

Metaverse Empowers Gamified Teaching: Innovative Applications, Realistic Challenges, and Coping Strategies

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Abstract: As a virtual shared digital space built based on the real world, the Metaverse integrates a variety of cutting - edge technologies. It brings new teaching models and learning experiences to the field of education, and in particular, provides a realistic possibility for the further development of gamified teaching. The innovative applications of Metaverse - empowered gamified teaching include the transformations from "single perception" to "multi - dimensional immersion", from "passive acceptance" to "active creation", and from "individual learning" to "collaborative symbiosis". Although the Metaverse provides a broad space for educational innovation, it also faces challenges such as technological limitations, educational dilemmas, social ethics, and addiction risks. The article proposes a series of countermeasures, aiming to solve technical problems, improve the quality of education, attach importance to ethics, and safeguard students' mental health, so as to promote the healthy development of gamified teaching in the wave of the Metaverse.

Keywords: Metaverse, Gamified Instruction, Innovative Applications, Challenges.

1. Introduction

Metaverse, a concept that integrates a variety of emerging digital technologies, is closely related to technologies such as extended reality and digital twins, and aims to build a virtual shared digital space based on the real world. Currently, the fields involved in the Metaverse are expanding and bringing about many remarkable changes. Among them, the field of education is an important position for Metaverse to show its unique value. In recent years, Metaverse has initially changed the traditional teaching mode, provided students with a more immersive and interactive learning experience, and provided a new opportunity to build a high-quality education support system, and to promote the digital transformation and intelligent upgrading of education in the future^[1].

At the same time, the urgent needs of the education sector are clearly visible at the time of new technological changes. The traditional teacher-centered education model can hardly adapt to the urgent demand for personalized talents in the new era, and the learner-centered education model is gradually gaining wide recognition^[2]. With the strong impetus of the technological revolution and the urgent need for educational change, it is the right time for Metaverse to empower education.

It is worth noting that the possibilities that the Metaverse brings to educational innovation can be especially highlighted in the context of gamified teaching. The gamified teaching empowered by the Metaverse has significant advantages in building personalized teaching and ubiquitous learning mechanism.

Therefore, it is of vital significance to study the innovative applications and challenges of gamified teaching under the wave of Metaverse. We should be clear about the potential of Metaverse-enabled gamification teaching in contextualized teaching, personalized learning and other aspects of multi-dimensional innovative applications. At the same time, we also need to pay close attention to the challenges brought by the empowerment process, and on the basis of which we

should put forward effective coping strategies, so as to open up new ideas for the change of education and the application of gamified teaching in the new era.

2. The Concept of Metaverse and its Application in Gamified Teaching and Learning

Metaverse, as a much-anticipated emerging concept, is bringing about profound changes in various fields with unprecedented momentum. In the field of education, especially in gamification, Metaverse shows a very broad development prospect. It brings brand-new opportunities for gamification teaching and is likely to become the core force driving the innovative development of gamification teaching. Before exploring the innovative application of Metaverse in gamification and the challenges it faces, we first need to have a clear understanding of the concept of Metaverse and a comprehensive overview of the application of Metaverse in gamification, so as to better grasp the development of the fusion of this emerging technology and teaching mode.

2.1. The Concept of Metaverse and its Current Development

The concept of a Metaverse did not come out of nowhere, but was generated by a long-term drive of technological development^[3]. Its origins can be traced back to the concepts of "Metaverse" and "avatar" introduced in Neal Stephenson's 1992 science fiction novel *Snow Crash*^[4]. This suggests that the concept of Metaverses has existed for at least a few decades, but it is only in recent years, with the advancement of technology, especially virtual reality and artificial intelligence, that Metaverses have begun to receive widespread attention and develop rapidly.

In a narrow sense, Metaverse is a new type of business represented by 3D embodiment; in a broader sense, it is the concept of fusion of the virtual and the real, representing people's imaginations and thoughts on the higher-order

development of digitization^[5]. Metaverse is a complex and ever-evolving concept, the core of which lies in the realization of a deep fusion of the virtual and the real through technological means to provide users with a persistent, immersive, and highly interactive digital space^[6].

The Metaverse is characterized by two main features: civilization and intermingling^[7]. It is not only a virtual world, but also a complex system consisting of the integrated use of multiple digital technologies. It is not only a virtual world, but also a complex system consisting of the integrated use of multiple digital technologies. The characteristics of the Metaverse include, but are not limited to, immersive experiences, real-time interaction, high customizability and the ability to generate user-generated content. In addition, the Metaverse emphasizes the concept of virtual-reality symbiosis, i.e., the seamless interface and interaction between the virtual and real worlds^[8].

Currently, in the field of education, the Metaverse plays a crucial role. The development of Metaverse technology, especially the maturity of 5G, virtual reality and other technologies, has facilitated the creation of educational Metaverses and helped the deep integration of Metaverses with educational practices^[9]. Especially in gamified teaching, it shows great potential for development. For example, data analysis and artificial intelligence technology in Metaverse can help teachers better understand students' learning behaviors and needs, thus realizing personalized teaching and improving the effect of gamified teaching^[10]. In addition, it provides a richer and more authentic learning experience by creating an immersive virtual environment in which students can explore, interact and learn.

