Analysis of Research Hotspots and Status of Virtual Reality in Education and Teaching

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Abstract. The purpose of the research in this article is to explore the current research status and trend of virtual reality in the field of education on a global scale, this study uses CiteSpace to visually analyze 892 related papers in the WOS database from 2019 to 2023. The results show that the current research on virtual reality in education continues to expand, and the annual publication of papers shows an overall upward trend. Current research focuses on simulation, augmented reality and multimedia teaching; Research trends in this field are moving in the direction of big data, chemistry, and gross anatomy. Based on the analysis and summary of the research status, this paper proposes a conceptual model of the virtual continuum to provide feasible research ideas for future scholars.

Keywords: virtual reality, education, CiteSpace, visual analysis

1   Introduction

The formal concept of Virtual Reality (VR) was proposed by Jaron Lanier, founder of VPL Reserach in the United States, in 1989. Nowadays, as one of the "three most promising computer technologies" [1], the definition of virtual reality is not yet unified. In general, scholars believe that virtual reality technology refers to the use of computer technology as the core means to generate the virtual environment. With the help of some special input/output leaks, users interact with objects in the virtual world to obtain the same feeling as the real world. in sight, hearing and touch [2].

At present, the development of domestic virtual reality has moved from theory to real products, which are applied to various fields including education. In 2019, the Ministry of Education implemented the "Double Ten Thousand Plan" and certified the first batch of national first-class courses of about 1,500 virtual simulation experiment teaching [3]. Driven by the development of science and technology and policies, the relevant research of virtual reality technology in the field of education at home and abroad has gradually increased. On this basis, with the help of the scientific knowledge graph of CiteSpace software, this study combs the global research on virtual reality technology in the field of education in the past 5 years, observes the hot spots and future development trends in this research field, and provides a reference for future research of virtual reality in the field of education.

2 Study design

2.1 Data Sources

The study was based on WOS (Web Of Science) as the data source, searched with the subject word "virtual reality technology with education", limited to the publication period from 2019 to 2023 (the search date is May 1,2023), irrelevant data such as reviews, conferences, newspapers, and books were eliminated, and 892 articles related to "virtual reality technology with education" were finally retrieved. In this study, these 892 papers were used as samples for visual analysis.

2.2 Research methods

The study first analyzed the annual publication volume and national sources of the sample, and then used CiteSpace software to analyze the research of virtual reality technology in the field of education. CiteSpace software is a analysis software invented by Dr. Chaomei Chen who focuses on the potential knowledge contained in analytical scientific analysis, and is gradually developed in the context of scientometrics and data visualization, analyzing and predicting the evolution path and knowledge frontier of the discipline [4]. Compared with other visualizations, CiteSpace have become more accurate and complete, can also observe the research trend more intuitive [5].

3 Visual analysis

3.1 Annual publication volume analysis

To a certain extent, the trend of publication volume reflects the scale of this research field and the attention of society [5]. 2023, the annual publication volume of papers related to "virtual reality technology with education" is shown in Figure 1. According to Figure 1, the number of papers published on "Virtual Reality Technology + Education" has increased significantly. According to the survey, the emergence of 5G technology in 2019 provides the key to the development of virtual reality [6]. It can be seen that virtual reality technology is synchronized with the development of policies and times, and with its support, virtual reality technology research has increased attention, and research in the field of education has also been deepened.
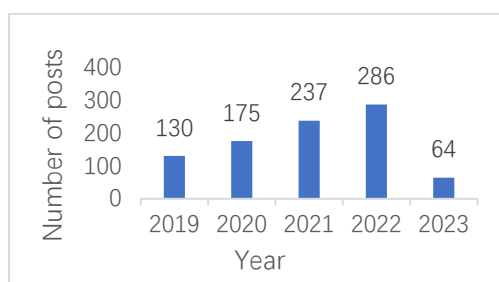
Fig. 1. Annual publication volume of papers related to "Virtual Reality Technology + Education"

