([Figure 2](#)) reveals 'game', 'will', 'need', 'video', 'time' and 'work' as the most frequently mentioned terms. This choice of words may imply a focus on the practical and logistical aspects of integrating metaverse technologies into educational systems. 'Game' could refer to gamification strategies for learning, while 'will' and 'need' indicate discussions around future requirements and possibilities. 'Video' and 'time' suggest that content delivery and temporal investment in learning are key concerns, and 'work' points to the application of metaverse education in preparing students for the workforce. The emotion analysis ([Figure 3](#)) complements this by showing a predominance of positive emotions like

**TABLE 1** Themes, number of comments and percentage frequency.

No.	Theme	Number of comments	Percentage frequency
1	Innovative Learning Methods	923	21.57
2	Accessibility and Inclusion	816	19.08
3	Concerns about Quality and Effectiveness	568	13.27
4	Technological Challenges and Digital Divide	674	15.76
5	Future of Work and Skills	639	14.93
6	Privacy and Security Concerns	658	15.38
	<b>Total</b>	<b>4277</b>	<b>100%</b>

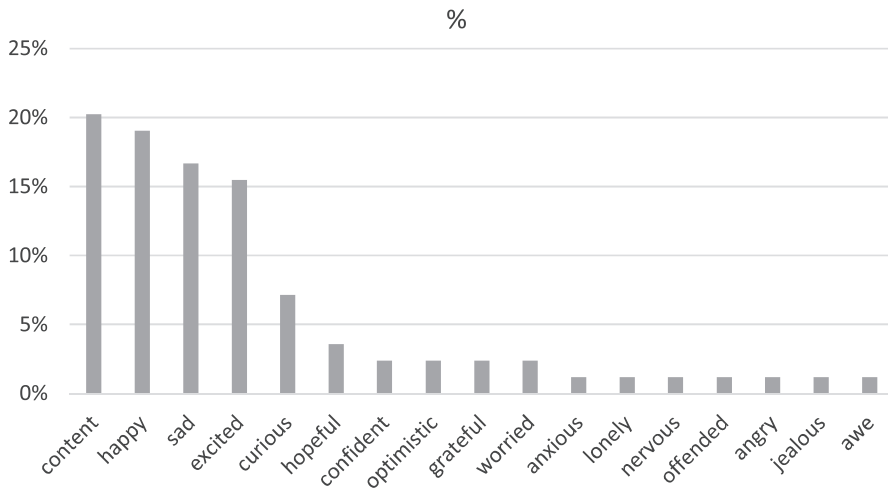


FIGURE 1 Emotion analysis results.

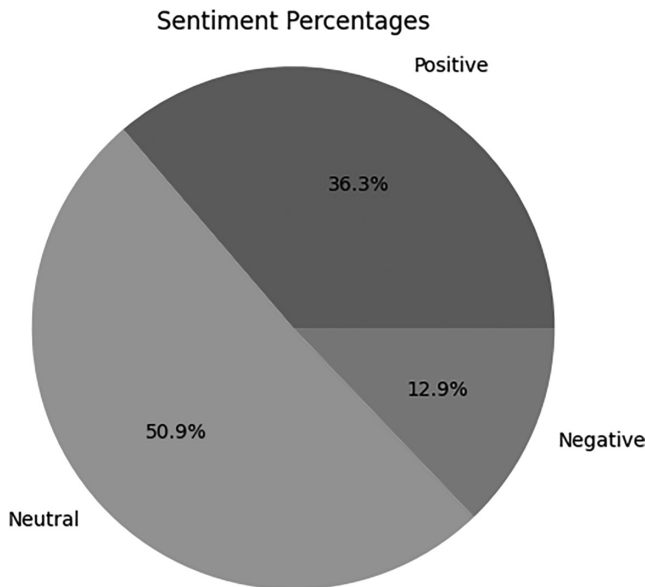


FIGURE 2 Sentiment analysis results.

