

The Metaverse empowers the Research, Study, Culture and Tourism Industry: Value, Challenges and Future Trends

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Abstract: With the development of digital technology, the metaverse moves from concept to application, presenting new opportunities for the study, culture and tourism industry. This article examines the value, challenges and future direction of the metaverse in empowering this industry. In terms of value, the metaverse innovates learning experiences, enables "immersive" learning interaction and integration, deepens knowledge practice with professional tools, and promotes collaborative exploration through virtual social platforms; Optimize the allocation of educational resources, with intelligent virtual mentors and real teachers working together, and resource sharing platforms breaking the limitations of time and space; Expand the space for industrial development, break through the limitations of time and space, attract investment and give birth to new business forms. However, it faces technical bottlenecks such as insufficient graphics and data processing capabilities, high cost and poor experience of hardware equipment; Conceptual biases, with some groups equating it with games, and educators worried about over commercialization; Policies and regulations are incomplete, and there are deficiencies in data security, virtual content regulation and industry standards. In the future, metaverse empowerment of the study, culture and tourism industry will be driven by technological innovation, including increased investment in research and development, innovation of hardware equipment, and promotion of technology integration; Conceptual renewal and practical exploration, building cognitive systems. Exploring application models, and conducting pilot projects; Policy guarantee and regulation of development, formulation of special regulations, strengthening of platform supervision, formulation of industry standards, promoting healthy and sustainable development of the industry.

Keywords: Metaverse; Study, Culture and tourism industry; Value; Challenge; Future.

1. Introduction

With the rapid development of digital technology, the metaverse is gradually moving from concept to practical application. The term "metaverse" is derived from "Snow Crash" by American science fiction master Neal Stephenson. At the beginning of the 20th century, with the rise of a new generation of information technologies such as artificial intelligence, mixed reality, big data and cloud computing, the metaverse has been widely applied in all aspects of social life and has brought a new era to education [1]. From the four levels of "virtual representation", "virtual simulation", "virtual-real integration", and "virtual-real integration", it has expanded the temporal and spatial boundaries of teaching and brought about profound changes [2] in teaching scenarios, teaching interactions, and teaching methods. In 2022, Xu Xu and Chen Shi, from a hermeneutic perspective, proposed that geography teaching in the context of the metaverse could rethink the concept of human-land harmony, improve practical geographical abilities, and use computer technology to promote the improvement of students' comprehensive thinking abilities [3]. Later, some discussions based on digital education theory explored the role of the educational metaverse in the reform of middle school geography curriculum from a more macroscopic perspective. To better enable the metaverse to empower geography education, existing research has proposed a new perspective, namely contextualized learning [4] in geography teaching assisted by the metaverse.

2. The Value of Empowering the Study Travel and Cultural Tourism Industry with the Metaverse

2.1. Innovative Learning Experience

The research and study metaverse, with virtual reality technology at its core, completely overturns the traditional interactive model of learning and research, achieving a deep integration of "immersive" learning and interaction. Students step into highly realistic virtual geographical environments, as if they were in real scenes. They can "climb" to the top of snow-capped mountains to overlook the movement of glaciers, or "travel through" rainforests to trace the course of streams, observing the topographical and geomorphic features of different regions in detail. At the interactive experience level, the research and study metaverse integrates cutting-edge technologies such as gesture recognition, visual tracking, and haptic feedback. When students reach out to touch virtual rocks, their fingertips can truly feel the rough texture; when zooming in to observe geological faults, the 3D models respond to the operation in real time. The coordinated stimulation of multiple senses closely couples students' perception and cognition of the geographical environment with the environment itself, forming a comprehensive learning experience.

With the help of professional tools in the metaverse, students can become "geodesigners" and freely adjust terrain heights, modify climate parameters, and even simulate urban planning schemes. Through continuous debugging and optimization, the ideal geographical environment is gradually

formed, and the knowledge is deepened in practice. In addition, the virtual social platform breaks down the barriers of space, and students can form study groups, observe the terrain and discuss solutions collaboratively online, and collide with sparks of ideas in interactive sharing, making research a group exploration journey full of fun and creativity.

