STEAM Education Mode Based on New Technology and User Experience Design

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Abstract. With the application and development of China's STEAM education field, a STEAM education model that is more suitable for Chinese students should be proposed. In order to optimize students' learning experience and quality which is based on the characteristics of students' learning and thinking. By comprehensively considering the combination of new technology and service design thinking system, we have constructed a set of STEAM education curriculum system based on AR technology and spatial experience. This research aims to explore the new model and form of STEAM education in the future. The results of this study can be reference for as the new model of STEAM education.

Keywords: STEAM education · User experience · Augmented reality · Spatial interaction

1 Introduction

To face the rapid development of the times, the importance of comprehensive talent training in the education field has gradually been recognized by the world, and highly comprehensive STEAM education has become one of the hot spots of education in the 21st century. The problem-based learning method (Problem-Based Learning, PBL) has many similarities with the concept of STEAM education pursuit because of its teaching characteristics, and is often used in the design of STEAM courses to improve teaching quality [1].

However, here are still many problems in China's STEAM education market at this stage. Due to the involvement of commercial interests, many research institutions have neglected the research of related courses and teaching methods, Teachers follow the old form in class, the content of the class is homogenized and the curriculum is single. The students did not get a good teaching experience so as to fundamentally break away from the essence of STEAM education [2].

Therefore, how to use user experience design thinking to dominate PBL-style STEAM education, so as to enhance students' user experience in the learning process as well as to achieve the goal of STEAM education and cultivate comprehensive talents in the new era is an issue worthy of discussion [3]. In order to achieve the above purpose, we research on the existing PBL-style STEAM education model, proposing a PBL-style.

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STEAM education model design method based on augmented reality and space interaction, and construct a Mars transformation STEAM education curriculum experience which design for middle school students based on the research results scheme, in this way, the above-mentioned design scheme is derived to test its rationality. The research uses AR technology to propose a forward-looking design plan for the STEAM education space, which is of great significance to improving the user experience of STEAM education under the PBL mode.

2 STEAM Education and PBL Learning

2.1 STEAM Education Model and Current Situation

STEAM refers to five courses of science, technology, engineering, art, and mathematics. STEAM education refers to a multidisciplinary integrated interdisciplinary comprehensive education [4]. In 2015, the Ministry of Educational Affairs of China proposed "Explore STEAM Education, Maker Education". In 2017, the Ministry of Educational Affairs once again pointed out that STEM is a form of curriculum organization oriented by project learning and problem solving [5]. Since then, STEAM education has gradually entered the national education development plan.

However, STEAM education in China is mainly based on the background of Maker education, and teaching is based on project-based courses, such as robotics, artificial intelligence, 3D printing, Lego and other course content [6]. Compared with the diversification of foreign STEAM education, domestic STEAM education is obviously tending to be homogeneous. Especially under the intervention of commercial interests, domestic STEAM education institutions have over-packaged educational products in order to compete for the student source market, ignoring the research of related curriculum content and teaching methods, which has further aggravated the separation of the STEAM curriculum and the essence of education.

2.2 The Integration of PBL Education Mode Under the STEAM Education

PBL is a problem-based teaching method based on a real-world student-centered education method [6]. STEAM education and PBL teaching, the former is an educational concept that advocates the integration of multidisciplinary knowledge to solve specific problems, while the latter, as a teaching method, advocates guiding students to think about solutions from problems, which shows that STEAM education and PBL mode have common points and can complement each other. The current PBL is divided into problem-based learning and project-based learning, but it is easy to be confused and used in actual teaching applications. Some scholars have integrated the advantages of the two teaching methods and proposed design-oriented production learning (Do PBL) mode. Do PBL emphasizes students' active learning, solving problems or projects in group cooperation, and with the deep expansion of learning, it also requires the development of students' design thinking [7]. Therefore, the team constructed a basic teaching model of STEAM courses based on Do PBL teaching mode, as shown in Fig. 1.

