The Application of Virtual Reality Technology in Geography Teaching

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Abstract. Virtual reality technology can help students enter the virtual teaching scene, satisfy students' multi-sensory experience teaching, and promote the effective occurrence of teaching. Simulation technology can create realistic virtual scenes, which provides the possibility of virtual visualization for teaching. The use of sensing technology makes the created virtual scene closer to reality in terms of audio and visual. Taking a geography class as an example, through the practical application research of virtual reality technology in the field of education, a teaching process and model integrating simulation technology and sensing technology are constructed, which promotes the coordinated development of virtual reality technology and subject teaching.

Keywords: Virtual reality · Simulation technology · Sensing technology · Simulation teaching

1 Introduction

The International Charter for Geography Education (2016) states that geography, among the natural and social sciences, is the only science concerned with the spatial distribution and is an important subject resource for global citizens in the 21st century [1]. The study of geography contributes to the development of core literacy in young people, but geography education still suffers from neglect, lack of structure and little attention. With the development of technology and the birth of virtual reality technology, it provides the possibility of virtual reality for geography teaching and solves the current predicament of geography teaching to a certain extent.

The support of computer technology is indispensable to improve the quality of geography teaching and to achieve the development of computer technology in geography teaching as well as an inclusive and equitable geography education [2]. We must deeply understand the revolutionary impact of contemporary computer technology, especially virtual reality technology, on education. This kind of change makes subject teaching have to use computer technology to assist teaching.

2   Theoretical Basis and Related Technologies

2.1   Virtual Reality Technology

Virtual Reality (VR) simulates a three-dimensional virtual environment through computer simulation and other technologies. With the help of specific sensing devices, users can immerse into the virtual environment and interact with virtual objects in real time. Virtual reality has four basic characteristics of imagination, interactivity, immersive and intelligence [3].

In geography teaching, in the face of specific knowledge structures, such as volcanic eruptions, earthquakes, tsunamis, typhoons and other related knowledge, virtual reality technology can simulate specific scenarios, making the teaching process more vivid and improving the effectiveness of teaching behaviors. The development of virtual technology provides strong support for the development of geography teaching and the realization of situational teaching.

2.2   Geography

Geography is a discipline that studies the spatial distribution law, time evolution process and regional characteristics of geographic elements or geographic complexes [4]. With the development of informatization, great changes have taken place in geographic information technology and its research methods. The successful practice of "General Junior High School Geography Curriculum Standard" and "General Senior High School Geography Curriculum Standard (Experiment)" shows that the current geography teaching reform should conform to the trend of international basic education geography curriculum reform.

The core competencies of geography require geography learners to acquire geographical knowledge, mastered geographical methods, formed geographical ability, geographical awareness, and geographical emotion in the process of learning, develop the habit of observing things from the perspective of geographical subjects, and be able to apply them. Geographical attitudes and methods to solve life problems [5]. The current geography teaching should not only be the description of geographic knowledge or a simple explanation, but also should establish the inevitable connection between students and nature through the explanation of knowledge, understanding of the earth environment on which human beings live and the impact of human life and production on the earth environment, help students establish a correct world view and geographic view, correctly deal with the relationship between human and earth, and promote the harmonious coexistence between human beings and nature.

3   The Deep Integration of Virtual Reality Technology and Subject Teaching

3.1   Virtual Reality Technology Selection and Use

The virtual reality technology system contains six parts: detection module, feedback module, sensor module, control module, modeling module and 3D module. In this system, the detection module and the feedback module establish the connection between

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Algorithm
1: Initialization: model
2: iterations=1000
3: for each iteration do
4:      image denoising by Wavelet decomposition
5:      feature extraction by Gradient extraction
6:      image matching by mot algorithm
7:      Model optimization by gradient descent algorithm
8: end for
9: return model;
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Fig. 1. 3D scene image algorithm

the user and the sensor module, the connection between the sensor module and the 3D module is built through the control module, and the user generates the 3D module through the operation of the modeling module, so all the modules are interconnected and complementary to each other [6].

3D modeling as one of the core technologies of virtual reality technology, the quality of modeling directly affects the authenticity of the virtual scene experience, and improving the construction of 3D scene images will increase the experience of the virtual scene. For the image of the 3D scene, we generally carry out the following processing, as shown in Fig. 1.

