

Smart Computing and Intelligence

Series Editors: Kinshuk · Ronghuai Huang · Demetrios Sampson

Dejian Liu · Ronghuai Huang ·
Ahmed Hosny Saleh Metwally ·
Ahmed Tlili · Emma Fan Lin *Editors*

Application of the Metaverse in Education

 Springer

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Series Editors

Kinshuk, Athabasca, AB, Canada

Ronghuai Huang, Beijing Normal University, Beijing, China

Demetrios Sampson , Department of Digital Systems, University of Piraeus, Piraeus, Greece

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Dejian Liu · Ronghuai Huang ·
Ahmed Hosny Saleh Metwally · Ahmed Tlili ·
Emma Fan Lin
Editors


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Editors

Dejian Liu
Smart Learning Institute
Beijing Normal University
Beijing, China

Ronghuai Huang
Smart Learning Institute
Beijing Normal University
Beijing, China

Ahmed Hosny Saleh Metwally 
Smart Learning Institute
Beijing Normal University
Beijing, China

Ahmed Tlili
Smart Learning Institute
Beijing Normal University
Beijing, China

Emma Fan Lin
NetDragon Websoft
Fuzhou, China

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Foreword by Dr. Pan Hui

It is with great pleasure that I write this Foreword for the book *Application of the Metaverse in Education*, edited by Dr. Dejian Liu, Dr. Ronghuai Huang, Dr. Ahmed Hosny Saleh Metwally, Dr. Ahmed Tlili, and Ms. Emma Fan Lin. This book brings together a diverse group of authors from around the world to explore the potential of the Metaverse in educational contexts. With chapters covering a wide range of topics, from immersive learning design to virtual collaborations and cultural immersion, this book offers valuable insights into the transformative power of the Metaverse in education.

As a leading voice in the field of virtual-physical blended classrooms in the Metaverse era, I am particularly excited about the vision presented in this book. The COVID-19 pandemic has underscored the need for innovative approaches to teaching and learning, and the Metaverse offers a promising solution. In my own research, I have explored the potential of immersive environments to create more attractive and effective educational activities.

The Metaverse, as a virtual world that seamlessly integrates physical and digital environments, holds immense potential for transforming the learning experience. In the Metaverse classroom, students and teachers can interact with each other and with virtual objects and environments in real-time, creating a more engaging and interactive learning environment. This learner-centric approach promotes collaboration, creativity, and innovation, ultimately enhancing student engagement and performance.

However, there are still challenges to be addressed in realizing the full potential of the Metaverse classroom. System performance, user-centric evaluation, and networking issues are just a few of the complex aspects that require careful consideration. It is through joint research efforts and collaborations that we can further develop and refine the Metaverse classroom, addressing these challenges and unlocking its full potential.

The “Conclusion” chapter of this book provides a valuable summary of the key findings and highlights the hotspots of Metaverse in education. It also acknowledges the limitations and challenges reported by the authors and offers trends and future recommendations for educators and researchers. This chapter not only emphasizes

the pedagogical applications of the educational Metaverse but also invites readers to contemplate the broader implications of the book's topics, encouraging thoughtful engagement beyond the current applications.

In addition to the diverse range of topics covered in this book, I would like to highlight the HKUST Metaverse Classroom project that is currently being led by me and my team. It addresses the challenge of cross-campus teaching and learning between the HKUST campuses in Hong Kong and Guangzhou. To overcome this distance, the project proposes the adoption of virtual-physical blended classrooms in the Metaverse. The HKUST Metaverse classroom provides an intuitive and user-context environment for learners and educators, enabling effective communication among participants from various campuses. By leveraging the Metaverse, students, instructors, and speakers physically located in HKUST campuses or online can interact within the same activity, bridging the geographical gap and enhancing the learning experience.

In Fall 2023, the HKUST Metaverse Classroom project successfully launched the Metaverse Design Thinking course with students from both Hong Kong and Guangzhou campuses. This course demonstrated the potential of the Metaverse in facilitating cross-campus collaboration and creating immersive learning environments. This project serves as an inspiring example for educators and researchers seeking to explore the transformative power of the Metaverse in their own educational contexts, offering a blueprint for enhancing teaching and learning experiences across physical and digital environments.

In conclusion, the book *Application of the Metaverse in Education* is an important contribution to the field, bringing together a diverse range of perspectives and insights. I commend the editors and authors for their efforts in exploring the potential of the Metaverse in education. It is my hope that this book will inspire further research and collaboration, ultimately leading to the development of innovative and effective educational experiences in the Metaverse era.