2.2. Optimize the Allocation of Educational Resources

In the metaverse research environment, intelligent virtual tutors and real teachers build a new education ecology of "human-machine collaboration". Relying on a huge knowledge graph, virtual tutors can instantly integrate interdisciplinary knowledge such as geography, history, and physics. When students explore the murals in the virtual Dunhuang Grottoes, the virtual instructor can not only explain the chemical principles of color pigments, but also connect the trade routes and cultural exchanges at that time, making up for the blind spots of real teachers' knowledge. Real teachers, on the other hand, focus on emotional guidance and personalized inspiration, which complement each other to promote the accurate matching of educational resources to the needs of students, so that each student can obtain customized learning paths, and accelerate knowledge transformation and thinking upgrading.

The metaverse resource sharing platform is to break the shackles of time and space of educational resources. In the platform, resources such as high-precision global terrain sand tables, 3D restored historical scenes, and dynamically simulated scientific experiment models are readily available [8]. Whether it is students in remote mountainous areas or teachers and students in key universities, they can freely access the required information through virtual terminals. Teachers can quickly build thematic research scenarios based on platform resources, and students can also independently combine resources to carry out exploration. This sharing model allows high-quality educational resources to break through regional and inter-school restrictions, and children in remote areas can also "walk" into the Forbidden City to observe the details of cultural relics, achieving a win-win situation of educational equity and resource innovation.

2.3. Expand the Space for Industrial Development

The metaverse has opened up a new dimension of development for the research, culture, and tourism industry. With the help of digital technology, research products such as virtual Dunhuang research and polar ecological exploration have broken through the time and space limitations of traditional offline activities. Whether in a remote mountainous area or a bustling city, students and tourists can log in to the metaverse platform at any time, follow a virtual guide through thousands of years of history, or go deep into the polar regions to observe glacial landforms, which greatly expands the scope of the industry's audience.

Innovative metaverse research projects have become the focus of capital's attention. Companies can attract investors with a unique sense of experience by building immersive virtual research scenarios, such as recreating the trade boom of the ancient Silk Road and simulating space exploration missions. These investments not only help project development, but also promote the development of the industry in multiple directions such as popular science education, cultural communication, and scientific and

technological experience, forming a complete industrial chain covering content production, platform operation, hardware equipment and other links, and creating considerable economic benefits.

The in-depth integration of the metaverse and research and cultural tourism has given birth to a series of new business formats. Virtual study trips allow participants to "visit" World Heritage sites without having to travel long distances; The digital cultural experience project uses holographic projection, motion capture and other technologies to allow users to incarnate historical characters and immerse themselves in the charm of traditional culture. These new forms of business not only enrich the industrial expression, but also enhance the competitiveness of the industry through technological innovation, attract more young people to participate, and inject a steady stream of vitality into the sustainable development of the research, cultural and tourism industry.

3. The Metaverse Empowers the Challenges Faced by The Research and Cultural Tourism Industry

3.1. Technical Bottlenecks

The application of the metaverse in the field of research, research, culture and tourism is still restricted by technical bottlenecks. To construct complex scenes such as virtual Zhangjiajie peaks and simulate the ecology of the Amazon rainforest, tens of thousands of polygons and dynamic light and shadow need to be rendered per second, but the current graphics processing technology is difficult to balance detail and efficiency [8]. For example, the rock texture of the virtual mountain is prone to jagged and blurred after magnification, and the refraction effect of the water flow is stiff, which is obviously different from the real environment. At the same time, data processing capabilities have become another high wall, when hundreds of students enter the metaverse classroom at the same time, the server needs to process massive data such as motion capture and environmental interaction in real time, and ordinary network bandwidth and hardware devices often lag, delay, and even cause scene crashes, seriously weakening the immersive learning experience.

The cost and experience defects of hardware equipment also hinder the promotion of metaverse research [9]. A set of professional-grade VR headsets costs more than 10,000 yuan, and the supporting high-performance computer equipment is even more expensive, making it difficult for most schools and research institutions to afford large-scale procurement costs [10]. In addition, the comfort and portability of existing devices are not good, heavy headsets can easily cause discomfort such as dizziness and indentation when worn for a long time, and some devices have poor heat dissipation, and the body is hot when used continuously, forcing learners to interrupt the experience frequently. These problems not only increase the difficulty of project implementation, but also limit users' long-term in-depth participation in metaverse research activities, and urgently need technological breakthroughs and product iterations.

3.2. Perception Biases

The novelty of the concept of the metaverse has caused its application in the field of research, culture, and tourism to encounter cognitive barriers. Some schools and parents simply equate the metaverse with virtual games, believing

that children "visiting" the ancient Egyptian pyramids and "climbing" virtual Mount Everest in virtual scenes are just entertainment and pastimes, and cannot replace the learning effect of field trips. Some parents once questioned: "How can 'walking' the museum in front of the screen be compared to seeing the cultural relics with your own eyes?" This misunderstanding makes them hesitant about the metaverse research project, and they are more inclined to choose the traditional research model.

