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Transforming University Life with Virtual Reality: Campus 2.0 – MetaCBU

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Abstract

This study investigates the transformative potential of Virtual Reality (VR) and Extended Reality (XR) technologies in education, with a particular focus on the design and implementation of the MetaCBU virtual campus at Manisa Celal Bayar University. The primary research objectives are to examine how immersive VR platforms can enhance traditional educational methods by increasing student engagement, motivation, and collaboration, and to identify the technical and pedagogical challenges involved in their development. MetaCBU leverages advanced VR technologies to replicate and extend the capabilities of physical campuses, providing experiential learning opportunities that are otherwise difficult to achieve in conventional classrooms. Key challenges, such as optimizing system performance to mitigate issues like motion sickness and latency, were addressed using advanced rendering techniques, efficient server management, and iterative testing. The findings demonstrate that MetaCBU successfully integrates academic and social functionalities into a single platform, offering students a more interactive and engaging educational experience. The broader implications of this research suggest that VR and XR technologies are poised to revolutionize not only teaching methods but also the operational structures of educational institutions. Future studies are encouraged to explore the scalability of such platforms and their applications across diverse educational contexts and disciplines, ensuring that universities remain at the forefront of digital transformation. By addressing both technical and pedagogical dimensions, this study provides a comprehensive framework for the continued integration of VR in higher education.

Keywords: Artificial intelligence, Extended reality, Metaverse, Virtual classroom, Virtual reality.

1. Introduction

The rapid advancement of Virtual Reality (VR) and Extended Reality (XR) technologies has instigated a significant transformation in the development of virtual platforms, particularly within higher education. These technologies offer immersive and interactive environments that transcend the traditional boundaries of physical spaces, creating new opportunities for academic institutions to enhance both learning and operational processes. The COVID-19 pandemic further accelerated the adoption of digital transformation strategies, compelling universities to explore innovative virtual solutions to maintain and improve educational delivery and campus experiences [1].

Unlike other digital transformation approaches, VR provides a unique value by combining interactivity, immersion, and personalization. This positions VR as an unparalleled tool for fostering student engagement, creativity, and collaboration. Studies in Environmental Design Education (EDE) have highlighted how VR enables students to engage with complex design concepts in ways that conventional methods cannot, fostering problem-solving skills and enhancing experiential learning [2]. Similarly, in industrial operations, VR applications have demonstrated significant benefits in improving safety and operational efficiency, though these implementations also underscore the technical and organizational challenges of scaling such technologies [3].

A central challenge in implementing VR-based platforms in a university setting is the technical complexity involved in creating a scalable, multi-user environment that accurately replicates and enhances the physical campus. The design and development of such platforms require a meticulous integration of diverse software and hardware components to ensure high performance, user accessibility, and seamless interaction. This study focuses on the development of the MetaCBU virtual campus, a VR-based platform engineered to transform the traditional university experience by integrating cutting-edge VR technologies with academic and social functionalities. By leveraging advanced rendering techniques and robust server management, MetaCBU addresses common VR issues such as motion sickness and latency, creating an immersive and user-friendly experience.

The digital transformation of university environments through VR is not merely a conceptual exploration but a practical necessity, as evidenced by recent studies. While traditional online learning platforms often struggle to maintain engagement, VR offers unparalleled experiential opportunities that replicate and surpass physical classroom experiences. For example, VR has been shown to enhance deep learning and retention rates by creating interactive, multi-sensory environments that engage students in active learning [4].

MetaCBU exemplifies a comprehensive effort to address these challenges by creating a virtual campus that goes beyond merely replicating the physical university environment. The platform is designed to support a wide range of academic and extracurricular activities, from virtual classrooms to social spaces, thereby offering a holistic virtual campus experience. This study delves into the design and development process of MetaCBU, examining its potential to transform educational practices and how it addresses key challenges such as engagement, scalability, and accessibility. Furthermore, the innovative teaching strategies and collaborative learning opportunities provided by MetaCBU are explored in depth, positioning the platform as a model for future VR and XR applications in education.