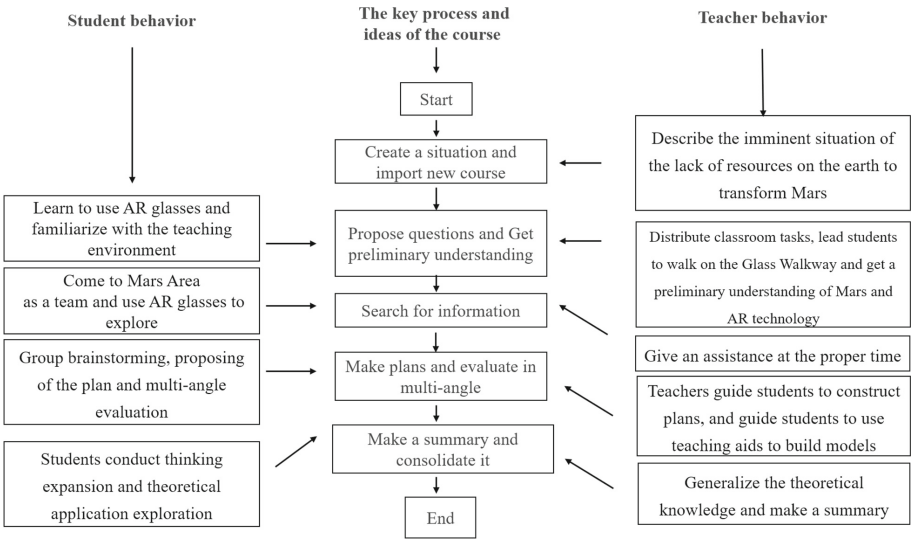

Fig. 1. Basic teaching model of STEAM course based on Do PBL teaching mode formulas

This model is divided into three modules, the basic process of classroom lectures, teacher behavior and student behavior. After the course begins, the teacher needs to create a situational premise to import the new course content, ask questions and guide students to spontaneously understand the background of the problem. The next is the exploration, excavation and program discussion of students in groups. Teachers mainly observe and record students' classroom input in this process and make suggestions for improvement of students' programs. In the final stage of the course, the teacher summarizes the knowledge points of the course, and guides the students to think deeply and sublimate the meaning of the course.

3 STEAM Education Led by User Experience Design Ideas

3.1 User Experience Design and Education Situation

User experience refers to the overall feelings of users before, during and after using a product or service, including emotions, beliefs, preferences, cognitive impressions, physical and psychological reactions, behaviors and achievements. Morville, an information construction expert, proposed a "hive" model of user experience, which pointed out that user experience is composed of seven aspects: findability, usability, usefulness, desirability, accessibility, reliability and value. Traditional usability pays more attention to users' cognition in human-computer interaction. However, some researchers believe that in addition to practical functional standards, the emotional component of the design will also affect the user's product evaluation [8].

Learning is a process from perception to concept formation. Perception is the ability to accept sensory impressions from the environment and prior knowledge. Therefore,

the learner's feelings, feelings, thinking and conceptual development are closely related. Thinking and emotion are usually cultivated together [9]. Therefore, from the perspective of students as users, in addition to fulfilling the knowledge education function of "usability" in education courses, constructing teaching situations based on the students' experience in the learning process can improve students' emotional participation and thus positively affect students' participation in the curriculum so as to evaluates and triggers students to think more deeply.

Constructing experiential teaching based on student learning experience is a learning process that allows learners to gain cognition from the process of practice and reflection. By creating experiences of sharing, interaction, reflection, and practical application, learners are promoted to produce more in-depth Cognition and insight.

3.2 STEAM Education Integrated User Experience Design

STEAM education emphasizes interdisciplinary learning, which means that the content and teaching methods of the courses in STEAM learning courses will be more diversified. From the perspective of the usability in the composition of user experience, the current "usability" of user experience in STEAM education refers more to the interface and process operation of students on the computer side, and lack of design for other sensory contacts and emotional experience of students. The user experience design (User Experience Design, UED) is to research and analyze the user's experience of the product, and optimize the design on this basis, focusing on the user experience process and sense of experience, which exactly compensates for the current STEAM Deficiencies in education.

