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Combination of STEAM Concept and Virtual Reality Teaching—Taking the Virtual Smart Car Experiment as an Example

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ABSTRACT
Being project-based or problem-solving-oriented, STEAM education aims to guide learners to use interdisciplinary knowledge to solve practical problems. While being immersive and imaginative, virtual reality (VR) is becoming more and more popular in education as a new and effective interactive way. A virtual intelligent car laboratory, which consists of virtual car assembly, obstacle avoidance car experiment and sensor learning, is therefore built by combining STEAM education concepts with virtual reality technology. In the laboratory, learners can obtain a feeling and experience similar to that in the real world through interacting with necessary equipment and virtual scenes. And the visualization, contextualization and perception of STEAM teaching theory and practice are achieved through virtual interactive teaching projects. Also, the experiment confirms that the laboratory could be of practical use and cultivate learners' comprehensive ability and practical innovation capability.
Keywords*: STEAM education, Discipline integration, Virtual reality, Project-based learning*

1. INTRODUCTION

Virtual reality is a scientific method and technology created and gradually formed by human beings in the process of exploring and understanding nature for understanding and simulating nature, and then better adapting and using nature. It combines computer technology, sensor technology, multidisciplinary knowledge such as artificial intelligence and electronic technology. Virtual reality technology generates a digital visual environment that is highly similar to the real environment through multi-source information fusion, interactive three-dimensional virtual scenes and specific virtual equipment [1]. At present, it has been widely used in entertainment, military, medical and other fields. As a new interactive means, its application in the field of education has become more and more extensive. In the digital learning environment constructed by virtual reality, learners can interact with it to get immersive feelings and experiences, so as to realize autonomous learning in a similar real environment [2]. The virtual learning resources can be interconnected and integrated with the real teaching environment, and its characteristics are the same as the STEAM education philosophy, which allows learners to learn knowledge immersively while stimulating creativity and imagination. This paper proposes to combine the construction of the virtual smart car laboratory with the STEAM education concept, and with the STEAM education concept as the leading idea, construct a virtual smart car laboratory for the integration of multidisciplinary knowledge.

2. STEAM EDUCATION OVERVIEW

2.1. The origins of STEAM education

STEAM education started in the United States and integrates science, technology, engineering, art and mathematics. To solve the crisis of the talent gap in science and technology, the US government originally proposed the SMET education strategy in the 1980s. In 2011, in order to make the connotation of STEM education broader, American scholar Georgette Yakman incorporated Arts (humanities and arts) into STEM education, and emphasized that STEAM education emphasizes both liberal arts and sciences, focusing on cultivating science and engineering literacy, and thus proposed the concept of STEAM education [3]. In recent years, STEAM has begun to attract widespread attention from the education community in China. Under the requirements of "China Education Modernization 2035" for the cultivation of top-notch innovative talents and the realistic requirements of "increasing the proportion of applied, compound, and technical talent training", a new wave of STEAM education has been triggered, and the country has gradually paid attention to the development and implementation of STEAM education [4].

2.2. Characteristics of STEAM education

Through the integration of interdisciplinary knowledge, STEAM education creates a situation for learners to creatively solve practical problems by using multidisciplinary knowledge. Its goal is to cultivate learners' basic literacy in science and innovation. Compared with the traditional subject education, STEAM education truly breaks the limitation and lag of the traditional subject education concept by cultivating the comprehensive application ability of knowledge under the guidance of interdisciplinary thinking, and realizes the organic integration of science, technology, engineering, art, mathematics and other disciplines [5]. Project-based learning and problem-based learning are the two most common STEAM teaching methods at present. The STEAM education philosophy emphasizes that learners should carry out practical activities to complete projects closely related to real life and solve practical problems in reality. In this process, learners can master interdisciplinary and multi-disciplinary knowledge, and cultivate their comprehensive ability to explore different aspects of the real world and practical operation ability by transforming the knowledge they learn and the project process.

3. REALIZATION OF VIRTUAL SMART CAR LABORATORY BASED ON STEAM CONCEPT

The STEAM education concept has many distinctive features such as interdisciplinary, contextual, interesting, artistic, design, collaborative, experiential, multidimensional, and technical and its teaching methods are diverse. We use virtual technology to build a learning environment for STEAM project learning, providing new ideas for STEAM learning resource design.[6] Integrating the STEAM concept into the design process of the entire virtual scene, integrating knowledge in different fields, promoting learners to use the connections between various disciplines to solve practical problems and achieve targeted teaching goals. At the same time, combined with the curriculum standards of each subject to give the project scoring standards, it is convenient for the objective evaluation and feedback of learners' performance in learning, which is conducive to strengthening the learners' understanding of the curriculum and clarifying their own strengths and weaknesses.