The primary objective of this study is to comprehensively examine the potential applications of VR and XR technologies in education, with a particular focus on the virtual campus "MetaCBU" at Manisa Celal Bayar University. MetaCBU is designed as a multi-user learning environment based on VR and XR technologies. This study details the design and development process of MetaCBU and investigates how such a virtual campus can transform educational processes and what advantages it offers compared to traditional educational methods. Additionally, the study explores how the innovative teaching strategies, user interactions, and collaborative learning experiences provided by MetaCBU could shape future trends in VR and XR applications in education. In this context, the potential of MetaCBU to revolutionize the field of education and its applicability across various disciplines, including engineering, health sciences, physics, chemistry, and information technology, is thoroughly examined.

By addressing the technical challenges associated with creating a comprehensive and scalable VR platform, MetaCBU not only replicates but also enhances the traditional university experience. This study contributes to the growing body of literature on the digital transformation of higher education, offering insights into the design, development, and implementation of VR platforms that can serve as a blueprint for future initiatives in this field.

2. Theorical Framework

2.1. Virtual Reality

VR technology offers diverse applications that enable tracking of users' movements, thereby providing an immersive experience that significantly enhances user engagement [5]. As a rapidly emerging medium, VR and immersive technologies possess the potential to convey ideas and concepts in innovative ways [6]. The increasing sophistication of head-mounted display technologies is continually improving the perception of reality and seamlessly integrating virtual worlds into real life. VR is poised to revolutionize user interaction, paving the way for groundbreaking applications across various fields [6].

Recent studies have further emphasized the transformative role of VR in education, particularly in health sciences. For example, Kouame et al. [7] demonstrated that VR can be effectively utilized to provide immersive learning experiences in health sciences education, offering a unique opportunity for students to engage in experiential learning environments that traditional methods cannot replicate. This finding aligns with the broader trend of integrating VR into various educational domains, as reported by Zhao et al. [8] who highlighted that VR technologies are increasingly being adopted across diverse fields such as medicine, engineering, and the arts. The growing interest in VR's potential to enhance educational outcomes underscores the importance of continuous research and innovation in this area.

Given the ability of VR environments to effectively disengage users from their immediate reality, there has been growing scholarly interest in exploring the potential of this technology. Educational researchers have been investigating the transformative potential of VR technologies, highlighting them as cutting-edge tools for effective training and education [9, 10]. Moreover, Mc Dermott et al. [11] pointed out that immersive technologies, including VR, are not only enhancing the student experience but also addressing the challenges associated with traditional learning environments. As VR continues to evolve, it is expected to play a crucial role in shaping the future of education by providing more engaging, interactive, and effective learning experiences.

2.2. Benefits of VR

With the progress of human-computer interaction technologies, VR has been integrated into various fields, leading to the future of educational processes [12]. VR technology offers an effective method to reduce training time, minimize or prevent errors in the application process, and improve product quality [13]. The interaction, immersion, and imagination feature it provides have led to the creation of virtual environments to overcome the limitations of traditional educational processes [12]. The high level of interest in immersive VR technologies for educational purposes and the wide range of fields that incorporate VR into teaching processes support this situation [14]. For instance, virtual assembly activities have emerged as the primary application of VR technology in industrial production and manufacturing sectors [12]. On the other hand, using VR technology is suggested to improve students' collaboration and communication skills [14]. In fact, many researchers have presented cases that highlight the benefits of using VR in education. Some of these benefits are summarized below:

- VR supports peer cooperative learning [8, 14].
- VR fosters the development of learners' problem-solving abilities and the discovery of new concepts [15-18].
- VR significantly increases student motivation [19, 20].
- VR offers a high level of interaction [21, 22].
- VR enables learners to acquire knowledge with less effort compared to traditional learning environments [11, 23].
- VR makes teaching processes more realistic and secure [24].
- VR enhances the quality of education in engineering fields by providing students with intuitive, multi-sensory experiences that improve deep learning and application processes [25].
- VR offers potential for innovative applications in architecture and urban design education, enabling students to engage with design concepts in a virtual, interactive space [26].
- VR provides immersive experiential learning opportunities in health sciences, allowing students to practice and master skills in a safe and controlled virtual environment [7, 27].
- VR provides innovative assessment tools by enabling automated analysis of student-created content, allowing educators to evaluate learning outcomes with greater precision and efficiency [28].

In addition to these benefits, Geriş et al. [23] highlight that VR environments, when optimized for performance and comfort, can significantly enhance the overall educational experience. Their study emphasizes the importance of maintaining high frames per second (FPS) and low latency to minimize discomfort such as motion sickness, thereby improving user engagement and learning outcomes. The research also points out that optimizing batch processing and rendering techniques within VR can lead to more immersive and seamless experiences, which are crucial for maintaining student attention and fostering an effective learning environment. As VR technology continues to evolve, these technical optimizations are essential to fully realizing its educational potential.