In the real environment where 3D scene images are constructed, the edges of 3D scenes are usually blurred, and the collected image signals will have different noise signals, and we need to pre-process the images. In this study, the pre-processing of the image only involves noise reduction processing, so wavelet decomposition is used in this part to process the image texture information. The process of wavelet decomposition is as follows.

$$W_{i+1} = P\,W_i P'; \;\; E^h_{i+1} = W\,W_i P' \;\; E^v_{i+1} = P\,W_i W'; \;\; E^d_{i+1} = W\,W_i W' \tag{1}$$

The filter index matrix of the scale function $y(x)$ relative to the wavelet function $w(x)$ is P, W. The horizontal, vertical and diagonal constants of the 3D scene image are E^h_{i+1}, E^v_{i+1}, E^d_{i+1} respectively.

After the image preprocessing, the next step is to extract the image features and correct them. After calculating the grayscale change, the image edge information is extracted and a critical value is set manually to seek a stable critical value in continuous iterations to improve the accuracy of edge point detection. In the correction of 3D scene images, the first-order partial derivatives can be operated by using the difference approximation strategy, and the image edges are usually located at the highest, lowest and zero positions of the difference [7].

$$G_X = f(x+1,\,y) = f(x,\,y) \;\; G_y = f(x,\,y+1) - f(x,\,y) \tag{2}$$

In this paper, we draw on the surface reconstruction algorithm for 3D scene images based on virtual reality technology, using a 2×2 first-order difference to calculate the partial derivatives of the x and y orientations that are at the interpolation point [8].

For point cloud matching of virtual scene 3D images, we take the existing mot algorithm that fuses 2d and 3d detection sources to implement the gradient descent method to complete the optimization of the model.

3.2 Classroom Teaching and Anchoring Pedagogy

The classroom teaching process is a rich, complex, and interactive dynamic process in which participants realize their multiple needs in intellectual, emotional, and inter-personal activities and bring their potential abilities into continuous play [9]. In simple terms, any teaching activity and learning behavior that takes place in a certain fixed place can be called teaching.

Anchored teaching requires building based on contagious real events or real problems. The real situation or problem in teaching is called "anchor". Once the "anchor" is determined, the entire teaching content and teaching process are also determined. An "anchor" is generally a situation with a plot, but it is difficult to visualize the real situation of geography teaching. The application of virtual reality technology in teaching is completely in line with the methods of classroom teaching and anchored teaching to create teaching situations. The introduction of virtual reality technology into classroom teaching, combined with the anchored teaching method, can help learners to accept knowledge faster.

The reform of teaching structure promotes the change of teaching focus, and the educational concept and educational method are bound to change as well. The classification of teaching objectives has changed from the original equilateral triangle structure to the inverted triangle structure, that is, under the condition that the original six levels of cognition remain unchanged, the three levels of higher-order cognition are more emphasized. Although the trend of teaching structure reform has led to a certain degree of change in the classification of teaching objectives, such as the change in the focus of teaching testing, the teaching process has not changed. This does not achieve the purpose of reforming the teaching structure.

3.3 Pattern Building

Constructivist teaching theory emphasizes the student as the main body, the teacher as the leader, learning and teaching at the same time, and the teaching concept of meaningful transfer-led inquiry. The teaching process and even the teaching structure will inevitably change, then teachers will no longer teach according to Bloom's cognitive structure hierarchy, and the new teaching should be unstructured according to students' characteristics as well as the teaching content, and the teaching objectives will become relatively open. Based on this, the study followed the hierarchical content of the cognitive domain and found that students' learning was in the following order.

First, the process of analyzing problems leads to the understanding and construction of knowledge content. Second, knowledge transfer occurs and is applied. Third, they become skilled in solving real-world problems creatively or making creative suggestions.
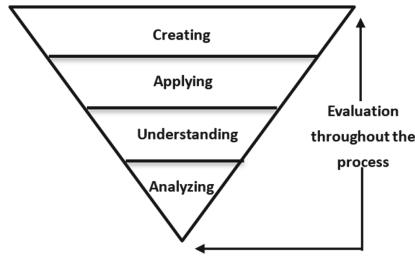
Fig. 2. Teaching process design is based on the classification theory of teaching objectives

In this regard, evaluation is carried out throughout the teaching and learning process, as shown in Fig. 2.