2.2. Gamified Teaching

Gamified teaching is a teaching method that applies game elements and mechanisms to the teaching and learning environment in order to enhance learning efficiency and effectiveness. Gamification teaching is not just a simple recreational activity, but a teaching strategy that can stimulate students' interest, enhance their motivation to learn, improve their cognitive ability and promote the internalization of knowledge^[11].

Gamified teaching has many advantages. It makes the learning process more engaging by introducing elements such as competitions, challenges and rewards, thus increasing students' interest in learning^[11]. In addition, a gamified environment can stimulate students' intrinsic motivation and make them more active participants in the learning process. Through interaction and problem solving in games, students are also able to better understand and master knowledge through practice. At the same time, many educational game designs require teamwork and communication, which helps students develop these important social skills during the learning process^[12].

The theoretical foundations of gamified teaching mainly include constructivism, self-determination theory, mind-flow theory, and multiple intelligence theory. Constructivist learning theory believes that knowledge is constructed through the process of interaction between the learner and the environment, and gamified teaching promotes students' active exploration and knowledge construction by providing rich learning contexts^[13]. Self-determination theory emphasizes that satisfying an individual's sense of autonomy, competence, and belonging is key to promoting their intrinsic motivation. Gamified instruction meets these needs by giving students

more choice and control^[14]. Mindstreaming is a mental state that people show when they focus on a certain behavior. When they are in the state of mindstreaming, they will be fully concentrated and engaged, and filter out irrelevant perceptions, and their sense of time will change, which is usually accompanied by a high level of excitement and a sense of fulfillment. Gamified teaching helps students enter the state of mindfulness by designing challenging and skill-matched tasks to enhance learning^[15]. The theory of multiple intelligences proposes multiple types of human intelligence, including logical-mathematical intelligence, spatial intelligence, etc. Gamified teaching can activate and cultivate students' multiple intelligences at the same time through diversified game activities^[15].

3. Innovative Applications of Metaverse-empowered Gamified Teaching

3.1. From “Single Perception” to “Multi-Dimensional Immersion

The shift from single perception to multidimensional immersion is an important development direction for the application of Metaverse technology in the field of education. This shift is not only reflected in the technical level, such as the application of virtual reality (VR), augmented reality (AR) and mixed reality (MR), but also in the profound change of the educational model and learning experience.

In the field of gamified teaching, the development of Metaverse technology has transcended the single perception mode of vision and hearing that traditional gamified teaching relies on, and realized the evolution from desktop virtual reality to immersive virtual reality, extended reality, and Metaverse. This technological advancement has made it possible to create a new form of spatial and temporal “co-presence” in online education, generating intelligent online learning environments. In addition, the key technological applications of 5G and AR have brought about a “mind-body-situation” learning experience for immersive learning, injecting new momentum into immersive learning^[16].

Meanwhile, research and practice of VR/AR/MR interactive teaching have shown that these technologies can visualize abstract scientific concepts, breaking through traditional teaching and making teaching and learning more intuitive. For example, the children's mathematical thinking puzzle game “22/7 Kube Street”, which won the Silver Award in the VR Game Category of the 2020 Qualcomm XR Innovative Application Challenge, creates a cozy house for children to explore freely, which enhances their interest in learning and helps them learn and train their minds. The AR “Magic Scribble Book” of Mirage Technology utilizes AR technology to scan the pattern to make the animals 3D and interactive, and the children can also scribble and display it through AR. MR intelligent courses are applied in multiple disciplines, and in geography learning, students wear MR glasses as if they were in the space to see the earth and understand the rotation of the rotation, which realizes the knowledge and solves the problem of spatial imagination, and combines with the textbook to turn the boring knowledge into the virtual reality image to stimulate the students' desire to learn, and so on. It stimulates students' desire for knowledge and enables them to operate with their hands, observe from multiple angles, and absorb knowledge in depth in the game

exploration.

To sum up, under the background of Metaverse empowered education, the innovative application of gamification teaching from single perception to multi-dimensional immersion is of great significance. It not only breaks the limitations of traditional teaching and allows students to change from passively accepting knowledge to actively exploring and experiencing, but also greatly stimulates students' learning interest and creativity. By creating an immersive learning environment, students are able to understand and master knowledge more deeply and develop problem-solving ability and innovative thinking. In the future, we should further explore the application of Metaverse technology in gamified teaching and continuously optimize the teaching mode and method. The R&D and application of VR, AR and MR technologies can be strengthened to develop more high-quality educational games and learning resources to provide students with richer and more diverse learning experiences.

3.2. From “Passive Acceptance” to “Active Creation”

In the field of education, the introduction of Metaverse technology marks a shift from the traditional passive acceptance of knowledge to active creation of knowledge. This shift is not only reflected in the innovation of teaching methods, but also in the fact that it stimulates the unlimited potential of students and provides them with unprecedented learning experiences and creative space.

Advances at the technological level are key to this transformation. The use of blockchain technology and tools such as 3D modeling provides a secure, transparent and creative environment for students. The decentralized and tamper-proof nature of blockchain technology ensures the fairness of the creative process and the true value of the work. 3D modeling technology enables students to materialize abstract ideas and express their creativity and thinking through virtual works^[9].