2.3. Next Generation of VR

VR is an innovative technology that offers exceptional opportunities for science education by immersing students in a virtual world where students can engage directly with scientific phenomena [5]. Embodied VR devices intensify sensory stimulation, which in turn directly affects affective and behavioral responses [29]. However, it has been observed that in the development of VR applications in higher education, learning theories are often overlooked, and the evaluation of educational VR applications tends to focus mainly on their usability while the incorporation of VR-based learning activities into the curriculum is not adequately explained [14]. Furthermore, it is recommended that the issues pertinent to virtual reality technologies be taken into consideration, especially in educational settings [30].

In more recent developments, the integration of 360-degree learning environments and telepresence capabilities, supported by emerging 6G networks, represents the cutting-edge of educational technology. These innovations allow students to explore remote locations and complex environments as if they were physically present, significantly enhancing the realism and engagement of virtual learning [31]. Zhao et al. [8] further emphasize that the growing adoption of VR and AR across multiple disciplines, including education, medicine, and engineering, is revolutionizing the way educational content is delivered and experienced.

Recent advancements in XR technologies, encompassing XR, Augmented Reality (AR), and Mixed Reality (MR),

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are shaping the future landscape of education. These technologies collectively push the boundaries of traditional learning environments by merging elements of real and virtual worlds. XR technologies, which began with foundational VR platforms, have now expanded to include AR—overlaying digital content onto the physical world—and MR, which interactively merges real and virtual objects [32]. As these technologies evolved, their application in education has also grown, offering more immersive and interactive learning experiences [33]. Moreover, the integration of machine learning (ML) and business intelligence (BI) techniques into VR systems has provided new dimensions for data-driven educational experiences. By analyzing vast amounts of data generated within virtual environments, such as in the MetaPortal application developed at Manisa Celal Bayar University, these tools enable more personalized and effective educational interventions [34]. Similar approaches have been explored in other contexts, demonstrating how AI and ML can optimize VR experiences by enhancing user interactions and learning outcomes [35, 36].

3. Method

3.1. Design and Development Process

The development of the MetaCBU virtual campus follows a specific set of procedural steps, which are organized in a cyclical and iterative flowchart. Furthermore, the platform is continuously refined through multiple rounds of testing and expert feedback. A graphical representation of the MetaCBU virtual campus development process shown in Figure 1.

During the implementation of the MetaCBU project according to the phases depicted in Figure 1, an advanced hardware infrastructure was employed. The graphical processing unit (GPU) of the computer system used played a crucial role in this infrastructure, while the central processing unit (CPU) power also proved to be significant. Furthermore, various types of virtual reality headsets were employed to ensure platform integration. The hardware infrastructure utilized during the study is outlined below. However, it should be noted that it showcases the features required for the optimal design and development of a virtual reality-based system, rather than the features necessary to experience the platform:

- Computer: Intel i7 12700 CPU, 32GB RAM, NVDIA RTX 3080 12GB GPU, 1TB SSD.
- Oculus/Meta Quest 2: Qualcomm Snapdragon XR2 Platform, Single Fast-Switch LCD 1832×1920 px per eye, 72Hz (default), 6GB RAM.
- Oculus/Meta Quest 3:
- HTC Vive Pro: 1440 x 1600 px per eye, 90Hz (default), 110 degrees view, Dual OLED 3.5" diagonal panel.
- HTC Vive XR Elite: Qualcomm Snapdragon XR2 Platform, LCD RGB 1920×1920 px per eye, 90Hz (default), 110 degrees view, 12GB RAM.
- Pico 4: Qualcomm Snapdragon XR2 Platform, LCD Pancake lenses 2160×2160 px per eye, 90Hz (default), 105 degrees view, 8GB RAM.