Pan Hui
Chair Professor
Computational Media and Arts
Hong Kong University of Science and
Technology (Guangzhou)

Director
Center for Metaverse and
Computational Creativity
Hong Kong University of Science and
Technology (Guangzhou)

Chair Professor
Emerging Interdisciplinary Areas
Hong Kong University of Science and
Technology

Foreword by Dr. Maiga Chang

Metaverse has gained growing interest and attention from massive number of users recently. Although the term is not new, it has flourished again and has dominated as a new trend. The immersive nature of the Metaverse and technologies adopted opens several opportunities in education for learners and educators as well as challenges on the other side. This provoked stakeholders seeking to find answers on what will learning in the Metaverse look like? (Bauld 2022) Is Metaverse in education a blessing or a curse? (Tlili 2022), how can the Metaverse transform learning? (Misha 2023), how does the Metaverse shape education? (De Felice 2023), and should Metaverse for education in virtual or real? (Hussain 2023). Therefore, this book attempts to find answers on addressing the questions from both theoretical and practical perspectives. This book discusses the Metaverse applications in education including presenting conceptualization, educational Metaverse world, educational opportunities and resources, immersive learning design, metaversity, and inclusive Metaverse.

This book covers interesting topics of the Metaverse in education. It introduces the Metaverse as a new frontier for education and sheds light on broad views about education in the Metaverse. It also highlights the design of Metaverse world by showing examples of promising immersive environments. Therefore, this book can be of interest to a wide range of stakeholders, students, researchers, educators, instructional designers, school administrators, educational technology specialists, etc.

This book, *Application of the Metaverse in Education*, aims to demonstrate the research efforts and best practices for readers where immersive digital experiences meet the pedagogical landscape. It explores the ground-breaking impact of the Metaverse on educational practices, with a particular focus on its application in immersive student meetings and the realm of special education.

Readers will embark on a journey through the current landscape of Metaverse applications in education, including interdisciplinary conversation of the Metaverse in teaching and learning, analysis of insights by higher education practitioners, students learn using design thinking, instructional frameworks, models and taxonomies of immersive learning design in the Metaverse, ongoing projects on

multiversity and GUYUK Metaverse for Mongolian culture, immersive student meetings in the Metaverse, and Metaverse for students with disabilities. From virtual classrooms designed for diverse learners to the potential of immersive simulations for skill development, we will uncover the numerous ways in which the Metaverse is transforming the educational experience.

Chapter 1 “Metaverse Learning: A New Frontier for Education” introduces Metaverse conceptualization, then presents resources needed and educational opportunities of the Metaverse. The chapter emphasizes the advantages and limitations of the educational Metaverse at the end.

Chapter 2 ““At the Edge” of the Metaverse in Teaching and Learning: An Interdisciplinary Conversation” presents broad views about education in the Metaverse as a learning space and an autoethnographic analysis of insights by higher education practitioners in an open and distance e-learning (ODEL) university. It found an important tension between the possibilities and difficulties in using Metaverse and other related technologies in the Philippines and other developing countries through interesting collaborative conversation. This chapter answers the following questions: why is it necessary to conduct a critical dialogue about the role of the Metaverse in education? How do we perceive the role of the Metaverse in advancing our delivery in our respective fields as educators in higher education? The chapter provides thematic analysis to elaborate on an imaginative scenario that can occur in virtual environments to enhance the learning. At the end, the chapter discussed the results, emphasizing that the Metaverse can influence social and educational activities in the future.

Chapter 3 “Education in the Metaverse” defines the relationship between the virtual classroom, the importance of identity and shared presence, and how students learn using design thinking. The goals summarize the resources available to educators who wish to teach in 3D spaces, how design thinking strengthened the design of class simulations to support 58 classes and 800 8th-grade students as they studied in a virtual world, depicting the Design Studio Framework. The chapter provides some future research directions such as AI in the virtual worlds, the design of accessible spaces, and learning activities classifications that enhance the Metaverse design.

Chapter 4 “Immersive Learning Design in the Metaverse: A Theoretical Literature Review Synthesis” presents three strategic approaches for effective immersive learning design in the Metaverse in attempt to answer the following question: how should we design and organize education in the Metaverse? It also analyzes instructional frameworks, models, and taxonomies with the support of XR technologies. The chapter ends with theoretical and practical implications and recommendations for future work.