In the field of gamification teaching, Metaverse empowers students with a broad creative space. Take Roblox as an example, the platform it builds supports users to be both players and developers. With the help of Roblox Studio, players can build physical interaction models, design complex geometries, and write game mechanism scripts, and the finished games can be distributed to a variety of devices. Some secondary school students use the platform to create levels or mini-games after school, actively engaging in everything from theme conceptualization and level layout design to scripting and adding interactive elements. In this way, students not only acquired the basic skills of game development, but also unleashed their imagination and creativity to turn their unique ideas into actual game content. For example, in the game design of the theme “Food Travels in the Body”, students had to use their thinking skills to analyze the operation of the human digestive system and consider how to present this complex phenomenon in a game, which involves the visualization of abstract concepts and logical reasoning. During the creation period, students' creativity was deeply stimulated, and they designed unique scenarios such as building the digestive system into a fantasy world of adventure, and food in the form of elves marching along specific routes, etc. They also created different challenge levels such as the role of digestive enzymes and intestinal peristalsis, and gave play to their creativity in designing the rules of the game, which effectively practiced

and enhanced their innovation ability, and at the same time, they introduced special props and hidden tasks to increase the fun and challenge, and continuously optimized the interface design and operation mode to fit in with the theme of the game. The interface design and operation mode are continuously optimized to meet the needs of players. Through this educational game design framework, students can enhance their thinking, creativity and innovation ability while learning scientific knowledge, and cultivate their interest and initiative in learning, which is in line with the concept of creative learning and realizes the change from passive acceptance of knowledge to active exploration, practice and creation, and practical experience of DIY fun and sense of achievement^[17].

In addition, ACAI, one of the world's top AI academic conferences, is organizing a seminar in 2020 within Nintendo's Animal Crossing. During the seminar, speakers will present PowerPoint presentations within the game. Attendees will participate in exchanges through their avatars, deepening their discussions by using interactive features such as chat, emoticons, and actions. Moreover, the game space can be customized according to the theme of the meeting to enhance the sense of immersion and participation. This case highlights the feasibility of gaming space as a non-traditional academic meeting place, emphasizing its medium flexibility and potential for facilitating communication and discussion, which is of great significance to educational fields such as distance learning and virtual collaboration. In the virtual classroom scenario, students can independently participate in the discussion of topics of interest, interactive exchanges, and even organize activities to present their results, changing the passive mode of participation in traditional online courses and actively expressing their views and ideas. This fully embodies the advantage of the game space across time and space can provide new ideas for education, making learning more interesting, efficient and creative. In future education, this advantage should be fully utilized to carry out diversified teaching activities and communication, enriching the learning and communication experience of teachers and students.

The above two scenarios both reflect the development of gamification teaching to stimulate learner's initiative and creativity by means of game elements and environment, which is in line with the interdisciplinary learning and the cultivation of innovation and creativity advocated by the concept of STEAM education^[18].

Under the background of education empowered by the Metaverse, the innovative application of gamified teaching “from passive acceptance to active creation” shows special value. Supported by advanced technology, it opens up a wide world for students to actively create knowledge and fully stimulates their potential. In the gamified teaching scenario of Metaverse, students actively explore, not only mastering a variety of skills, but also shaping innovative thinking and active learning attitudes. It is foreseeable that with the help of Metaverse technology, gamified teaching will certainly play a greater role in cultivating innovative talents adapted to the development of future society.

3.3. From “Individual Learning” to “Collaborative Symbiosis”

The introduction of Metaverse technology can bring about a significant shift from individual learning to collaborative symbiosis. This shift not only reshapes the way of learning, but also expands students' learning horizons and develops their teamwork spirit and comprehensive literacy.

From a technological perspective, platforms such as social networks and virtual communities in the Metaverse provide students with powerful support for collaborative learning and serve as a powerful vehicle for gamified teaching and learning. These platforms break the geographical constraints and enable students to meet with classmates from different regions and backgrounds in the virtual space to learn and explore together^[19].

In gamified teaching, Metaverse brings many collaborative learning opportunities to students. The educational version of My World is recognized as an effective learning tool that promotes project-based teaching and learning and enhances student engagement, collaboration and practice^[20].

Some international school teachers use this opportunity to organize global cooperation projects, where students take on the role of adventurers and embark on a journey of knowledge. For example, in a sustainable city building project, students first study key elements, such as green energy and transportation design. Then different regional teams take on different construction tasks, some planning energy facilities, laying out solar panels and wind turbines, while others create transportation networks, paving roads and designing subways. During construction, students use chat and collaboration platforms to exchange ideas, brainstorm, and work together to solve problems. The program greatly enhances students' creativity and design skills, enabling them to learn cross-cultural cooperation and experience the power of teamwork.

In addition, AR, VR, and MR technologies also help students shift from individual learning to collaborative symbiosis. Taking the VR history exploration course as an example, students wear the equipment to travel through time and space, and explore ancient Egypt, Greece, Rome and other civilizations in groups in the ancient civilizations course. Like archaeologists, students follow clues to dig for information, observe buildings, feel systems, and explore cultures. Afterwards, they share their results in a virtual workshop to explore civilization connections. This process deepens students' understanding of history, develops teamwork and communication skills, and keeps them engaged.