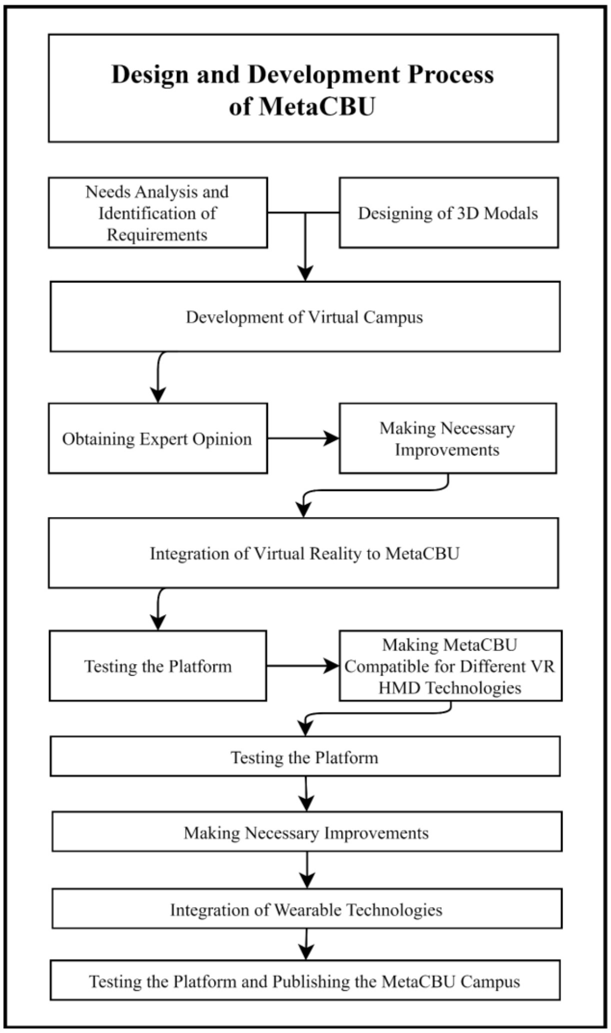

Figure 1. Design And Development Process of MetaCBU

In the fourth and fifth sections of this study, the technical infrastructure, and visual characteristics of the MetaCBU virtual campus are elaborated upon. The Visual Structure section encompasses a detailed description of the campus's visual properties, modeling techniques, and examples of screenshots taken from within the campus. On the other hand, the Technical Infrastructure section outlines the software, plugins, libraries, assets, and server information that were utilized during the development process of the virtual campus.

3.2. Visual Structure

The MetaCBU virtual campus was developed using the MetaCBU Unity Game Engine, while three-dimensional models integrated into the campus were created using programs such as Blender, Solidworks, and 3DSMax. Prior to the development of the virtual campus, a storyboard outlining the general structure of the campus was prepared during the needs analysis phase, and the design process was conducted accordingly. The virtual campus was designed to include various structures, such as academic units, classrooms, social areas, clinic, library, sports fields, and a conference center. The design process of these structures has been completed, and an overview of the general structure of the virtual campus can be seen in Figure 2.

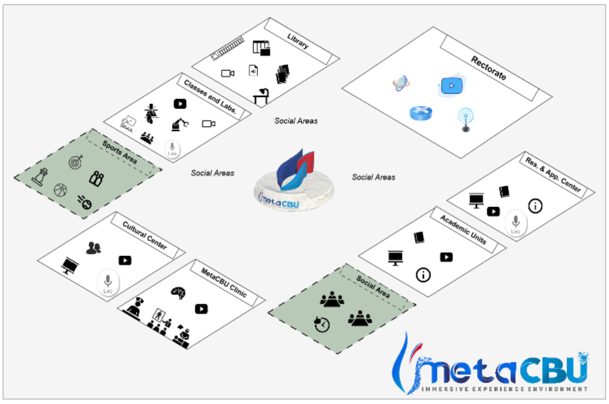

Figure 2. MetaCBU General Structure

The MetaCBU virtual campus serves as a convergence point for a multitude of university departments and systems. Among its many features are a central building which houses promotional units, classrooms, academic units, a library, social areas, a conference center, sports fields, and a clinic. The virtual campus is designed to be as authentic and realistic as possible, featuring a detailed, unit-based organization.

Figure 3. MetaCBU Library

Both live and pre-existing lectures can be accessed within the academic units and classrooms of the MetaCBU campus, with a plethora of educational materials will be integrated into the platform through 360-degree videos potentially. The library represents a critical component of the platform, where users can physically engage with books and enjoy unrestricted access to their contents in a database and cloud storage unit. This allows users to read PDFs of desired books while on the MetaCBU platform (Figure 3).