'content' and 'happy', which could be associated with the engaging and interactive nature of gamified learning expected in the metaverse. These insights collectively depict an audience that is positively inclined yet pragmatically cautious about the transformative potential of the metaverse in education, keen on understanding how it will fit into the broader educational and professional landscape.

Integrating the thematic, emotion and sentiment analyses regarding adopting the metaverse in education reveals a landscape marked by enthusiasm and caution. The excitement is evident, as many envision a future where the metaverse transforms learning into more immersive and engaging experiences, echoing the positive sentiments found in the analysis. Yet, alongside this optimism, there is a prevailing caution. While the emotional analysis highlights general contentment with innovative potential, the large portion of neutral





(Rogers, 2010). Moreover, the theme of innovative learning methods aligns with DOI's notion of relative advantage, suggesting that the metaverse is perceived as *superior* to existing educational technologies (Rogers, 2010).

Second, the accessibility and inclusion theme expressed in the public's beliefs highlights issues of complexity that could inhibit adoption, again aligning with DOI and reflecting a growing consensus on the metaverse's potential to democratise education. This theme extends DOI by emphasising the importance of accessibility and inclusion in the diffusion of educational innovations. This belief also raises questions about the digital divide and equitable access to technology, a concern our study's participants frequently voiced. These concerns echo the findings of self-reported studies (e.g., Almarzouqi et al., 2022) and reviews (e.g., Park et al., 2023), acknowledging barriers like digital literacy and technological access in adopting metaverse technologies in education. These concerns challenge the assumption of equal access to technology in TAM and DOI, highlighting the need to consider socioeconomic factors in technology adoption.

Third, the public's concerns about quality and effectiveness highlight the necessity of a balanced and critical approach to adopting metaverse technologies in education. Such challenges in virtualising events in the metaverse indicate that the shift to virtual learning environments must be carefully managed to maintain educational quality and improve engagement levels among the parties involved in the learning process. This theme extends TAM by suggesting that perceived usefulness alone may not be sufficient for adoption if concerns about quality and effectiveness persist. While previous studies have acknowledged challenges in virtualising experiences, like in touristic events (Flavián et al., 2024), in the metaverse, our study contributes by empirically extending that to the education sector.

Fourth, as expressed in the public discourse, *technological challenges and the digital divide* stress the importance of a sustainable technology infrastructure, a concern that is increasingly relevant in the digital age. This theme aligns with DOI's emphasis on the role of infrastructure in the diffusion of innovations (Rogers, 2010). It also resonates with concerns highlighted in review papers (e.g., Alfaisal et al., 2022; Prakash et al., 2023; Sunardi Hidayanto et al., 2022) regarding technical limitations, privacy and security risks and unequal access to technology as challenges in the integration of the metaverse in education. Our study adds value by providing empirical evidence suggesting the validity of those concerns.

Fifth, the theme of the *future of work and skills* suggests that the metaverse could significantly influence behavioural intentions towards acquiring digital literacy and future-oriented skills. This theme extends TAM by highlighting the potential impact of the metaverse on skill acquisition and career development, factors not explicitly addressed in the original model. This finding aligns with the growing interest in the development of 'metaversities' aimed at establishing best practices for metaverse-enabled education (e.g., Hadi Mogavi et al., 2023; Sopher & Lescop, 2023).

Sixth, *privacy and security concerns* highlight the public's apprehensions about the security of social learning environments in the metaverse. This theme challenges the assumption of trust in technology inherent in TAM and DOI, emphasising the need to address privacy and security issues to facilitate adoption. This finding empirically validates the concerns raised by review-based research (e.g., Pathak-Shelat & Mehta, 2023; Zallio & Clarkson, 2023) about the ethical implications of metaverse education and the need to ensure equitable and secure learning experiences.