In summary, with its advanced technology, Metaverse builds a broad stage of collaborative learning for students, fully stimulates their cooperation potential, and cultivates their teamwork spirit and cross-cultural communication ability.

In the future, we should make full use of the social network and virtual community platform in Metaverse to strengthen the connection and cooperation between students, and at the same time, increase the application of AR, VR, MR and other technologies to develop more creative game courses, to provide students with richer collaborative learning experience and cultivate their teamwork ability.

4. Real Challenges of Metaverse-empowered Gamified Teaching

Many of the challenges posed by Metaverse environments are prevalent in Metaverse education, and the nature of gamified instruction tends to exacerbate some of these challenges, or even give rise to challenges that are unique to Metaverse gamified instruction. For example, technical issues may arise in various application scenarios of Metaverse education, and the high demand for immersion and interactivity in Metaverse gamified teaching may further highlight the problems of insufficient technological maturity

and high arithmetic power demand. At the same time, Metaverse gamified teaching emphasizes students' active participation and teamwork, which makes issues such as students' adaptability more critical. In addition, the virtual behaviors and rich contents in Metaverse gamified teaching are more likely to trigger social and ethical challenges such as privacy security and moral ethics. Therefore, we need to deeply analyze these challenges in order to seek effective coping strategies.

4.1. Technical Limitations

4.1.1. Lack of Technological Maturity

Metaverse related technologies such as VR, AR, MR and blockchain, although developing fast in recent years, are still in the primary stage, with problems such as poor stability and poor user experience^[21]. In Metaverse gamification teaching, this brings many challenges. VR and AR presenting game scenes may have blurred, lagged or distorted images, affecting students' learning interest and knowledge understanding. Although blockchain has a great potential to guarantee the security and authenticity of teaching data, it is difficult to realize its advantages in actual teaching due to its complex technology and difficult application. Technical instability also often leads to teaching failures, interfering with the continuity and efficiency of teaching.

4.1.2. Higher Arithmetic Demand

Metaverse applications require high computational power, which makes the hardware equipment costly and limits its popularity. In gamification teaching, Metaverse environments need to render complex virtual scenes in real time, process a large amount of user interaction data, and run intelligent algorithms, all of which rely on powerful computing power. Currently, the price of equipment that can meet the arithmetic power of the Metaverse is expensive, which is a heavy burden for schools and families. Even if there are high-performance devices, energy consumption and heat dissipation problems also increase the difficulty of teaching implementation. And there are big differences in hardware levels between regions and schools, which can easily lead to uneven distribution of educational resources and aggravate educational inequality.

4.1.3. Network Latency Disaster

In Metaverse virtual teaching, real-time interactive collaboration is extremely critical, yet network latency is a problem that cannot be ignored. Although it does not always exist, during network peaks or unstable device connections, student communication is prone to lagging and delayed responses, which seriously affects the fluency of teaching and student participation. For example, during group discussions in VR history exploration courses, network latency can prevent students from communicating their speeches, disrupting the coherence of the discussion and reducing the learning effect. Network delay not only interferes with students' communication, but also affects teachers' instructional feedback, resulting in teachers not being able to convey information to students in time, which affects learning effectiveness, and also slows down the loading of virtual scenes, weakening students' sense of immersion and learning experience.

4.1.4. Lack of Technical Standards and Norms

The lack of unified technical standards in the current Metaverse field has led to application incompatibility problems, which are particularly prominent in the teaching of Metaverse gamification. Different teaching platforms and

tools have different technical standards, which may cause students to encounter compatibility problems when using different platforms and tools. For example, some students are unable to learn game development with Roblox due to incompatible devices, missing the opportunity to cultivate creativity and programming skills. In addition, the lack of standards also leads to the waste of teaching resources and duplication of development. Similar resources developed by developers without unified standards may not be compatible with each other, which not only wastes development resources, but also makes it more difficult for teachers and students to choose teaching resources.

4.2. Educational Dilemma

4.2.1. The Content and Technology Convergence Conundrum

In Metaverse-empowered gamified teaching, it is a challenge to effectively integrate traditional educational content into the Metaverse environment and to maintain the systematic and coherent nature of education. Teachers need to redesign and repackage traditional content to adapt it to virtual environments and gamification features. For example, VR technology can be utilized in history teaching to let students experience history in an immersive environment, but the integration is not a simple transplantation, but also requires the design of a reasonable process and guiding mechanism to ensure that students master knowledge systematically. At the same time, according to the characteristics of different disciplines and teaching objectives, to choose the appropriate Metaverse technology and teaching design, which is a key issue for teachers.

4.2.2. Educational Equity in Trouble

Metaverse education may increase the inequality of educational resources in schools in remote and economically disadvantaged areas^[22]. Their teaching requires hardware equipment and network support, which are unevenly distributed across regions and schools, making them unavailable in some schools and making it difficult for students to take advantage of them. In addition, teachers' technological literacy and teaching abilities vary, and teachers in remote areas often lack training support, further exacerbating inequity. Addressing this problem requires the concerted efforts of the Government, schools and society to increase investment in upgrading teacher capacity and ensuring that students benefit.