The excessive hype of the metaverse concept in the early stage has also exacerbated the controversy in the field of education. Some educators have witnessed the popularity of the metaverse concept in the capital market and are worried that education will become a tool for commercial profit. They are worried that once the research of the metaverse is dominated by capital, the curriculum design may overly pursue sensory stimulation, while ignoring the systematization of the knowledge system and the achievement of educational goals. The person in charge of an educational institution said frankly: "If the metaverse research becomes a gorgeous 'digital coat', but loses the core of education, it will deviate from the original intention of research." This wait-and-see attitude makes it difficult for the metaverse research project to obtain strong support in curriculum development, teacher training and other links, delaying its landing and healthy development in the research and cultural tourism industry.

3.3. Policies and Regulations Are Not Perfect

The vigorous development of the metaverse in the research, cultural and tourism industry has exposed a huge gap in data security protection. In the virtual research classroom, the platform not only collects basic information such as students' names and ages, but also records their learning progress, interaction habits, and other behavioral data [11]. However, the current regulations have not yet formulated detailed rules for the full lifecycle management of data in the metaverse scenario, resulting in scattered data storage and ambiguous permission management. In the event of a hacker attack or internal data leakage, students' personal privacy may be maliciously trafficked, or even become the target of precision fraud, which seriously threatens the physical and mental health of minors.

The regulatory gap for virtual content is equally worrying. In some metaverse research scenarios, due to the lack of real-time censorship mechanism, it may be mixed with violence, vulgar and bad elements, or spread unverified historical rumors and erroneous scientific knowledge. When students are immersed in the virtual world, these harmful information can easily mislead cognition and distort values, especially causing unpredictable harm to young people who lack discernment.

The lack of industry standards has led to chaos in the market. Due to the lack of unified technical specifications, content moderation standards, and educational effect evaluation systems, the quality of metaverse research products launched by different companies varies greatly [12]. Some products have rough pictures and stuck interactions, which cannot achieve teaching goals; Others are excessively entertaining, alienating serious research activities into "video games". This kind of disorderly competition not only harms the rights and interests of consumers, but also hinders the industry from moving towards specialization and standardization.

4. The Metaverse Empowers the Future Direction of The Research and Cultural Tourism Industry

4.1. Technological Innovation Drives Development

Increasing investment in R&D of metaverse support technologies is the key to promoting the upgrading of the research, research, cultural and tourism industry. The government and enterprises can jointly set up special funds to focus on core areas such as virtual reality, augmented reality, artificial intelligence, and blockchain, and encourage universities and scientific research institutions to carry out industry-university-research cooperation [13]. For example, artificial intelligence algorithms are used to optimize graphics rendering to make the rock texture, light and shadow changes in the virtual scene closer to reality. A distributed data storage system is built through blockchain technology to ensure the security of user data and improve processing efficiency.

In terms of hardware equipment innovation, efforts should be made to overcome the contradiction between performance and cost. The R&D team can learn from technologies such as flexible screens and lightweight materials to design more ergonomic headsets to reduce the discomfort of long-term wear. At the same time, the 5G/6G network transmission protocol is optimized to achieve millisecond-level response to virtual scenes, completely eliminating picture delay. In addition, to reduce the cost of equipment production, it is necessary to introduce a large-scale production model, and through technology iteration and supply chain optimization, the price of high-end VR equipment will gradually become more accessible to the people, and help the popularization of metaverse research projects.

Technology integration and innovation provide fertile ground for the development of high-quality research products. Combining high-precision geographic information systems with the metaverse, students can observe global terrain changes in real time; Using the digital technology of historical and cultural resources, cultural relics such as terracotta warriors and horses, Dunhuang murals and other cultural relics can be "resurrected" in a 3D dynamic form. By integrating multiple technologies and building a highly customized virtual research environment, it can not only meet the needs of geography for field investigations, but also create immersive scenes for historical and cultural learning, truly realize teaching according to their aptitude, and stimulate students' interest in learning and enthusiasm for exploration.