Turning to address the second research question, our analysis of emotions and sentiments in the public discourse on adopting metaverse education provides valuable insights into the affective dimensions of technology adoption, complementing the cognitive perceptions captured by TAM and DOI. While previous research has not discussed emotions and sentiments extensively in the context of metaverse education, their importance in shaping intentions and behaviours towards technology adoption has been acknowledged in the broader literature



on technology acceptance (e.g., Lu et al., 2019; Meishar-Tal & Levenberg, 2021; Tzafilkou et al., 2021; Zuo & Shen, 2023). Our study extends this line of research by examining the specific emotions and sentiments associated with adopting metaverse education uncovered through the analysis of extensive social media data.

Finally, the positive emotions of contentment and happiness likely relate to perceived usefulness, while negative emotions connect to perceived barriers to use. While the predominant emotions of contentment and happiness align with our expectations of public enthusiasm for innovative education experiences, the presence of sadness reveals an unexpected depth of emotional engagement, highlighting the complex emotional landscape of metaverse education. These findings extend TAM and DOI by incorporating emotional dimensions into the understanding of technology adoption. This emotional complexity aligns with the existing literature (e.g., Chuah & Kabilan, 2021; Jiang et al., 2022; Xie et al., 2023), which hints at the importance of capturing the emotional and psychological cues behind the acceptance and rejection of innovative technologies.

## Practical implications

The exploration of the public's beliefs, emotions and sentiments towards adopting the metaverse in education, as revealed by our study, offers critical insights into the practical implementation of metaverse technologies in the educational sector. These implications span across various aspects of educational delivery, policy and technological adoption.

At the forefront is the enthusiasm for *innovative learning methods* in the metaverse, which signals a transformative opportunity for educational institutions. This enthusiasm advocates for the integration of VR and AR technologies into curricula, enabling dynamic teaching methods such as virtual labs and historical simulations. To realise this potential, a significant investment in technological infrastructure and educator training is imperative, ensuring that these innovative methods are effectively utilised.

Simultaneously, the theme of *accessibility and inclusion* presents an opportunity to democratise education. The metaverse's ability to transcend geographical barriers can make education more accessible, especially for students in remote areas or those with disabilities. However, realising this potential requires a concerted effort to develop inclusive policies and strategies, ensuring that metaverse education is equitably accessible and addresses the socioeconomic disparities that may hinder access.

However, amidst these opportunities, the study also highlights *concerns about quality and effectiveness*. These concerns necessitate a focus on maintaining academic rigour in virtual settings. Educational institutions should establish robust frameworks for assessment and accreditation of metaverse-based courses, ensuring they adhere to high educational standards.

Moreover, the *technological challenges and digital divide* highlighted in the study underscore the need for equitable access to metaverse technologies. Addressing the digital divide requires policies that make VR technology both affordable and accessible to all students. Collaborations with tech companies could be a strategic approach to facilitate this access and ensure that no student is left behind in the shift to digital learning.

The anticipation that the metaverse will align with the *future of work and skills* suggests a proactive revision of curricula to include digital literacy and virtual collaboration skills. Educational institutions must anticipate the evolving job market and technological landscape, ensuring that students are equipped with skills relevant to the digital age.

Lastly, the concerns over *privacy and security* in virtual learning environments highlight the need for stringent data protection and cybersecurity measures. Institutions venturing into the metaverse must prioritise the safety and privacy of their students and staff, implementing robust protocols to protect data in these new digital spaces.

In sum, the transition to metaverse-based education offers tremendous opportunities but also presents distinct challenges. Institutions need to embark on strategic planning and policy development, complemented by technological investment and curriculum innovation. Such a multi-faceted approach will ensure an effective, inclusive and secure transition to metaverse education, enhancing the overall learning experience and addressing the concerns of all stakeholders.

## Research limitations and implications

Our study's exploration of the public's beliefs, emotions and sentiments towards adopting the metaverse in education presents certain limitations that naturally pave the way for future research directions.