3.1. Combination of STEAM education and virtual reality

Figure 1 shows the combination of virtual laboratory and STEAM education; the virtual reality teaching project guided by the STEAM education concept breaks through the limitations of traditional teaching projects, allowing learners to complete multi-disciplinary knowledge integration projects in virtual environment interaction, acquire knowledge and improve comprehensive scientific literacy. STEAM education focuses on the connection between knowledge of different subjects and guides learners to use interdisciplinary thinking to learn and solve real problems. The immersive and interactive learning method of the virtual laboratory fully reflects the concept of STEAM. The integration of multi-disciplinary knowledge is delivered to learners through a virtual environment, and abstract knowledge is embodied and visualized, so that learners can learn and master knowledge intuitively. At the same time, the project-based teaching mode of virtual laboratory is conducive to learners' practical ability Promote. The combination of the concept of multidisciplinary integration and the characteristics of virtual reality can not only stimulate learners' interest in learning, but also promote the transformation of thinking mode. In the process of interaction with the virtual environment, the learner's comprehensive ability is fully exercised and improved. This is a dynamic learning and improvement process.

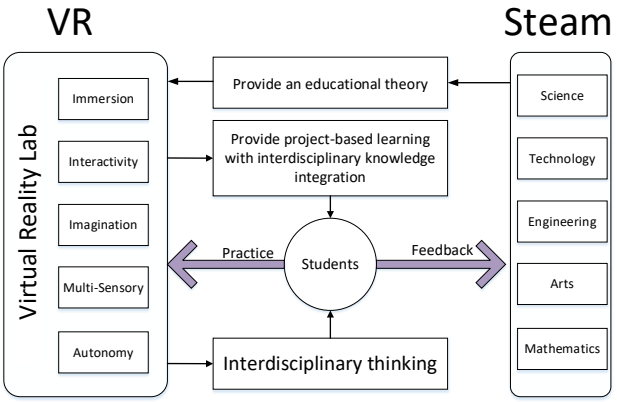

Figure 1. Combination of VR and STEAM education

3.2. Construction of Virtual Intelligent Car Experiment

The virtual smart car laboratory is composed of two parts: hardware and software. The hardware part is composed of HTC VIVE virtual reality head-mounted displays. The software part is modeled by 3DMAX. The model is built in Unity3D for the virtual laboratory scene. Visual Studio writes scripts to control the model and realize the logic functions in the scene. By operating the virtual device handle to interact with the scene in real time, learners learn experimental principles in a deeply immersive virtual scene, assemble the car, and realize the intelligent obstacle avoidance car. Finally, the system was released and tested on the Windows platform. The main functions are virtual scene roaming, virtual car building, sensor knowledge learning and obstacle avoidance principle, evaluation system.

3.3. Introduction of main scenes

Overall function introduction: As shown in Figure 2, the system includes four major modules: laboratory main scene, practice mode, principle and sensor characteristic learning, and experiment selection. The initial interface is the main laboratory scene and menu panel. Wear VR glasses, and use the handle disc buttons to emit rays to control the movement of characters to realize roaming in the virtual scene (move in the virtual scene and browse the facilities in the virtual scene).

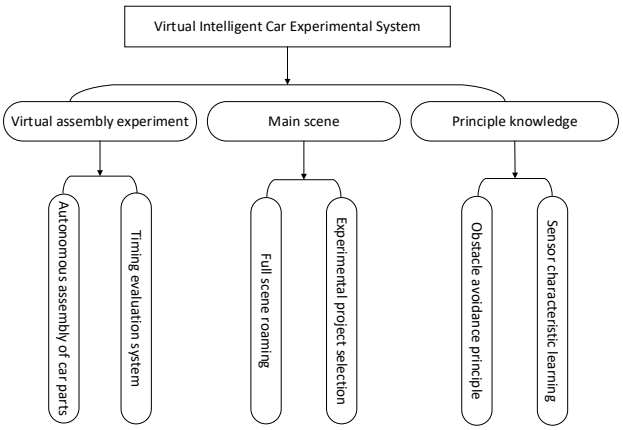

Figure 2. Virtual Intelligent Car Experimental System

As shown in Figure 3, you can select a specified experiment item in the menu panel, and click the handle trigger button to jump to the selected experiment item interface. Figure 4 shows the virtual car assembly experiment. Click to start the assembly and the car parts will appear and the timing will start. Handle will be used to grab the parts and install them to the correct position. When the package is completed, the corresponding evaluation will be given according to the time used.

Figure 3. Main scene panel

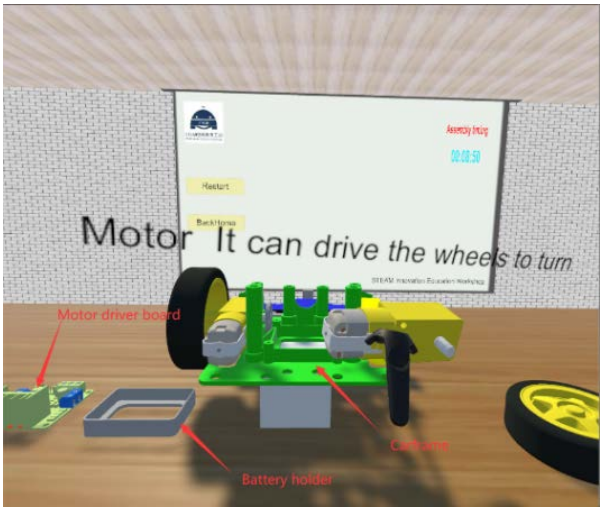

Figure 4. Virtual car assembly

Figure 5 is the obstacle avoidance car experiment project. The principle of the obstacle avoidance car experiment is introduced through pictures and text information, and the program flow diagram is given. Graphical programming can be realized on the left panel of the table. After completion, the test can be performed to view the obstacle avoidance car movement status. Figure 6 is the sensor characteristic learning scene. Use the handle to grab the corresponding sensor, and select the left and right buttons through the handle to emit rays to view the introduction of different sensor characteristics.