In geography teaching, students should not only understand and master the knowledge of geography, but also apply the knowledge in real life to improve their ability to analyze and solve problems. The anchored teaching method used in geography teaching is more in line with the current educational philosophy and curriculum standards. In the information age, it is necessary to be good at applying technology to promote teaching reform. The design principle of the anchored teaching method is based on Gibson's "supply theory", aiming at the contagious real situation, the real situation is presented with the help of virtual reality technology, and the teaching situation is intuitively interpreted to the students, making the situation more contagious and motivating the students interest in learning. Students complete the construction of knowledge through autonomous learning and collaborative learning in the classroom, and acquire the ability to solve practical problems and promote the occurrence of effective learning behavior and stimulate the potential of students [10].

The teaching sessions include creating a context, identifying problems, independent learning, collaborative learning, and evaluation of effectiveness. Applied to teaching, its structure can be further divided into four parts: anchor setting, dropping anchor, unanchoring and anchoring. The teaching activities as well as teaching methods under the comprehensive constructivist idea are constructed to conform to the process of geography teaching, as shown in Fig. 3.

The process of teachers' analysis of teaching materials (teaching contents) as well as learners' characteristics can be regarded as the basis of anchoring. Teachers create situations based on students' existing cognitive structures as well as textbook knowledge to determine the teaching contents and teaching process in the classroom.

In the process of breaking down, the teacher presents the created situation to the students in an appropriate way with the assistance of computer technology and according to the teaching content of the current class. The use of virtual reality technology to create a teaching environment with realistic scenarios and bring students into virtual scenarios can not only make students mentally prepared for learning, but also stimulate students' interest and motivation in learning. In the link of identifying problems, the teacher does not just ask questions, the questions should be inspiring, and the problems should be progressive in their inspiration. Students make connections with their existing knowledge in the context to pave the way for further analysis of the problem, and the teacher should do a good job of guiding students' learning strategies. In the process of
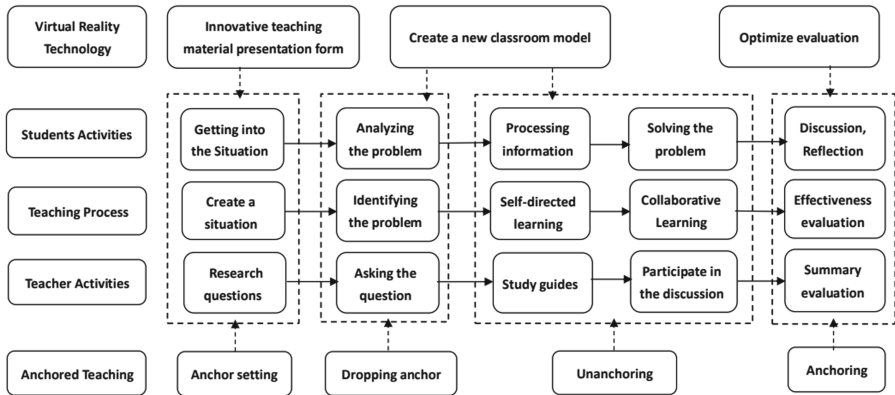
Fig. 3. Teaching process based on anchoring teaching method

releasing anchors, students make full use of computers to collect, analyze and process information in the process of self-inquiry learning, while teachers provide cognitive tools for timely guidance; in collaborative communication, students discuss and share information resources to further solve problems and gain knowledge construction, and teachers actively participate in students' discussions and make progress together with them.