A state university in the United States launched a control group to conduct a case study, which was divided into two phases of teaching: one group was for the development of interactive learning resources; the other group was for curriculum learning using somatosensory controllers. The comparison result shows that both students and experimental observers agree more with the teaching effect of somatosensory controller and its learning resources. It can be seen that enriching students' experience and promoting the deep integration of information technology and education and teaching has forward-looking significance for the development of education [10].

4 PBL-Style STEAM Education Experience Based on Augmented Reality and Spatial Interaction

Augmented Reality is abbreviated as AR technology, also known as augmented reality technology. It is a technology that calculates the position and angle of the camera image in real time and adds corresponding images, videos, and 3D models. The goal is to superimpose the virtual world on the screen and interact with the real world which is widely used in the field of interaction design today in order to enhance the user experience.

STEAM education focuses on cultivating students' application-oriented skills such as problem solving, group collaboration, and communication. Therefore, how to construct a scene in a real situation as the background of driving problems and

stimulate students' interest is the key problem that class researchers need to solve. And AR technology can present things that are difficult to simulate and costly to implement in the real world in the form of virtual images, which provides the possibility of realizing the simulated scenes required by STEAM education for certain specific topics. At the same time, students' interest and experience can also be effectively improved in the process.

Compared with ordinary courses, STEAM education pays more attention to the cultivation of students' ability to use the knowledge and skills learned to solve practical problems. In addition to interdisciplinary and design, it also emphasizes the fun and experience in the process. Students acquire feelings and knowledge through experience and operation in the course, form their own experience, and use them as the basis for solving problems in the future. Therefore, it is a question worth pondering that how to enhance students' experience in STEAM education, so that they can leave a deep impression on the problem under the situation and the way to solve the problem. AR technology can bring students a concrete and vivid scene experience in the education process. Through AR technology, some obscure knowledge can be displayed in visual forms such as animation. In addition, it can also simulate certain difficult-to-achieve or professional and dangerous scenarios, which broadens the channels and provides more possibilities for STEAM teaching.

Different from VR (Virtual Reality), the essence of AR technology is to superimpose virtual images on the basis of real scenes, instead of directly creating an overhead scene. Relying solely on AR technology, it is difficult to create a real and infectious immersive scene. In order to solve this problem, it is necessary to design the STEAM education space to enhance the immersion of the student experience based on the use of AR technology. At present, China's STEAM education space layout is relatively rigid, and it is difficult to meet the increasingly abundant STEAM education and teaching needs. It is roughly divided into the following three types: unit type, large space type, and integrated type. Among them, the feature of the unit layout is that several functional rooms are connected together by several traffic arteries, and the space utilization rate is high, but the space is homogenized, lacks change, and it is difficult to get out of the atmosphere of the traditional classroom; Hard cutting, flexible space, strong applicability, but also causes interference between various functional areas; comprehensive education space combines the characteristics of the previous two, has its own advantages and disadvantages, and is a compromise treatment method.

Through the research of AR technology and the combing of the existing STEAM education space, a PBL-style STEAM education experience design method based on AR technology and spatial interaction is now proposed, aiming to create an immersive course scenario, thereby enhancing students' experience in the project process Experience provides more possibilities for STEAM course design. This method requires that the STEAM curriculum design be regarded as a service design for the target population, and the touch point management method is used to plan the user's class process and the behavior of related personnel by drawing a service blueprint. In the setting of the curriculum, it is in accordance with the PBL-style education on the basis of the design principles, drawing up a course theme scene, and design specific course content according to the scene. In addition, the teaching space breaks the existing style and plans according to the course scene on the basis of a comprehensive layout whose

intention is to create a real and immersive teaching space as well as to combine AR technology on top of this to further enhance the immersion of the user experience.