Chapter 5 “A Roadmap Toward Metaversity: Recent Developments and Perspectives in Education”. This chapter concisely discusses the recent developments of Metaverse campuses, primarily in higher education. Also, it summarizes and discusses the ongoing projects focusing on establishing virtual campuses and promoting virtual learning, i.e., the metaversity initiatives. The chapter also addressed some challenges, e.g., the issue of users lagging behind, which can be effectively mitigated through the implementation of advanced crowd control mechanisms, privacy concerns, difficulties in comprehending and effectively navigating the virtual event,

and other technical issues. Additionally, the authors recommend future solutions to overcome those challenges. For example, incorporating caching mechanisms to optimize performance, establishing a connection between each Head-Mounted Display (HMD) and its respective mobile companion application, establishing a connection between the headset and a computer, followed by the transmission of various commands via the Android Debug Bridge (ADB), and the implementation of joint collaborative sessions.

Chapter 6 “The Potential of the GUYUK Metaverse for Mongolian Culture and Traditions” introduces the GUYUK Metaverse, a nomadic Metaverse developed by Mongolians, which serves as a platform for disseminating knowledge and culture. The chapter develops to present features of the GUYUK Metaverse. Therefore, it seems a promising project serving the Asian culture in an immersive environment.

Chapter 7 “Meta-in or Meta-out of Students with Special Needs: A Systematic Review on the Use of Metaverse in Special Education” delves into inclusive Metaverse by conducting content analysis to identify Metaverse in special education. The chapter reviewed the related published literature aiming to identify the distribution of research on Metaverse in special education, the types of disabilities and level of education, the Metaverse technologies and tools adopted to meet each disability in special education, and challenges in the research on Metaverse in special education. The findings indicate that the problem of equal access is still prevalent in most of the studies and this problem can only be resolved when Metaverse platforms and devices are designed and developed based on the recognized needs and expectations of learners with disabilities and inclusive participation of all stakeholders.

Chapter 8 “Exploring Immersive Student Meetings in the Metaverse: Experiential Learning and Emergent Group Entitativity” describes a novel course design that utilizes the Metaverse as a learning and research environment to explore immersive meetings using virtual reality (VR) headsets to investigate attendee experiences, group participation, and emergent group entitativity as a key factor for interaction behavior in the Metaverse. The chapter applied experiential case study with 20 undergraduate students. The findings demonstrate that students without an academic background in technology or IT and a lack of prior experience using immersive technology were still able to quickly adapt to the new immersive setting. Low to moderate levels of task load and simulator sickness indicated a joyful immersive experience overall. Furthermore, the chapter addresses some implications with limitations and future work.

Finally, the last Chap. 9 “Application of the Metaverse in Education: Hotspots, Challenges and Future Directions” summarizes the book chapters and highlights the most interesting insights. Moreover, it provides some challenges and future directions in terms of implementing educational Metaverse.

Dr. Maiga Chang
Athabasca University
Edmonton, Canada

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Dr. Dejian Liu
Dr. Ronghuai Huang
Dr. Ahmed Hosny Saleh Metwally
Dr. Ahmed Tlili
Ms. Emma Fan Lin

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Chapter 1

Metaverse Learning: A New Frontier for Education



Jesús López-Belmonte, Santiago Pozo-Sánchez,
Antonio-José Moreno-Guerrero, and José-Antonio Marín-Marín

Abstract In the education sector, the metaverse offers the possibility of more immersive and authentic learning experiences, such as virtual field trips, simulations, and virtual collaborations and projects. The metaverse has the potential to revolutionize education by enabling educators to create more engaging and interactive learning experiences that can increase student engagement and achievement. The use of virtual reality and augmented reality in the metaverse can provide opportunities for students to explore and experience subjects in new and innovative ways. For example, students can explore historical sites and events, observe scientific phenomena, and practice language skills with native speakers from around the world. In addition to enhancing learning experiences, the metaverse can also improve access to education, particularly for learners who face geographic, economic, or social barriers to education. The metaverse can enable learners to access high-quality educational resources and experts from anywhere in the world, and participate in collaborative projects and discussions with peers from diverse backgrounds and cultures. However, the use of the metaverse in education also raises some potential limitations and challenges, such as the need for adequate technological infrastructure and resources, the development of effective pedagogical strategies and guidelines, and the protection of user privacy and security.

Keywords Metaverse · Immersive learning · Educational technology · Educational innovation

J. López-Belmonte (✉) · S. Pozo-Sánchez · A.-J. Moreno-Guerrero · J.-A. Marín-Marín
University of Granada, Granada, Spain
e-mail: jesuslopez@ugr.es

S. Pozo-Sánchez
e-mail: santiagopozo@ugr.es

A.-J. Moreno-Guerrero
e-mail: ajmoreno@ugr.es

J.-A. Marín-Marín
e-mail: jmarin@ugr.es

1.1 Introduction

The metaverse is a term that has been gaining popularity in recent years (López-Belmonte et al., 2023). It refers to a virtual world that is an extension of our physical world, but with its own set of rules, norms, and economies. It is a space where people can interact, collaborate, create, and engage in various activities using virtual reality, augmented reality, and other immersive technologies (López et al., 2022c).