In fact, whether it is independent learning or collaborative learning, teachers and students have the same role - learners - to facilitate problem-solving and meaningful construction of knowledge. In the anchoring session, which is to remove the anchor, the teacher summarizes the students' discussions and expands the relevant knowledge as a way to promote the transfer of students' knowledge and achieve the teaching objectives. In the whole teaching process, the teaching method is no longer the traditional indoctrination teaching, the teacher is no longer the only provider of knowledge, and the students are no longer one-way listening and taking notes; the process of analyzing the problem from the situation to the problem solving, understanding and mastering the relevant knowledge, when the internalization of knowledge is completed, further promoting the transfer of knowledge, applying the knowledge to solve similar problems, and when the knowledge is constructed to a certain extent, when solving When the knowledge is constructed to a certain extent, constructive opinions are put forward in solving practical problems in life, and teachers intervene in the whole process to guide students' learning at the right time, so that evaluation is carried out throughout.

3.4 Teaching Application

Under the requirement of the new standard, geography teaching pays more attention to the cultivation of students' geographic core literacy rather than the memorization of relevant geographic knowledge. However, as far as China's high school geography teaching is concerned, it is deeply influenced by the concept of exam-oriented education, and both teachers and students are under great pressure, thus the teaching is still mainly traditional teaching. In order to further promote the reform of teaching structure, the
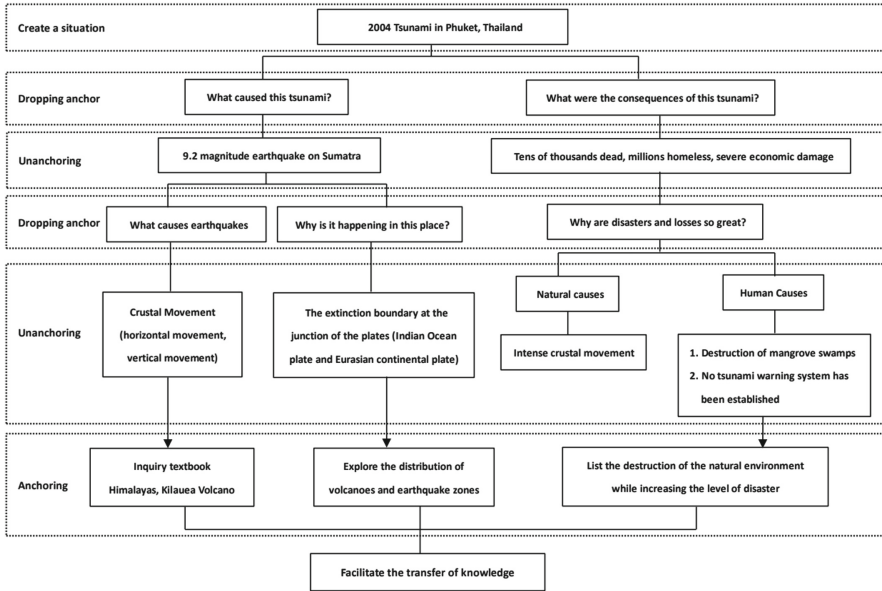
Fig. 4. Teaching model based on anchor-based teaching method

author chooses the study for the high school geography stage, and combines the above-mentioned model to select the classroom teaching design of the first section of Chapter 4, Shaping of Surface Form, Chapter 4 of the compulsory geography of the first year of the human education version, as shown in Fig. 4.

The teaching content of this chapter is about what is the surface form, what are the forces that create the surface form and how to shape it. Students in senior high school are not unfamiliar with this section based on their junior high school learning, and the surface form is closely related to their life.

Taking the 2004 tsunami in Phuket, Thailand as the background, teachers use virtual reality technology to create a realistic tsunami-related situation, so that students can enter this situation, feel the whole process of the tsunami more intuitively, and do a good job of learning psychology.

After the teacher identified the problem, the students used the computer to collect relevant information, and discussed the causes and consequences of the tsunami through independent learning and collaborative communication. After experiencing the tsunami scene, the students were deeply shocked, which intuitively promoted the students' understanding of the tsunami, shortened the time to analyze the problem, and improved the learning efficiency. After the first session of dropping anchor and unanchoring, students get a tsunami caused by an earthquake, resulting in massive casualties and economic losses. Ask what would cause a 9.2 magnitude earthquake in Sumatra? Students explore the relevant knowledge points of this lesson from the context of crustal movement, and reorganize and construct with the existing cognitive structure. Layers of progressive problems constantly break down and unravel. In this process, students can continuously improve their cognitive level and the ability to use computer-assisted problem-solving.