5 Plan Interpretation

STEAM education emphasizes guiding students to develop their knowledge and skills as well as solve real-world problems, which focus on interdisciplinary experiential learning and application. Through operation and experience in the course, then feelings and knowledge as the basis for future problem solving that students obtained. (Scholar's point of view) Therefore, how to use UED (user experience design) to improve students' experience in STEAM courses and improve the learning effect is the focus of the current education and design circles. Based on the above research, we put forward the following views on this issue. First of all, the makerspace is the primary carrier for students to conduct STEAM education, which should try to establish connections with the real world and solve real world problems as well as undertake specific projects and tasks. Rob Davies, a senior consultant of the UK Information and Digital Access Network, has long been engaged in the research of makerspace and innovation education. He believes that makerspace can be used as a "manufacturing laboratory", "media laboratory", and "hacker space". "Digital creation", "coding" and other functions. In this regard, we believe that the space for STEAM education needs to be based on the theme of the STEAM course, breaking through the traditional classroom pattern, and create an immersive space experience for students, making it seem to be in the background of the course.

Through the creation of an immersive education space, students can put themselves in and understand the nature of the right problem under the scene of the course setting, which improves their perception of knowledge and problem-solving ability. Secondly, UED (user experience design) focus on the interaction between people and products (in particular, people and the environment). In order to create the medium or environment, it depends on for a particular experience. Some scholars believe that there are three basic methods for exploring the formation mechanism of user experience: one is product-centric, the other is user-centric, and the third is interaction-centric.

In the design of STEAM education courses, it is necessary to follow the user-centered approach, thinking about the contact points between students and the course, and think about the interaction formation between students and contact points. In this regard, we believe that the introduction of AR technology can make it possible to avoid some dangerous or difficult touch points in the scenario developed by the STEAM course. An immersive classroom space can create an environment, which is difficult to achieve with AR technology; and AR technology can bring a concrete and visual interactive experience, which improves students' experience in the course.

Based on the above research, we propose We try to make changes on the existing STEAM education model based on the use of user experience design thinking, and propose a STEAM education curriculum design plan for junior high school students with the theme of "Mars Transformation", and use AR technology and spatial interaction to optimize the student's experience in the course. The STEAM education course is called "Reburning Project", whose background is that the future earth

resources are scarce and human survival is threatened. Students play the role of a space expedition team to travel to Mars for transformation, making the Martian environment suitable for human survival.

A course based on AR technology and spatial interaction is now proposed. The course design process follows the above-mentioned design method as a verification of the above-mentioned concept.

The classroom environment is a highly simulated spacecraft and the surface of Mars. After receiving the mission in the spacecraft, the students explore and adventure on the surface of Mars for proposing the solutions finally. The course follows the principles of PBL-style STEAM course design. After the problem situation is raised, students are encouraged to explore and innovate on their own so as to make the solutions come true, while ensuring that the course content covers all subject knowledge.

The curriculum space adopts a comprehensive education space to ensure the utilization and flexibility of space, breaking through the traditional curriculum atmosphere. Following the user experience design requirements for usefulness, ease of use, friendliness, and aesthetics, the space is reasonably divided into five areas: waiting room, spacecraft interior, glass walkway, Mars area, and aerial view platform. The functions of each area which have unique decoration styles, are reasonably divided. The space movement is smooth to ensure that the students complete their tasks opportunely without interfering with each other. The interior of the classroom adopts a spacecraft decoration style for lectures and discussions. The Mars area uses sand and stones to construct real scenery for exploration and discovery. The combination of spacecraft classroom and Mars area restores the real environment of the spacecraft landing on Mars, creating an immersive course scene and optimizing students experience in the course (Figs. 2 and 3).

Space Deduction

Spatial Sequence	Waiting Room	Spaceship	Glass Walkway	Mars Area	Aerial View Platform
Spatial Function	Gather students temporarily before class	Course theory teaching and practice site	Used to familiarize with the teaching environment	Used for class exploration plan	Tourists watch the course
Spatial Type	Rational and static space	Rational and static space	Overhead and next to the wall	Interactive space to explore	Dark and static space
Spatial Shape	Spaceship corridor	Polygonal symmetry space	Overhead glass walkway	Hexagonal and immersive sand	Large glass facade