4.2. Concept Renewal and Practical Exploration

Schools, research institutions, and education departments need to build a systematic metaverse cognitive system, and deeply analyze the core value of the metaverse in the field of education by organizing special training, academic seminars, etc. Educators should move away from the stereotype of "virtuality as entertainment" and understand its "embodied learning" from the perspective of cognitive science, such as in a virtual chemistry lab, where students can observe microscopic molecular reactions through simulations, which can significantly improve knowledge absorption.

In the exploration of application modes, it is necessary to closely follow the educational objectives for scenario design. Taking historical and cultural education as an example,

a "time travel" metaverse project can be created: students wear VR devices to become literati in the Tang Dynasty, participate in the imperial examinations and observe the Silk Road trade in the virtual streets of Chang'an City, and understand the social logic behind historical events through first-person interaction. At the same time, the Department of Geography can develop a "Global Geomorphological Exploration" scenario to allow students to compare the formation mechanism of karst landform and Danxia landform in a virtual environment, so as to achieve the deep integration of theory and practice.

The pilot project is the key to verifying the feasibility of the metaverse study. Some schools were selected to carry out small-scale practices, such as organizing more than 100 students to participate in the "Dunhuang Digital Cave" study, collecting learning effect data through real-time feedback, and evaluating the actual role of virtual scenes in knowledge mastery and interest stimulation. Use the results of the pilot to create a demonstration case to show educators how metaverse research can break through the limitations of traditional teaching; At the same time, through the Parent Open Day, parents can experience the virtual classroom first-hand and dispel doubts about its educational value. We will continue to optimize product details based on the feedback from the pilot, polish everything from scene fluency to content professionalism, and gradually promote the metaverse research from pilot to large-scale application.

4.3. Policy Guarantee and Standardized Development

The relevant authorities need to use existing laws such as the Cybersecurity Law and the Data Security Law as the cornerstones, and formulate special regulations based on the characteristics of the metaverse research and cultural tourism industry [14]. The minimum necessary principle of data collection is clearly stipulated, requiring enterprises to only collect user information directly related to research activities, and to realize the traceability of the whole process of data through blockchain technology to ensure the security of data storage, transmission, and use [15]. Establish a hierarchical and categorical data protection system, implement encrypted storage and strict access management of students' sensitive information, and prevent the risk of data leakage.

At the level of platform supervision, we will build a joint review mechanism with multi-departmental coordination, use artificial intelligence algorithms to monitor and filter the content of the metaverse platform in real time, and intercept the spread of violent, vulgar and other negative information in a timely manner. At the same time, a code of conduct for the virtual world is established to regulate the interaction behavior of users in the virtual scene, and clearly prohibit the dissemination of false information, malicious attacks and other behaviors that violate ethics and morality, so as to create a healthy research environment.

The formulation of industry standards is the key to the standardized development of the industry. Relevant departments should work with education experts, technical teams, and business representatives to develop unified standards covering dimensions such as the achievement of educational goals, technical performance indicators, and content review processes. For example, it is stipulated that the historical and cultural content of virtual scenes must be certified by an authoritative organization, and the graphics rendering accuracy must meet the requirements of a specific

frame rate. Carry out regular special inspections of the market, force products that do not meet the standards to be removed from the shelves for rectification, guide enterprises to increase R&D investment, promote the upgrading of metaverse research products in the direction of specialization and quality, and promote the sustainable development of the industry.

5. Conclusion

The metaverse empowers the research, cultural and tourism industry, and has important values such as innovating learning experiences, optimizing the allocation of educational resources, and expanding industrial development space. It brings students an immersive learning experience, breaks the time and space constraints of educational resources, promotes the diversified development of industries, and creates new economic growth points. However, at present, the development of the industry is facing challenges such as technical bottlenecks, conceptual cognitive biases, and imperfect policies and regulations, which restrict the application and promotion of the metaverse in the field of research, culture, tourism, etc.

Looking forward to the future, the development of the metaverse-enabled research and cultural tourism industry needs to be coordinated from three aspects: technological innovation, concept renewal and policy guarantee. Improve the quality of virtual scenes and user experience by increasing investment in technology research and development, promoting hardware equipment innovation and promoting technology integration and innovation; Build a metaverse cognitive system, explore application models and carry out pilot projects, update educational concepts, and promote the development of practice; Formulate special regulations, strengthen platform supervision and improve industry standards, and provide a solid guarantee for the healthy development of the industry. If we can effectively respond to the challenges and give full play to its advantages, it will bring new development opportunities to the education and cultural tourism industry, promote the research and cultural tourism industry to move in an innovative, efficient and sustainable direction, and achieve a win-win situation between educational value and industrial value.

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