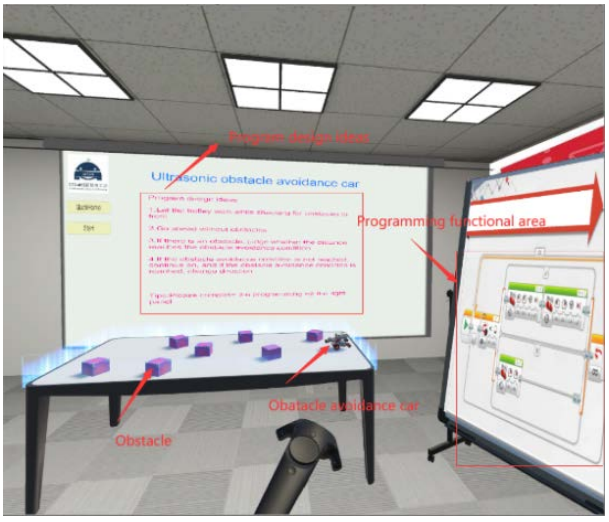

Figure 5. Obstacle avoidance car experiment

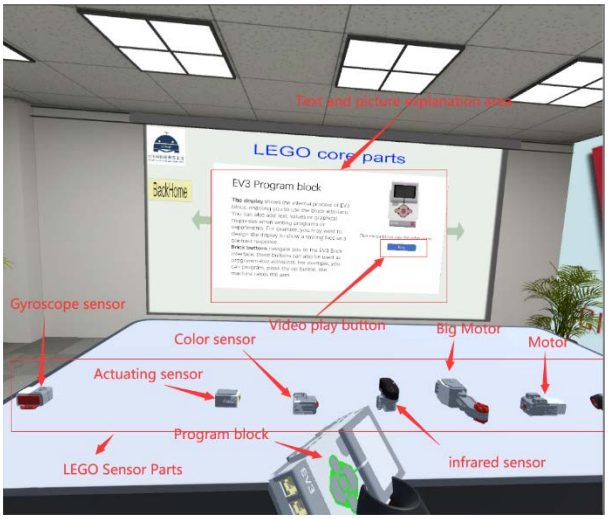

Figure 6. Sensor learning

3.4. Analysis of the practical effect

In order to verify the operating effect of the virtual learning environment based on the concept of STEAM, we selected three males and two females with certain computer operation ability as the research objects for the empirical study. They were asked to use the virtual system to study course projects, so as to verify the learning effect of the virtual environment.

In the process of empirical research, most learners were highly interested and immersed in the learning experience. They can solve the problems encountered in the learning process by communicating with their peers, which helps to cultivate the learners' STEAM literacy. Through the virtual assembly system and the evaluation system that was actually operated by the learners, we can intuitively observe the use of the learner's mastery of the car's functional modules and assembly knowledge with a virtual environment. When using the visual programming system to simulate obstacle avoidance car verification, learners can intuitively discover the main influencing factors such as process control and sensor settings by adjusting the parameters and observing the status of the car. Based on the concept of STEAM education, virtual reality technology is used to assist learners to understand complex subject knowledge, and contribute to learners' inquiry learning in a virtual environment. This teaching model based on project learning and problem inquiry has achieved a good effect on cultivating learners' comprehensive ability.

4. CONCLUSION

The goal of STEAM education is to cultivate learners' interdisciplinary thinking mode and pay attention to digital learning mode. It requires teaching to make full use of digital teaching resources and tools to realize the sharing of teaching resources, which is conducive to greatly improving learning efficiency. And virtual reality technology has the characteristics of immersion, interactivity, imaginative. The virtual experimental environment created by the virtual intelligent car laboratory allows learners to practice and learn in exercise, promote learners to master experimental knowledge and experimental skills, and train learners to use interdisciplinary thinking to solve problems. This fits well with the philosophy of STEAM education. Incorporating virtual reality technology into STEAM education and teaching, integrating different subject knowledge, integrating multi-disciplinary knowledge background through project-based design to enhance learners' disciplinary literacy in all aspects, expanding teaching methods and enhancing the interest of teaching knowledge, reconstructing the knowledge system of course teaching has improved learners' interest and enthusiasm for learning. It has been proved in practical applications that the virtual laboratory is an effective virtual teaching method that conforms to the STEAM education philosophy.

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