The Change of floor height

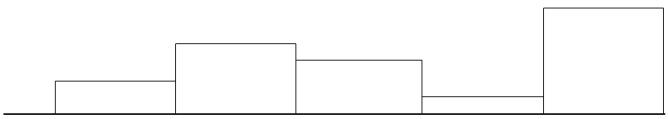

Fig. 2. The STEAM space deduction and the change of floor height

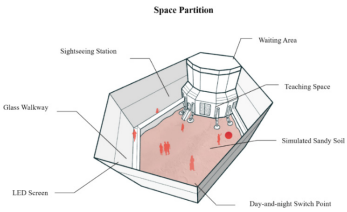

Fig. 3. The STEAM space partition

The use of AR technology runs through the course. At the beginning of the course, the use of AR technology helps students quickly familiarize themselves with the environment and into the learning atmosphere. During the expedition, AR technology presents the knowledge points of the Martian environment in the real world in the form of virtual images. Students use gestures to interact with the images of the information points arranged in the Mars area to independently explore knowledge about problem solutions. In the verification program link, AR technology visualizes the program and knowledge as animations, and integrates tedious and boring knowledge into interesting animations to stimulate learning interest and enhance learning experience. In the course, the virtual image and the real setting are combined, which is interesting and knowledgeable, enhances students' participation experience (Figs. 4 and 5).

AR Technology Use Location	Links	Behavior	Features
Spaceship	Background Introduction	Learn to use AR glasses with the help of teaching assistants, observe other students' name tags, and watch pop-up animations	Familiarize with the use of AR glasses and team members
Glass Walkway	Background Introduction	Observe the surface of Mars	Familiarize with the surrounding and understand the general situation of Mars
Mars Area	Explore and Make Plans	Explore the Martian region, interact with the information points discovered, and intercept information about the problem	Understand relevant knowledge about Mars
Mars Area and Spaceship	Scheme Inspection and Evaluation	Watch AR card and scenario model animation	Verify the feasibility of the plan

Fig. 4. The STEAM AR technology use location

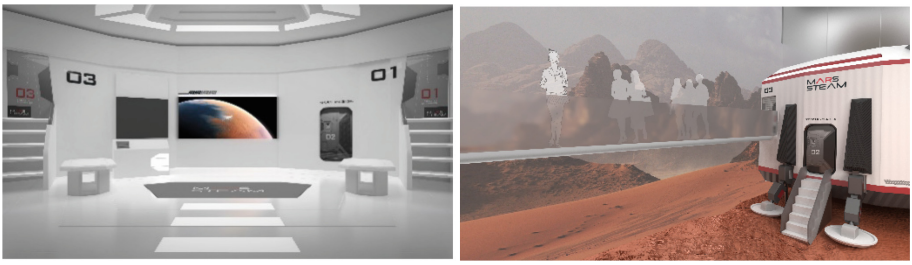

Fig. 5. The STEAM classrooms and external exploration spaces

The combination of AR technology and spatial interaction, real scenery and virtual images together create an immersive course scene, enhance students' experience during the project, and help achieve teaching goals. Students gain experience and knowledge by exploring the experience and operation of Mars in the course, forming a vivid experience about the transformation of Mars, and serving as the basis for solving problems in the future using what they have learned.

6 Summary and Conclusion

This research analyzes the current domestic STEAM education form and the development status of PBL in China. At the same time, it conducted in-depth analysis and explanation of the current STEAM education development issues, and from the perspective of user experience design and the approach of combining new technologies, a PBL-style STEAM education model design method based on augmented reality and spatial interaction is proposed. A kind of education mode plan effectively found that adapts to students and is dominated by future-oriented design thinking in spatial interaction and augmented reality. Expanded more design dimensions in user experience and improved user touch point experience.

Draws the following conclusions:

A: This STEAM education course has reference in space experience design. Compared with the traditional STEAM education space design, it proposes multiple dimensions such as intercommunication space and third-person perspective, which effectively broadens the experience dimension of students' thinking and observation.

B: The STEAM education course combines the course design process and user journey in the application of virtual reality, and considers the interactive relationship between students, effectively avoiding the technology-led curriculum system experience design.

C: This STEAM education course achieves a balance between augmented reality and space experience. Space experience is the basic external touch point of student experience, bringing students a full sense of space atmosphere, combined with augmented reality technology, breaking through the Mars Obstacles to the visualization of the theme effectively improve the interactive experience of students.

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