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Instructional Design of STEAM Education Based on Virtual Reality Technology ——Taking LEGO Bricks as An Example

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Abstract: STEAM education can integrate interdisciplinary knowledge through projects, develop learners' hands-on practical skills and promote innovation ability through project learning, which is conducive to the development of learners' comprehensive development. Meanwhile, with the rapid development of computer network technology, virtual reality (VR) plays an increasingly important role in education, and its combination with education has become much closer. This study combined the STEAM education with VR and developed an instructional design with LEGO Bricks as an example. The instructional design developed was proved not only to pass on learners' interdisciplinary knowledge imperceptibly, but also cultivate their hands-on practical skills and innovative ability during the whole project. Finally, VR technology is applied to realize the instructional design in a visualized way.

Keywords: STEAM education, virtual reality, instructional design

1. Introduction

Nowadays, countries are faced with the contradiction of lack of comprehensive talents while the task of cultivating innovative competence is becoming more and more crucial. However, problems remained in STEAM education can be attributed to three-fold. First, the results of some theoretical studies are too macroscopic to be landed in practical teaching and application. Second, there is a considerable gap in establishing a systematic and rigorous curriculum resource system. Third, lack of funds and education equipment has led to the inability of popularizing STEAM education to some extent.

The purpose of this study is to first, design a curriculum resource by accessing to literature and field research, and combine science, technology, engineering, arts, and mathematical into a project to help solving problems derived from reality. Second, apply virtual reality technology to create an immersive and simulated learning environment aiming at fostering learners' ability. LEGO Bricks were used as an example since this study is aimed at preschool children.

2. STEAM education

By integrating knowledge and skills in science, technology, engineering, art and mathematics, STEAM Education integrates disciplines that are traditionally unconnected and isolated, combining knowledge points in the discipline (Hetland & Winner, 2004; Liao, 2016; NAEA, 2016). In the process of project learning, it can effectively avoid the knowledge split caused by traditional teaching, which is not only conducive to cultivating students, but also help cultivate the comprehensive quality, hands-on practical skills, teamwork ability and innovation ability (Gates, 2017).

3. Virtual reality (VR) technology

With the development of technology, virtual reality technology has made great progress. At the same time, virtual reality has lots of advantages (Ke et al., 2015). Applying virtual reality technology to STEAM education can combine the advantages of both: providing a virtual immersive teaching

environment to stimulate students' interest; adopting interdisciplinary project teaching methods to improve students' comprehensive quality and innovation ability. Besides, the combine of these two can cost the least but create the more.

4. Instructional Design

4.1 Basic Ideas of Instructional Design

Project-based learning is a student-centered approach to teaching, and it emphasizes the tasks and problems of the real world, can be related to the reality of life. At the same time, project-based learning is usually carried out in small groups, they can communicate and collaborate with their partners, which is conducive to cultivating students' teamwork and communication skills. The project-based learning can be used in the STEAM education, and it also cultivates the students' comprehensive ability.

The "learning by doing" was proposed by the famous American educator Dewey. He believes that "all learning is a by-product of action, so teachers should 'do' to encourage students to think and learn". The instructional design of this study starts with the problems in real situation, which lets the students solve problems through hands-on practice to achieve real "learning by doing".

4.2 Instructional design

In the case of consulting relevant literature materials and field visits of existing STEAM training institutions, the content of the teaching is determined to "a big manor". It is necessary to use LEGO bricks to make houses, cars and parking lot gates. The project design is shown in Table 1.

Table 1

Project design

Project name: A big manor **Project goals:** To master basic scientific knowledge points and methods for building LEGO bricks. To use building blocks to build space thinking ability and hands-on practical skills. To enhance teamwork and communication skills through cooperation.
Design Challenge: Students are expected to design a manor. The project' success criteria are aesthetics and practicality.
Mini project Challenge 1: *Lovely house* To know the common building blocks in LEGO bricks. To master the method of "stitching" the building blocks. **Mini project Challenge 2:** *Fast car* To know the special blocks such as nine-hole beams and pulleys in LEGO bricks. To initially understand the existence of friction and simply determine the amount of friction. **Mini project Challenge 3:** *Flexible parking lot gate* To know the special blocks such as beams, gears, handles and turbine boxes in LEGO bricks. To know the simple turbine and understand its self-locking function.