3.2   Research trend and hotspot

3.3.1 Keyword co-occurrence analysis

Keywords are the core generalizations of a paper, in which high-frequency keywords are often used to identify research hotspots in a field [7]. This paper uses keywords as reference indicators, and obtains co-occurrence graph of the high-frequency keyword "virtual reality technology with education" through CiteSpace software, as shown in Figure 2. In the keyword co-occurrence knowledge graph, the size of the circular node indicates the frequency of the keyword, the greater the frequency, the larger the circle [8], it can be seen that "virtual reality" is the most core keyword, the frequency is the largest, in addition, virtual reality technology, augmented reality, virtual experiment, teaching, meta-analysis and other words are also important keywords in the co-occurrence map of the article.
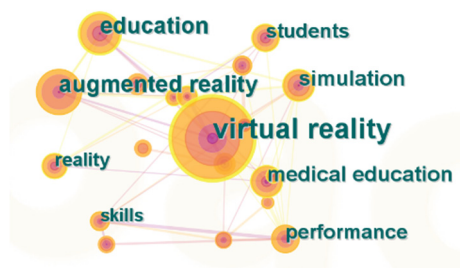

Fig. 2. High-frequency keywords of "virtual reality technology + education" are co-appeared

3.3.2 Research trend analysis

The research context can not only reflect the research trends in the field, but also quickly identify cutting-edge developments in the field [9]. The study of the development trend of a field can obtain the research trend in the field through the emergence of words [10]. In this paper, the "Brustness" setting in CiteSpace is used to adjust the threshold parameters to obtain 20 emerging keywords of the application of virtual reality in education and teaching as shown in Figure 3. It can be seen that the main emerging words are VR, Big Data, Gross Anatomy, and Chemistry, which are cutting-edge keywords for research and development.

Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2019 - 2023
engineering education	2019	1.89	2019	2020	
outcm	2019	1.79	2019	2020	
teaching anatomy	2019	1.79	2019	2020	
serious games	2019	1.49	2019	2020	
improve	2019	1.49	2019	2020	
learning outcm	2019	1.49	2019	2020	
simulations	2019	1.49	2019	2020	
adults	2019	1.19	2019	2020	
instruction	2019	0.99	2019	2020	
learning curve	2019	0.99	2019	2020	
visualization	2019	2.01	2020	2021	
virtual reality technology	2020	1.13	2020	2021	
distance learning/self instruction	2020	1.13	2020	2021	
cognitive load theory	2020	0.94	2020	2021	
clinical skills	2020	0.94	2020	2021	
high school/introductory chemistry	2020	0.94	2020	2021	
vr	2021	0.98	2021	2023	
big data	2021	0.81	2021	2023	
gross anatomy	2021	0.81	2021	2023	
chemistry	2021	0.81	2021	2023	

Fig. 3. Keyword highlights of "Virtual Reality Technology + Education"

4 Model analysis

Based on the above analysis of the research on virtual reality technology in the field of education, this paper proposes a conceptual model of the virtual continuum. As shown in Figure 4, augmented reality on the far left and virtual reality on the far right, the concept of mixed reality falls somewhere in between. Only by interacting with the environment through multiple senses can users correctly understand things in virtual reality and enter the state of mixed reality. It can be seen that augmented reality, virtual reality and mixed reality all make an important impact in the virtual continuum. Therefore, in order to better apply virtual reality to education and teaching, the application of augmented reality technology is also key.
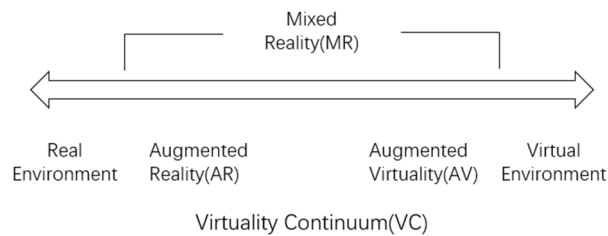
Fig. 4. Conceptual model diagram of Virtual Continuum

5 Conclusions

The study uses WOS as the data source, the theme is the core literature of the application of virtual reality in education and teaching as the research sample, and CiteSpace is used as the data analysis tool. Through the above visual analysis, the following conclusions are drawn:

(1) At present, research which related to the application of virtual reality in education and teaching is booming. The important keywords of the application research of virtual reality in education and teaching are virtual reality, augmented reality, education, simulation; It can be seen through the analysis of this article virtual reality is typically used in medical education

(2) The research about "virtual reality technology in education and teaching" is moving towards big data, anatomy, chemistry, etc., constantly meeting students' personalized experience and improving learning effects.

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