4.2.3. Difficulties in Assessing the Quality of Education

Quality assessment of Metaverse gamified teaching is crucial and challenging. With its high degree of autonomy and interaction, and the decentralized and diverse learning process of students, traditional assessment methods are difficult to apply, and new methods need to be developed. For example, the use of big data analysis to monitor students' learning behaviors and outcomes in real time and provide timely guidance. It is also necessary to build a diversified evaluation system to comprehensively assess the quality of the learning process, results and overall quality. Teachers play a key role in this process and need to improve their teaching and assessment skills and adjust their strategies according to the students' situation.

4.2.4. Curriculum Design Challenges

The Metaverse-empowered gamified teaching is different from traditional teaching in many ways, and designing a curriculum that meets the goals and takes advantage of the

Metaverse requires a high level of skill and technological understanding on the part of the educator. For example, when designing a course on "Food Travel in the Body", teachers need to integrate abstract physiological knowledge into virtual scenarios and ensure that students can grasp it systematically, so they need to have high instructional design skills and technical understanding. Curriculum design should take into account the characteristics of the Metaverse, such as using its immersion, interactivity and autonomy to design interesting and challenging task-based lessons, and at the same time, consider the individual needs of students, provide personalized pathways and resources with the help of intelligent algorithms and big data, and integrate with real life to enhance students' practical and innovative abilities.

4.2.5. Differences in Student Adaptation

Not all students adapt quickly to the Metaverse gamified teaching model. Some students are not comfortable with the virtual environment or teaching autonomy, which affects their learning. And students have different learning styles and rhythms, how to meet individualized needs is a problem that educators need to think about. For example, in the global cooperation program of My World Education Edition, some students have difficulties in teamwork, and teachers need to guide and support them. Teachers can gradually guide students to familiarize themselves with the environment and provide personalized support according to students' styles and rhythms, such as providing resources and tasks for self-directed learners, organizing activities for those who need interaction, and training and coaching to improve students' teamwork and communication skills and enhance adaptability.

4.3. Socio-ethical Challenges

4.3.1. Privacy and Security Concerns

The Metaverse involves a large amount of data collection and processing, which is prone to privacy breaches and abuses^[23]. In Metaverse gamification teaching, data such as students' identity, learning behaviors and outcomes are collected and processed, which can seriously threaten students' privacy and security if leaked or misused. For example, personal information may be fraudulently utilized by wrongdoers, and learning data may be used for commercial infringement. Therefore, teaching platforms and tools need to adopt strict privacy protection measures, such as encryption and access control, and the government and relevant departments should strengthen supervision to ensure that data are collected and processed legally and compliantly.

4.3.2. Risk of Social Isolation

While the Metaverse offers virtual socialization opportunities, it can also lead to real-world social degradation and social isolation^[24].

In gamified teaching, students are prone to over-reliance on virtual socialization and neglect of real socialization. Long-term immersion will reduce real socialization ability, affecting interpersonal relationships and social adaptability, and the virtual social circle may be segregated from the reality, resulting in cognitive bias of students. In order to avoid this risk, teachers should guide students to correctly view virtual and real social relationships, encourage participation in real social interaction, and schools and families should organize practical activities to exercise students' social and collaborative skills.

4.3.3. Moral and Ethical Controversies

Metaverse virtual behaviors are prone to blurring the

boundaries between reality and the virtual, triggering moral and ethical controversies^[25]. In gamified teaching, students' virtual behaviors may affect their moral and ethical concepts, such as inappropriate moral choices in the game will impact the values. Moreover, virtual behaviors may spread to the real society and cause controversy. Therefore, teachers should guide students to establish correct values and moral concepts, and make them understand that virtual behaviors must be abided by the rules and regulations, while teaching platforms and tools should build a perfect moral and ethical norms system to constrain and guide students' behaviors.

4.3.4. Difficulty in Regulating Content

The teaching content in the metaverse is rich and diverse, but there may also be inappropriate information. How to ensure that the content students are exposed to is positive, healthy, and in line with educational goals is an urgent problem to be solved. For example, some game platforms have inappropriate advertisements or undesirable user-generated content, which can negatively affect students' values. Due to the multiple sources of teaching content, it is difficult to ensure quality and safety, and a sound regulatory mechanism is needed. For example, an auditing system should be established to review the content provided by teachers and platforms to ensure quality and safety; user-generated content regulation should be strengthened to clean up undesirable information and erroneous knowledge in a timely manner. Teachers should also guide students to correctly identify and select content in teaching, and enhance information literacy and discrimination.

4.4. Risk of Addiction

4.4.1. The Hidden Dangers of Game Addiction

Metaverse-empowered gamified teaching may cause students to be overly addicted to games, trigger addiction problems, and then affect the quality of learning and life^[25]. Its virtual game scenarios are so attractive and immersive that they tend to make students spend too much time and neglect their knowledge learning. Just like when using Roblox for development or participating in Minecraft: Education Edition projects, some students might get so engrossed that they forget their academic responsibilities. In this regard, teachers should reasonably control the time and difficulty of the games, maintain a moderate level of tension and challenge, and guide students to correctly view the relationship between gaming and learning, so that they understand that games are only a learning tool and cannot replace real-life learning and socialization. Parents also need to strengthen supervision and limit the use of equipment to protect students' physical and mental health.