According to the students' cognitive level and classroom performance, the virtual reality technology is used in a timely manner to present the content related to the crustal movement intuitively.

The second dropping anchor and unanchoring has converted the knowledge related to the internal forces of crustal motion into the conclusions explored by the students, from the instillation of knowledge to students' independent inquiry, the real meaning of mastering the knowledge of this lesson, learning in the inquiry, not limited to the mastery of knowledge itself, but also the ability to analyze and solve related problems. In the final anchor link, the knowledge of this lesson is summarized and reflected, and the corresponding knowledge is expanded, from the movement of the earth's crust to the typical formation of the Himalayas due to plate movement and the Kilauea volcanic eruption to create new land also make a distinction, recall the distribution of volcanic seismic zones, and then to the students' reverence for nature and conservation, so as to promote the meaningful construction of knowledge and knowledge transfer of students. Virtual reality technology runs through the entire teaching process. Teachers should participate in students' discussions in every link and actively adjust teaching according to students' classroom performance [11].

4   Conclusion

Guided by the theory of constructivism, the research adopts the anchored teaching method, and discusses the practical application of simulation technology and sensing technology in virtual reality technology in geography classroom teaching. In teaching, virtual reality technology not only creates a teaching environment for broken-down teaching, but also promotes the integration of information technology and subject teaching. The use of technology has not only changed the indoctrination teaching mode in the original geography classroom teaching, but also cultivated students' interest in geography. Under this model, students not only master knowledge in geography class, but also solve practical problems, and improve their computer-assisted learning ability.

At present, with the development of computers, the development of virtual reality technology in the field of education will become more and more extensive. Follow-up research will continue to focus on the application of virtual reality technology in classroom teaching, in order to further improve the teaching mode and promote teaching through practical teaching. Structural change, and ultimately achieve the coordinated development of computing and education.

References

1. Yang Jie, Ding Yaoqing. International Charter for Geography Education 2016 [J]. Reference for Geography Teaching in Secondary Schools, 2016(15): 22–24.
2. Ministry of Education. Notice of the Ministry of Education on Printing and Distributing "Developing Educational Informatization to Promote Educational Modernization 2030" [EB/OL]. [2017–03–25]. http://www.moe.gov.cn/jyb_xwfb/moe_176/201703/t20170327_300988.html.

3. Shenyang, Lu Xing, Zeng Haijun. Virtual Reality: A New Chapter in the Development of Educational Technology—Interview with Professor Zhao Qinping, Academician of the Chinese Academy of Engineering [J]. Research in Electronic Education, 2020, 41(01): 5-9. DOI: https://doi.org/10.13811/j.cnki.eer.2020.01.001.
4. Fu Bojie. Geography: From Knowledge, Science to Decision [J]. Acta Geographica, 2017, 72(11): 1923–1932.
5. Niu Chao, Liu Yuzhen. On the connotation, characteristics and training strategies of core geographic literacy [J]. Journal of Tianjin Normal University (Basic Education Edition), 2015, 16(04): 48–51.
6. Wang Jing, Gao Bo. VR-based simulation study of video image processing effect optimization [J]. Computer Simulation, 2021, 38(03): 148–151+200.
7. Xiao Xiongwu. 3D reconstruction of tilt photogrammetry scenes with structure-aware function [J]. Journal of Surveying and Mapping, 2019, 48(06): 802.
8. Wang Zhen, Gai Meng, Xu Hengshuo. Surface reconstruction algorithm of 3D scene images based on virtual reality technology [J]. Journal of Jilin University (Engineering Edition), 2022, 52(07): 1620–1625
9. Xie Limin. Revitalizing the vitality of classroom teaching [J]. Curriculum. Textbook Teaching Method, 2001(07): 19-23. DOI: https://doi.org/10.19877/j.cnki.kcjcjf.2001.07.004.
10. Zhu Yongyong. On the implementation of the anchored teaching model [J]. Asia Pacific Education, 2016, (25): 290-291.
11. Shen Ruiqi, Li Lin, Yao Meng. The application of anchored teaching in junior high school geography classrooms—Taking "Australia" (first class hour) teaching as an example [J]. Geography Teaching, 2021(16): 35–39.