One of the primary limitations is the data source, which is predominantly social media platforms like Reddit, TikTok and YouTube. This choice may not fully represent the broader public opinion, as these platforms do not necessarily include the entire demographic interested in education in the metaverse. Addressing this, future research should diversify data sources, incorporating more varied platforms such as academic forums, professional networks and international channels. This would broaden the spectrum of perspectives and provide a more representative understanding of public opinion.

Another significant limitation is the focus on English-language comments, which introduces a language bias and potentially overlooks non-English-speaking perspectives. This limitation highlights the need for future research to incorporate multilingual and cross-cultural perspectives. By including a variety of linguistic and cultural backgrounds, future studies can offer a more global and inclusive understanding of the perceptions surrounding education in the metaverse.

The temporal constraints of the study, focusing on data from 2020 to 2023, might limit the generalisability of the findings to other time periods, especially given the rapid pace of technological advancements and societal changes. To capture the evolution of public perceptions over time, future research could benefit from longitudinal studies. Such studies would provide a dynamic view of how perceptions shift in response to ongoing technological and societal developments.

Furthermore, the methodological approach, primarily qualitative, might miss broader trends that a quantitative analysis could uncover. To build a more comprehensive picture, future research should integrate quantitative methods like surveys or large-scale data analytics. This approach would balance the depth of qualitative insights with the breadth of quantitative data, potentially revealing broader trends and patterns in public perceptions. Indeed, we call on future research to benefit from our findings in constructing and validating a multidimensional measurement model of beliefs, attitudes and behaviours regarding metaverse education.

The study also opens avenues for focused research on specific demographic groups, such as educators, students or technology developers. Understanding the unique needs and expectations of these groups is crucial. Additionally, exploring the ethical and policy implications of integrating the metaverse into education, especially in terms of privacy, security and equity, is a critical area for future research.

Lastly, the impact of technological advancements in the metaverse, including artificial intelligence integration and improved virtual-reality interfaces, represents a dynamic area for exploration. Future studies should examine how these advancements influence educational outcomes in the metaverse, providing up-to-date insights into this rapidly evolving field.

In conclusion, while the current study provides valuable insights into the public's beliefs, emotions and sentiments towards adopting the metaverse in education, it also lays the groundwork for a multitude of research paths. Addressing the study's limitations through

these suggested directions will undoubtedly enrich our understanding and guide the effective and responsible integration of metaverse technologies in education.

## CONCLUSION

This study has successfully identified the public's belief structure alongside the emotions and sentiments regarding the adoption of the metaverse in education. Social media comments suggest enthusiasm for the innovative, immersive learning methods offered by virtual and augmented realities, which could increase accessibility and inclusion. However, there are significant concerns about the effectiveness of virtual learning, the maintenance of educational quality and the potential for a widening digital divide due to technological disparities. This paper bridges the gap between theory and practice by applying the foundational theories of the Technology Acceptance Model (TAM) and Diffusion of Innovations Theory (DOI) to an empirical analysis of naturally occurring social media data. It provides an evidence-based anatomy of public opinions about adopting the metaverse in education, enriching theoretical applications with real-world insights. Although the metaverse has been recognised for its potential to align education with the constantly evolving job market, there are concerns regarding privacy and data security. Thus, this research has a significant impact on the education industry, providing educational institutions and policymakers with a grounded understanding of public perception, which is critical for the successful integration and adoption of metaverse technologies into educational frameworks. The paper concludes that the integration of the metaverse in education presents both unique opportunities and challenges. It emphasises the need for strategic planning and policy development to ensure equitable access, quality education and security in this emerging digital frontier. It not only emphasises the need for strategic planning and policy development to ensure equitable access, quality education and security in this emerging digital frontier but also highlights the importance of aligning technological innovation with educational goals to facilitate a responsive and inclusive educational ecosystem.

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## CONFLICT OF INTEREST STATEMENT

The author has no conflict of interest to declare.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## ETHICS APPROVAL STATEMENT

This research was ethically approved by St. John's University (IRB-FY2024-302).

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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