4.3 Virtual Reality Technology Implementation

This study uses Photoshop and 3ds Max to create classroom models and LEGO bricks' models, teacher role models and other models required by the classroom. And then import 3D models into Unity3d for integration and optimization, to achieve the basic functions of STEAM teaching. The software structure diagram for instructional design is shown in Figure 1.

The STEAM instructional design is mainly divided into three parts: "Recognition", "Learning" and "Doing".

"Recognizing": Introduce the LEGO bricks. Introduction and voice of the corresponding will appear if click on the Lego bricks. The mouse can control the zooming and rotation of the scene.

"Learning": Through the "Project Introduction Video", the tasks that need to be completed in this project are proposed. Other videos explain the skills of building LEGO bricks.

"Doing": Apply the above-mentioned learning to the actual situation. The left mouse button controls the appearance of the LEGO bricks, the middle mouse button controls the zoom of the screen, the right mouse button controls the rotation of the screen, and the keyboard control the movement of the screen. As all shown in Figure 2.

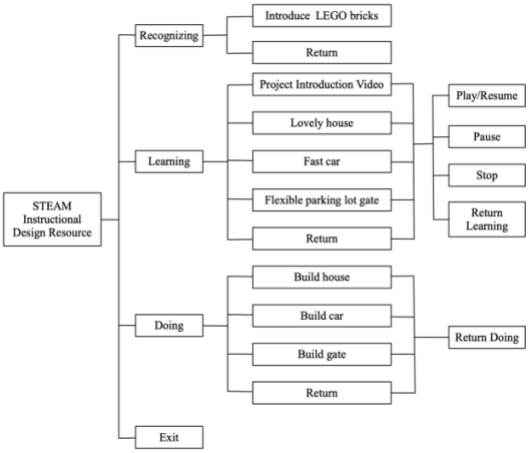

Figure 1. instructional design

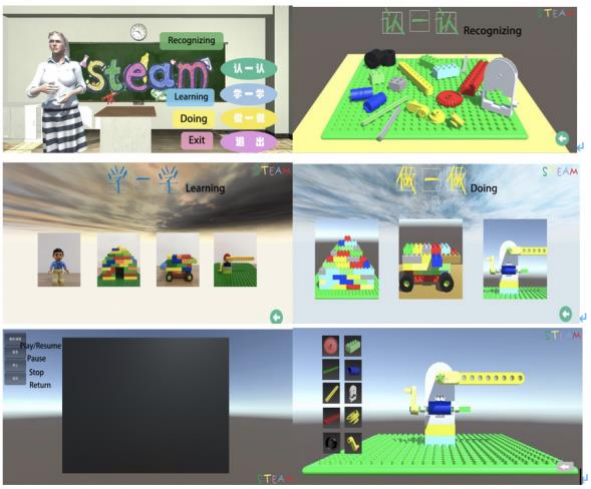

Figure 2. schematic diagram

5. Results

After the instructional design content was completed by virtual reality, it was practiced for three months in the audition course of a STEAM institution, and the results are quite good.

Students can integrate the life content in the learning process and make it easy to understand. And the construction of LEGO bricks requires not only three-dimensional design, but also the observation and analysis of the geometric features of the LEGO bricks, which has great benefit to the development of students' spatial thinking ability. Besides, through project-based learning, students can develop creativity and hands-on practice in the process of independent inquiry.

6. Conclusion

The development of STEAM education can be combined with the emerging technologies of the moment, and the combination with virtual reality is a good way. Virtual reality has many advantages such as stimulating learners' motivation, creating a realistic teaching environment, feeling immersive learning experience, and integrating cross-border knowledge. Because of the commonality of STEAM education and virtual reality, their combination will create a huge advantage. However, how to better demonstrate the advantages of virtual technology in teaching and how to better implement and popularize STEAM education is worth further exploration.

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