Figure 4. MetaCBU Screenshots

The MetaCBU campus has been designed to provide educational environments for a variety of academic units. One of the most significant components is the MetaCBU Clinic, which has been specifically developed for the field of health education. This feature includes a dedicated section for medical educators and students, allowing them to interact with various objects and incorporate different learning materials. The system also integrates models of various medical devices, instruments, organs, and non-living mannequins. In addition to academic units, areas that promote socialization and physical activity have been incorporated into the system. Examples of such areas include a chess playground, a conference center, and a basketball court. The accompanying visuals of these features are presented in Figure 4.

3.3. Technical Structure

The MetaCBU virtual campus is designed to be used in both virtual reality head-mounted displays and desktop mode. MetaCBU has been configured to work with Oculus, HTC, and Pico virtual reality glasses. In this process, the platform integrates several packages, including Oculus, SteamVR, OpenVR, Unity XR, and VRTK. Furthermore, MetaCBU has been optimized to work with numerous desktop computers. Additionally, the platform includes a multiplayer feature, allowing users to see what other participants are doing, communicate with them, or interact with them. To enhance the participants' sense of presence and integration into the environment, a realistic full-body avatar system has been integrated into the platform. This integration is achieved using the Ready Player Me avatar system and libraries, with Final IK and Unity Body System packages used to control the avatars and their skeletal systems.

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MetaCBU also incorporates a structure that allows participants to interact with many objects. To achieve this, numerous code libraries and packages have been utilized, particularly in facilitating interaction processes in the sports field, social areas, educational materials, and library. Packages such as Unity Interaction, Oculus, Tilia, and Zinnia have been integrated into the platform to provide various types of interaction. As a result, a multi-layered structure has been developed to support diverse interaction types. The technical structure of the MetaCBU platform is presented in Table 1.

Table 1. Technical Structure of MetaCBU

Specification	Package
Game Engine	Unity
Server	Photon, Photon Voice, Pun 2
VR / XR	Oculus, SteamVR, OpenVR, Unity XR, VRTK
Optimized HMD's	Oculus/Meta Quest 2, Oculus/Meta Quest 3, HTC VIVE Pro, HTC VIVE XR Elite, Pico 4
Interaction	Unity Interaction, SteamVR, Tilia & Zinnia, Unity XR
Avatar System	Ready Player Me
Avatar Controls	Final IK, Unity Body System
Modeling Tools	Blender, Solidworks, 3DS Max
Graphic Tools	Adobe Photoshop, Adobe Illustrator

During the development of the MetaCBU platform, careful consideration was given to the quality of the 3D models utilized and their impact on the system. To maximize the positive effects of the virtual reality environment on the participants, it is crucial to maintain an optimum Frame Per Second (FPS) value. Therefore, optimizing the processor latency and polygon values in the 3D models is essential for maintaining the desired FPS level. Special attention was paid to the polygon numbers of the 3D models used in the platform, and care was taken to ensure that they were developed and integrated into the platform without creating an excessive load on the system.

Various server structures were employed to enable multiplayer use of the MetaCBU platform, user registration, data collection, and interaction between users. Photon Server (S1), depicted in Figure 5, was used for the processes of registration, login, and inclusion of users in the MetaCBU campus. The platform's integration with the first server was achieved using Photon and Pun 2 infrastructure. All users included in the MetaCBU campus connect to this server, regardless of whether they are using a desktop or HMD. Server 1 facilitates multiplayer interaction within the virtual environment.

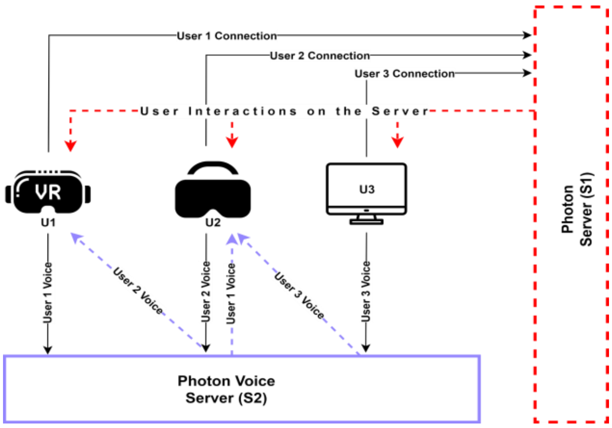

Figure 5. MetaCBU Server Structure

The second server structure (S2) is dedicated to facilitating voice-based communication between users. Unlike the first server, which utilizes the Photon infrastructure, S2 employs the Photon Voice infrastructure to enable voice interactions between users. Upon logging in to the first server, users are automatically logged into S2 as well. However, S2 is exclusively responsible for transmitting voice interactions between users.