4.4.2. Mental Health Impacts

Prolonged exposure to the virtual world of the Metaverse can have negative effects on students' mental health, such as creating loneliness, anxiety and depression. In gamification teaching, students are prone to disconnect from reality and social barriers, and the high pressure and challenges of the virtual environment may trigger psychological problems. To minimize the risk, teachers should pay attention to students' psychological conditions and identify and assist psychological problems in a timely manner. Schools and families should provide psychological counseling to help relieve stress and maintain mental health. At the same time, teachers should guide students to actively participate in real-life socialization and physical exercise to enhance their psychological quality and stress resistance.

In conclusion, Metaverse-empowered gamified teaching is like a double-edged sword. While bringing unprecedented innovation and opportunities, it inevitably faces numerous practical challenges such as technological limitations, educational dilemmas, social and ethical challenges, and the risk of addiction. However, opportunities and challenges coexist, and in order to explore its educational potential, we need to face the challenges and promote the healthy and sustainable development of teaching and help cultivate innovative talents.

5. Coping Strategies for the Challenges of Metaverse-empowered Gamified Teaching

5.1. Strategies for Coping with Technical Limitations

5.1.1. Enhancing Technological Maturity

In order to effectively overcome the current technical limitations, it is necessary to increase the investment in the research and development of Metaverse technology. Actively encourage research institutions, enterprises and universities to carry out close cooperation, give full play to the advantages and resources of all parties, and jointly overcome technical problems. In particular, efforts should be made to improve the stability of VR, AR, MR and other technologies, and continuously optimize the user experience^[9].

The establishment of the Metaverse Educational Technology Testing Center is of great significance. Through rigorous testing and evaluation of various types of Metaverse gamified teaching applications, potential problems can be identified in a timely manner and effective measures can be taken quickly to resolve them. This helps to ensure the quality and reliability of Metaverse gamified teaching applications and provide a stable and efficient teaching environment for students and teachers.

In addition, it is indispensable to provide technical training courses for teachers and students. Through these courses, their familiarity with Metaverse technology can be enhanced so that they can better adapt to the Metaverse gamified teaching environment. At the same time, it can also enhance their ability to cope with technical problems, so that when they encounter technical failures or problems in the teaching process, they can take timely and effective measures to solve them and ensure that the teaching activities are carried out smoothly.

5.1.2. Reducing Arithmetic Requirements

To promote the work on hardware and equipment for gamified teaching in the Metaverse environment, a multi-pronged approach is required. The first step is to promote hardware upgrading and optimization, improve performance and reduce cost at the same time, so that more schools can purchase equipment that meets teaching needs. Metaverse teaching requires high hardware performance, such as presenting realistic virtual scenes and realizing smooth interaction, but the high cost limits its popularity in education.

It is also extremely critical to actively explore the use of cloud and edge computing in Metaverse education^[21]. Distributed computing can reduce the local hardware arithmetic dependence, not only can use the cloud and edge resources to share the local pressure, to solve the problem of insufficient hardware performance, but also enable schools without high-end equipment to access high-quality teaching

resources with the help of the network.

The development of efficient energy management programs is of great significance. Hardware operation consumes a lot of energy and it is difficult to dissipate the heat, high energy consumption increases the cost and affects the environment, and poor heat dissipation affects the stability and life of the equipment, which in turn interferes with teaching and learning. Therefore, reducing energy consumption and proper heat dissipation are indispensable for the development of Metaverse gamification teaching.

5.1.3. Reducing Network Latency Hazards

Metaverse-empowered gamified teaching relies on a high-quality network environment. Emphasis should be placed on strengthening the network infrastructure in remote areas and areas with weak educational resources, where the narrow bandwidth and poor stability of the network are serious obstacles to the implementation of teaching. Increasing network investment and bandwidth can ensure smooth transmission of teaching resources and richness of content, and enhancing stability can avoid network interruption and ensure continuous teaching.

Adopting advanced network transmission technology such as 5G is an important means. Its high speed and low latency characteristics can significantly reduce network latency, ensure smooth real-time interaction and collaboration in teaching, improve teaching efficiency and quality, and strongly support teaching in virtual classroom discussions, group project cooperation, immersive learning interaction and other aspects.

It is indispensable to establish a network monitoring and early warning system. The system can monitor the network in real time, timely detection of network congestion, signal interference and other problems and rapid early warning, help the relevant personnel to solve the problem in a timely manner, minimize network delays on the interference of teaching, solid Metaverse gamified teaching operation, both in the classroom and distance learning are benefited.

5.1.4. Establishment of Harmonized Technical Standards and Norms

The government and industry organizations should lead the development of a unified technical standard for Metaverse education. This is the key to improve the compatibility of teaching platform tools. Currently, there are a lot of platform tools, but there is no unified standard and the compatibility is poor, which causes inconvenience to teachers and students and leads to the waste of resources and duplication of development.

It is imperative to urge developers to develop in accordance with the regulations, which can not only reduce the waste of resources and development costs, but also improve the quality and usability of teaching resources, as high-quality resources can optimize the learning experience and stimulate interest, and good usability ensures that the resources are adapted to a variety of teaching scenarios.

In view of the rapid development of Metaverse technology, it is necessary to regularly update and improve the standard specification, so as to make it fit the trend of technological evolution, to ensure that the teaching keeps pace with the technology, and to enhance the initiative and efficiency of students' learning.