The concept of the metaverse was first introduced in Neal Stephenson's 1992 science fiction novel *Snow Crash*, where he envisioned a virtual world that was accessible to anyone with a computer and an internet connection. Since then, the term has been used to describe various virtual worlds and online games, such as *Second Life*, *World of Warcraft*, and *Minecraft* (Novak, 2022).

However, the metaverse that is being talked about today goes beyond these virtual worlds and games. It is a fully immersive and interconnected digital universe that is being created by the convergence of various technologies, such as virtual reality, augmented reality, blockchain, artificial intelligence, and 5G (Tas & Bolat, 2022).

In this metaverse, people will be able to create their own avatars, or digital representations of themselves, and interact with others in a variety of virtual environments, such as virtual offices, shopping malls, concert venues, and even entire cities. They will be able to socialize, attend events, play games, and conduct business just as they would in the physical world, but with infinite possibilities and without the limitations of time and space (Sánchez Mendiola, 2022).

The metaverse is not just a place for entertainment and socialization, but also a new economy that is being driven by digital assets, such as virtual real estate, digital art, and cryptocurrencies. These assets can be bought, sold, and traded just like physical assets, but with the added benefits of decentralization, transparency, and immutability that come with blockchain technology (Getchell et al., 2010).

The metaverse is still in its early stages of development, but it has already attracted the attention of tech giants, such as Facebook, Google, and Tencent, who are investing billions of dollars in building their own versions of the metaverse. However, there are also concerns about the potential negative effects of the metaverse, such as addiction, privacy violations, and the widening of the digital divide (Sarıtaş & Topraklıkoğlu, 2022).

The metaverse is a virtual world that is being created by the convergence of various technologies. It is a space where people can interact, collaborate, create, and engage in various activities using virtual reality, augmented reality, and other immersive technologies. It is also a new economy that is being driven by digital assets, such as virtual real estate, digital art, and cryptocurrencies. While it has the potential to revolutionize the way we live, work, and play, it also comes with its own set of challenges and concerns that need to be addressed (López-Belmonte et al., 2022a).

The present chapter on the use of the metaverse in education will be structured as follows. Firstly, an introduction will be provided to contextualize the topic and highlight its relevance in the educational field. Next, the conceptualization of the metaverse will be addressed, exploring its key characteristics and functionalities. Subsequently, the necessary resources for utilizing the metaverse as a learning resource will be analyzed, detailing the required tools and technologies. Then, the educational opportunities offered by the metaverse will be examined, emphasizing its practical applications and benefits in teaching and learning. Additionally, both the advantages and limitations of the educational metaverse will be discussed. Finally, the chapter will conclude with the presentation of the chapter's conclusions, summarizing the key aspects discussed.

The motivation of this chapter lies in the need to explore the impact of the metaverse in education, adapting to the demands of digital students. The metaverse offers an immersive and collaborative environment, providing opportunities to transform teaching and learning processes. Its benefits include engaging and personalized educational experiences, as well as the simulation of practical scenarios. Sharing educational experiences in the metaverse is essential to learn from best practices and overcome challenges.

1.2 Metaverse Conceptualization

The metaverse has the potential to transform the way we learn and teach by providing a virtual environment that can enhance traditional classroom education or even replace it entirely (Tlili et al., 2022). In the educational context, the metaverse refers to a virtual space where students can interact with each other and with educational resources, such as textbooks, videos, simulations, and experiments, using immersive technologies such as virtual reality, augmented reality, and gamification (Getchell et al., 2010; Sarıtaş & Topraklıkoğlu, 2022).

One of the most significant benefits of the metaverse in education is that it can provide an engaging and interactive learning experience that can motivate students and enhance their understanding and retention of complex concepts (Ng, 2022). For example, a virtual simulation of a physics experiment can allow students to explore the principles of physics in a more interactive and engaging way than a traditional lecture or textbook (Alfaisal et al., 2022). Similarly, a virtual field trip to a historical site or a foreign country can provide students with a more immersive and culturally enriched learning experience (Dreamson & Park, 2023).

Moreover, the metaverse can also provide students with access to educational resources that may not be available in their physical classroom or school. For example, a student in a remote area can access the same high-quality educational resources as a student in a top-tier school, leveling the playing field and reducing the digital divide (Sun et al., 2022). Additionally, the metaverse can facilitate collaborative learning by enabling students to work together in virtual groups, regardless