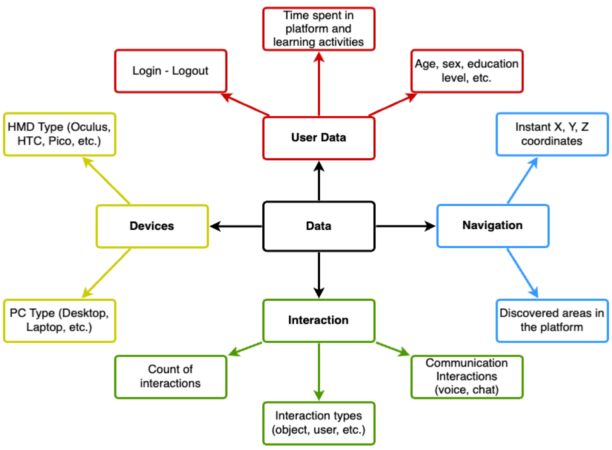

Figure 6. MetaCBU Data Types

The server infrastructure integrated into the MetaCBU platform enables the recording of various user variables, such as entry and exit records, interaction with objects or other users, duration of education, success rate, and location, in databases. By storing virtually all user actions in data warehouses with server connections, a significant data flow can be generated, and studies can be conducted to improve the platform. Additionally, the training materials provided on the platform can be customized and updated according to the user preferences, using the data obtained from the users within MetaCBU. Furthermore, the data collected from the users can be continually updated, and new additions or deletions can be made as necessary. Figure 6 displays some of the data information extracted from the current version of the platform.

4. Discussion & Implications

This study has explored the transformative potential of Virtual Reality (VR) and Extended Reality (XR) technologies within the educational landscape, with a particular focus on the development of the MetaCBU virtual campus at Manisa Celal Bayar University. The MetaCBU project offers a unique and innovative learning environment that has the potential to not only complement but also surpass traditional educational methods in several key areas. By leveraging the immersive and interactive capabilities of VR and XR, MetaCBU significantly enhances student engagement, motivation, and collaboration, providing experiential learning opportunities that are otherwise challenging to achieve in conventional classrooms.

The implementation of VR and XR technologies in educational settings marks a significant advancement in how immersive learning environments can be designed and utilized. These technologies have been demonstrated to provide students with highly interactive platforms that simulate real-world scenarios, thereby enhancing the overall learning experience. For instance, VR-based cooperative learning strategies have been shown to significantly improve student engagement and learning outcomes, particularly in disciplines requiring intricate spatial understanding, such as anatomy and engineering [37]. Similarly, VR's capacity for experiential learning has been validated in surgical training environments, where participants demonstrate improved retention and mastery of complex skills compared to traditional methods [38, 39]. Research consistently shows that VR and XR can significantly improve student engagement and learning outcomes by offering environments that traditional methods cannot replicate [14, 40, 41]. This study builds upon this foundation by systematically applying these advanced technologies to create comprehensive educational platforms that address the evolving needs of modern education.

However, the development of MetaCBU was not without its challenges. One of the key technical hurdles was ensuring optimal performance to prevent issues like motion sickness and latency, which are common in VR environments. Motion sickness, primarily caused by sensory mismatches between visual and vestibular cues, can be mitigated through advanced rendering techniques such as polygon optimization and maintaining high frame rates of 90Hz or above [42, 43]. Moreover, latency—a major contributor to simulator sickness—was addressed using robust server infrastructures and load balancing methods, achieving display update latencies below 20ms, which are critical for user comfort [44]. The integration of artificial intelligence to synchronize visual and vestibular cues has also emerged as a promising solution to reduce cybersickness in VR environments [45]. The platform's success in overcoming these challenges through the optimization of processing power and the careful management of 3D model rendering highlights the importance of technical precision in the development of immersive educational tools. This aspect of the project underscores the necessity for continuous refinement and adaptation of VR technologies to meet the high standards required for educational use.