5.2. Strategies for Coping with Educational Dilemmas

5.2.1. Promoting the Integration of Content and Technology

All parties should jointly form a research group on the integration of educational content and Metaverse technologies, with members covering teachers, technologists and subject specialists. Teachers' teaching experience and understanding of content, technologists' advanced technology, and subject matter experts' professional guidance should be combined to jointly explore effective integration paths to ensure the deep integration of educational content and technology.

Providing teachers with specialized instructional design training is critical. This helps teachers to redesign and repackage traditional educational content to fit the virtual environment of the Metaverse, taking into account the coherence of the educational system and the advantages of Metaverse technology, and creating a new learning experience for students. For example, the use of Metaverse technology in history teaching allows students to immerse themselves in history, which enhances their interest in learning and memorization.

At the same time, according to the characteristics of the subject and teaching objectives to develop a unique Metaverse gamification teaching program, selected adaptive technology and instructional design^[26]. Different disciplines have different needs. For instance, in science subjects, virtual reality technology can be utilized to enable students to visually and independently explore the microscopic world and the macroscopic universe, thus deepening their understanding of scientific knowledge. In language subjects, students can enhance their language proficiency by engaging in language communication and practice within virtual social scenarios where they can customize their appearance and the venue.

5.2.2. Guaranteeing Equity in Education

The government should take the lead in increasing investment in areas with weak educational resources. It should provide hardware equipment and stable networks to ensure that remote and economically backward schools can carry out Metaverse gamified teaching, enrich the learning experience with hardware, and support remote teaching and resource sharing with networks, so as to break the geographical and economic limitations and benefit more students.

In terms of teachers, the government actively organizes teacher training programs to enhance teachers' technical skills and abilities in teaching Metaverse, paying particular attention to the needs of teachers in remote areas and providing sufficient training opportunities and resources. Through training, teachers can better master teaching methods and techniques, improve the quality of teaching, and provide quality education services.

In addition, enterprises and social organizations are encouraged to carry out public welfare activities, such as donating Yuan Universe teaching equipment and resources. With the advantage of technical resources, they can help schools improve conditions and quality, and at the same time arouse social concern about education equity and create a favorable atmosphere.

5.2.3. Strengthening Quality Control in Education

Relevant departments should vigorously develop education

quality monitoring systems based on big data analysis. Advanced technology is used to monitor students' learning behaviors and outcomes in real time, observing the degree of participation, frequency of interaction, task completion, etc., accurately evaluating program outcomes, and identifying learning problems and giving targeted guidance in a timely manner.

It is indispensable to build a diversified evaluation system. Comprehensively consider the learning process (e.g. attitude, effort, collaboration ability, etc.), results (e.g. project completion) and comprehensive quality (innovative thinking, problem solving, expression ability, etc.), comprehensively assess the quality of education, and accurately reflect the level and potential of student learning.

Teachers play a key role in quality assessment and need to improve their teaching and assessment skills. Through professional training and seminars, they should update their teaching concepts and methods, enhance their ability in Metaverse instructional design and classroom management, and skillfully utilize the monitoring system to make timely adjustments to their teaching strategies according to the students' conditions, so as to ensure the effectiveness of education.

5.2.4. Optimization of Course Design

The schools can jointly organized the Metaverse Game Curriculum Design Competition to motivate teachers to create a curriculum that meets the teaching and learning objectives and highlights the advantages of the Metaverse. At the same time, experts provide curriculum design training for teachers to help improve their design skills and technical understanding.

Curriculum design should fully consider the individual needs of students, customize learning paths and resources with the help of intelligent algorithms and big data analysis, and closely integrate with real life to enhance students' practical and innovative abilities.

5.2.5. Improving Student Resilience

Teachers should gradually guide students to familiarize themselves with the Metaverse gamified teaching environment and adopt experiential teaching methods to help students adapt to virtual learning. Provide personalized support and guidance for students with different learning styles and rhythms, provide exploration resources for independent learners, and organize group activities for those who need interaction. In addition, teamwork and communication skills training should be provided to enhance students' adaptability to Metaverse gamified teaching and enable them to better participate in team projects.

5.3. Strategies for Responding to Socio-Ethical Challenges

5.3.1. Protecting Privacy and Security

Metaverse-empowered gamified teaching platforms and tools should adopt strict encryption and effective access control measures to protect students' personal information and learning data in all aspects, covering information about users, communications, virtual scenarios, and commodities. Encryption technology ensures that data is not stolen, tampered with or leaked, and access control clarifies data access rights so that only authorized personnel can access it.

The government should strengthen the supervision of platforms and tools and formulate complete laws and regulations. Regulations should clarify the principles of legal

compliance for data collection and processing, establish mandatory national technical standards to regulate storage, transmission and processing processes, and clarify product liability to ensure that providers take responsibility for data security.

At the same time, education on privacy and security for teachers and students is indispensable. Ethical guidelines and training programs can be utilized. The guidelines provide codes of conduct and moral norms to guide teachers and students in handling data correctly. Training courses and practical activities enhance the awareness and ability of privacy protection, address potential problems, and create a safe teaching environment.

5.3.2. Reducing the Risk of Social Isolation

Teachers should guide students to correctly understand the relationship between virtual and real social interaction, make students understand that virtual social interaction cannot replace real social interaction, and encourage students to actively participate in real social interaction to cultivate interpersonal skills.