Moreover, while the educational benefits of VR and XR are well-documented, this study also highlights the critical role these technologies play in transforming the infrastructure of educational institutions. The MetaCBU platform exemplifies how a well-designed virtual campus can offer more than just a replica of a physical university; it can create a dynamic and interactive space that enhances the educational process in ways that traditional campuses cannot. For example, MetaCBU fosters student collaboration and critical thinking by enabling immersive group activities that are difficult to replicate in physical settings [46]. Additionally, VR environments allow for safe, controlled practice of skills, such as medical procedures or engineering simulations, which would otherwise pose risks or logistical challenges [38]. The ability of VR and XR to provide multi-sensory, interactive learning environments represents a paradigm shift in educational methodology, where students are no longer passive recipients of information but active participants in their learning journey.

The integration of XR in various disciplines, particularly engineering and health sciences, has shown to significantly enhance the retention of complex concepts by allowing students to engage with practical lessons in a controlled virtual environment. In these settings, students report higher levels of motivation and satisfaction due to the immersive nature of the learning experiences, which traditional methods often fail to achieve [37, 39]. This aligns with broader educational trends, where XR technologies are increasingly being adopted to support interdisciplinary learning, providing a more holistic educational experience [47, 48]. Furthermore, recent advancements such as the XR Vest and e-skin technology have expanded the boundaries of immersive learning by integrating tactile, thermal, and olfactory sensations, thereby bridging the gap between physical and virtual worlds [49, 50].

In addition to these technological advancements, the use of VR and XR in education has been systematically optimized through the integration of learning analytics, which provides actionable insights into the learning process. This integration enables educators to tailor educational experiences to individual student needs, thereby enhancing learning effectiveness and providing new opportunities for research and practice [17]. The theoretical frameworks supporting the use of VR and AR in STEM education further reinforce the value of these technologies in enhancing cognitive skills and learning outcomes [51].

However, it is important to acknowledge the limitations of this study. The scalability of MetaCBU and its broader applicability across different educational contexts remain areas for further exploration. Additionally, while the technical challenges were successfully addressed, ongoing developments in VR and XR technologies necessitate continuous updates to the platform to incorporate new features and maintain high levels of user engagement.

Overall, the findings of this study not only highlight the current impact of VR and XR technologies on educational practices but also suggest a promising future where these technologies could become integral to the development of more effective and engaging educational environments. The continued exploration and integration of VR and XR in education are likely to lead to significant advancements in how we approach teaching and learning across various disciplines, offering new opportunities to enhance the educational process in ways previously unimaginable.

5. Conclusion

This study has demonstrated the significant potential of Virtual Reality (VR) and Extended Reality (XR) technologies in transforming the educational landscape, particularly through the development and implementation of the MetaCBU virtual campus. By providing an immersive and interactive environment, MetaCBU has shown the ability to enhance student engagement, motivation, and collaboration—elements that are often limited in traditional educational settings. The successful integration of these technologies into a multi-user, virtual campus highlights their capacity not only to replicate but also to extend the capabilities of physical educational environments.

The technical challenges encountered during the development of MetaCBU, such as optimizing system performance and ensuring user comfort, underscore the complexity of creating scalable and effective VR platforms. However, the solutions implemented in this study, including advanced rendering techniques and robust infrastructure management, provide a valuable blueprint for future projects seeking to incorporate VR and XR technologies into educational frameworks.

Moreover, the implications of this study extend beyond the immediate application of MetaCBU, offering insights into the broader potential of VR and XR technologies across various disciplines. The findings suggest that these technologies are poised to play a crucial role in the future of education, enabling more personalized, engaging, and effective learning experiences. As educational institutions continue to explore digital transformation, the integration of VR and XR will likely become a central component of innovative educational strategies.

Looking ahead, further research is needed to explore the scalability of platforms like MetaCBU and their applicability across different educational contexts. Additionally, ongoing advancements in VR and XR technologies should be continuously monitored and integrated to maintain the relevance and effectiveness of these virtual environments. By embracing these emerging technologies, the education sector can unlock new possibilities for teaching and learning, ultimately shaping a more dynamic and accessible educational future.

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Author’s Contributions

Barış Çukurbaşı: Supervised the experiment’s progress, result interpretation and helped in manuscript preparation.

Ali Geriş: Drafted and wrote the manuscript, performed the experiment and result analysis.

Orkun Teke: Assisted in analytical analysis on the structure and helped in manuscript preparation.

Murat Kılınç: Assisted in analytical analysis on the structure and helped in manuscript preparation.

Ethics

There are no ethical issues after the publication of this manuscript.

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