Schools and families need to jointly organize social practice activities so that students can experience social interaction in reality, exercise their social and collaborative skills, and enhance their identity and sense of belonging to the real society.

Metaverse gamified teaching platform can also play a role in designing functions to promote real social interaction, such as organizing offline activities to encourage students to meet offline, and promoting real social tasks to promote students' real interaction, so as to alleviate the risk of social isolation and realize the benign interaction between real and virtual social interaction.

5.3.3. Avoiding Moral and Ethical Controversies

In Metaverse-empowered gamified teaching, it is extremely crucial to avoid moral and ethical controversies. Teachers should guide students to establish correct values and moral values, and inform students that their virtual behaviors must also comply with moral and ethical norms, which can help regulate students' Metaverse behaviors and cultivate their moral qualities.

Platforms and tools should build a perfect system of moral and ethical norms to clearly regulate and guide students' virtual behavior, ensure compliance and create a healthy learning atmosphere.

Schools can vigorously carry out moral and ethical education activities, such as case studies, so that students can deeply understand the importance of morality and ethics, guide thinking about the dilemmas of virtual behavior and coping strategies, and enhance moral judgment and decision-making ability, so that students can enjoy the convenience of technology and abide by the norms in their learning, and avoid disputes.

5.3.4. Enhanced Content Regulation

Platforms need to establish a sound content review system, strictly scrutinize teacher-produced, platform-provided and user-generated teaching content, and comprehensively screen to ensure that it is positive, healthy and in line with the educational objectives, so as to provide students with high-quality resources.

Regulators should step up their efforts to supervise Metaverse platforms, clean up bad information and wrong knowledge in a timely manner, and create a good teaching environment, as they can affect students' values and learning

direction.

Teachers should also actively guide students to correctly identify and select teaching content in teaching, and develop information literacy and discernment. Through classroom teaching and case studies, they can help students to select appropriate content from the vast amount of resources and improve the efficiency and quality of learning.

5.4. Addiction Risk Response Strategies

5.4.1. Preventing Gaming Addiction

When teaching, teachers should reasonably regulate the time and difficulty of games, and set appropriate tensions and challenges to prevent students from becoming over-indulged, and to help them differentiate between the nature of games and learning, and to understand that games cannot replace real-life learning and socialization.

Teachers and parents should work together to guide students to correctly understand the relationship between games and learning, and emphasize to students that games are only learning tools and cannot replace real learning and social interaction.

Parents should strengthen supervision and management, strictly limit the length of time students use Metaverse devices, and pay close attention to their behavioral changes in order to detect problems and deal with them in a timely manner. Through the cooperation between home and school, we can help students to set up the right concept, so that they can enjoy the fun of learning and avoid the addiction problem in the Metaverse gamification^[25].

5.4.2. Focus on Mental Health

Teachers should pay close attention to students' mental health during teaching and provide timely assistance when problems are detected. Schools and families should work together to provide psychological counseling services to relieve students' psychological stress and maintain their mental health. At the same time, students are guided to actively participate in real-life socialization and physical exercise to improve their psychological quality and stress resistance.

Teachers should always pay attention to students' emotions and behaviors in Metaverse teaching and learning, identify psychological problems in time and intervene appropriately to channel them. Schools can open mental health courses and counseling rooms, with professional teachers to give systematic support. Families create a harmonious atmosphere, pay attention to their children's psychological needs, and work together with schools to guard their children's mental health. Encourage students to participate in social and sports activities to help them release stress, strengthen their physical fitness, cultivate an optimistic mindset, and cope with the psychological challenges brought about by Metaverse teaching.

6. Conclusion and Outlook

This study comprehensively explores the innovative applications and challenges of Metaverse-empowered gamified teaching. After clarifying the concept of the Metaverse, its current development status, and the related foundation of gamified teaching, it deeply analyzes the innovative applications of Metaverse-empowered gamified teaching, including the transformations from "single perception" to "multi-dimensional immersion", from "passive acceptance" to "active creation", and from "individual

learning" to "collaborative symbiosis", demonstrating the huge potential of the Metaverse in the field of education. Gamified teaching in the Metaverse has significant value as it can stimulate students' learning interest and initiative, improve learning outcomes, and cultivate students' innovative thinking and teamwork spirit. However, Metaverse-empowered gamified teaching also faces numerous challenges, such as technological limitations, educational dilemmas, and social and ethical challenges. Some of these challenges are prevalent in all applications of Metaverse-enabled education and are more prominent in gamified teaching, while some are unique to Metaverse gamified teaching. This study analyzes targeted solutions for each challenge, aiming to promote the further development of Metaverse-empowered gamified teaching.

In the future, Metaverse-empowered gamified teaching will become more mature and popular. It is expected that the government, schools, enterprises, and all sectors of society will work together to increase investment in Metaverse technology research and development and related educational applications, strengthen the training of teachers and students, improve relevant laws, regulations, and supervision mechanisms, and promote the development of Metaverse-empowered gamified teaching. Educators should actively explore and innovate to give full play to the advantages of the Metaverse in gamified teaching and make greater contributions to cultivating innovative talents adapted to future social development.

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