Illustration Design Teaching Mode based on Virtual Wall Painting Technology

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Abstract—With rapid development of 3D virtual scene, virtual reality (VR) technology starts to be applied in teaching practice. Because of its conception and innovation, VR technology has certain advantage in art creation learning and teaching. In traditional art course teaching, theoretical knowledge is more than design practice, and the depth of design cases is insufficient. Thus, students lack driving force of art creation. On this basis, wall painting technology and VR technology were combined and applied in the course of Illustration Design in this paper. According to the course requirement of Illustration Design – many design cases, Illustration Design teaching mode based on virtual wall painting technology was constructed. The study result showed that, students more approved the new teaching mode, their interest improved greatly and teaching efficiency boosted significantly. The teaching mode can make up for defects of traditional art design teaching mode and contributes to cultivating students' art creation ability.

Keywords—Virtual reality technology; wall painting technology; case-based reasoning teaching method

1 Introduction

As various kinds of assistant software including computer are generalized in the educational field, computer 3D digital scene has received extensive attention, such as virtual simulation campus, virtual experiment and virtual (distance) education. Virtual education generated by sufficient utilization of 3D virtual scene is an important direction of VR technology in the educational field [1]. 3D virtual scene generation technology synthesizes computer graphic (CG), simulation technology, artificial intelligence and display technique. Computer technology assists 3D virtual scene modelling technology and display technique to form integrated applications. The generated simulation system can provide users with visual virtual environment like true environment. Learners can simulate teaching cases in the true environment. The interactivity can make learners achieve situation-based learning. Especially for art courses, the teaching method which is characterized by conception and interactivity and generated on the basis of 3D virtual scene matches with creativity requirement of art, and it will significantly improve the effect of art practice teaching [2]. The

construction of Illustration Design teaching mode based on virtual wall painting technology was explored in this study. Meanwhile, teaching process and effect analysis of this teaching mode were investigated. Finally, the teaching mode for art courses with VR function formed, in the hope of improving teaching efficiency of art courses and enhancing learners' art creation level.

2 State of the Art

With the development of e-media technology, "online life" has become a normal living state of young people, which depends on the use of pictures which can be read fast and visually. The requirements for picture quality become higher and higher. The design effect of traditional graphic design means such as image processing and text editing cannot conform to market demand. Free element, passionate creativity characteristic and beautiful colors contained in illustration technology can make visual effect and expression force of art more prominent and vivid. Hence, illustration technology has been widely applied in each field such as advertising, books and textiles [1]. Meanwhile, it also promotes the development of Illustration Design, and proposes higher requirements for course teaching. During teaching Illustration Design, the teacher should link theory and practice and teach through lots of illustration examples to help students establish illustration thinking, independent study and innovation ability [2]. Traditional Illustration Design continues the thought of painting art teaching. Generally, the single teaching mode of "giving the lesson, demonstration, and comment" and "listening, design, making and modification" is applied. The teaching process lacks interestingness. Thus, it is hard for students to understand relatively abstract knowledge on textbooks [3]. Due to the lack of teaching assistance means, theoretical knowledge is more than design practice in course content, and the design cases are not in-depth enough. Except simple skill expression, Illustration Design teaching should turn to individual creativity performance nowadays [4]. In Illustration Design teaching, the teacher should fully consider design practice features and explore the appropriate course reform scheme.

The advantage of multimedia teaching lies in rich and diversified teaching assistance means. It can supplement single and stiff teaching method of traditional mode and provide multiple teaching cases simulating true situations. VR technology can perfectly solve such demand. Domestic and overseas relevant experts have started to focus on the application of various computer 3D digital scene techniques which combine computer aided design technology (such as CAD) and VR technology in educational reform [5]. Shelton [6] et al. applied 3D digital technique in science course teaching, adopted case analysis method and found that the teaching method of 3D digital technique will further improve students' knowledge understanding level. Leary [7] proposed the effects of technology such as Chromebooks, Google Drive on teacher learning and student activity in the development and implementation of a deeply digital biology unit in the high school. By design-based implementation research, teachers designed a student-centered unit aligned to the Next Generation Science Standards (NGSS) in which classroom technology is applied together with

researchers and course specialists. Lu [8] applied 3D digital technique in painting teaching, and put forward an interactive and data-driven painting system which applies scanned images of real natural media to synthesize both new strokes and complex stroke interactions, which obviates the need for physical simulation. Teaching practice showed that, 3D digital technique is more beneficial to improve art effect of painting.

Virtual wall painting technology is a powerful tool of 3D visualization scene technology applied in illustration course teaching field [9]. It is also a direction for the course reform. In practice, the difficulty of 3D visualization scene technology is that 3D scene editing technology has high requirements for professional technology. Generally, professional technical personnel need to consume lots of resources for modeling. If product design and scene layout in traditional design can be used, the technology can meet the demand of non-professional users and has important value and significance for facilitating application and promotion of VR scene in the public field. People start to focus on how to simple achieve 3D scene modeling in practical application. 3D scene modeling needs to gain 3D information. According to modeling information source, there is image-based 3D modeling approach and 3D scene generation method based on natural language, etc. [10]. For design cases, image-based 3D modeling approach is applied, that is, 3D virtual scene modeling is generated on the basis of design draft. In traditional production, illustration technology is further designed based on the draft. Thus, 3D virtual scene technology of Illustration Design can be further studied and developed on the basis of 2D illustration draft. The practice of professional content of Illustration Design can be conveniently presented through wall painting means. In this study, an improved wall painting method and device were used to implement it.

In the course reform of Illustration Design, virtual technology should be fully utilized to form the learning situation and enhance practice training, i.e. enhance design innovation ability training in the case of Illustration Design through certain case-based reasoning learning process. In this study, how to form 3D visualization scene, introduce it in Illustration Design and construct the new teaching mode was investigated. The innovation points are as follows: 1. the mode achieves simulation of 3D visualized virtual scene on the basis of 2D draft of illustration technology, and can give learners vivid case effect so that learners can profoundly experience and blend in the scene of Illustration Design; 2. The mode utilizes a simple and feasible wall painting technology and device to efficiently achieve generation and improvement of Illustration Design cases and help show virtual scene and case of Illustration Design; 3. Through the study on the cases of Illustration Design, the most effective and most suitable illustration case exhibition and optimization so as to gain the optimal effect of applying “cases” to explain the “reason”. Illustration Design reform scheme was studied through the above innovations, in the hope of changing the defect of traditional teaching method of Illustration Design – inability to train high-quality illustration design talents, and providing the reference for the course reform.

3 Case-based reasoning teaching mode construction based on Virtual Wall Painting Technology

3.1 Case-based reasoning teaching method

Case-based reasoning theory [11] aims to solve new problems based on the previous experience in problem solving. Case-based reasoning teaching method is the application practice of the theory in the teaching field. It emphasizes the learners are personally on the scene in learning process and bring the knowledge learned into a typical case to form the favorable substitution. Thus, the teacher should establish teaching cases suitable for the course in sufficient accordance with teaching content and learners' features. In the deeply application stage of computer technology, case-based teaching method can integrate multimedia technology and all kinds of teaching information resources to create vivid and concrete classroom teaching situation so that students can fully apply individual knowledge hierarchy in the vivid situation to deepen their understanding of new knowledge and establish more advanced and thorough knowledge framework system. The method manifests profound theories through practical project cases or living example carrier, which can motivate learners' learning enthusiasm and enhance students' ability to analyze and solve problems. It is the most remarkable superiority of case-based teaching method. Fig.1 shows learning mode construction of case-based teaching method.

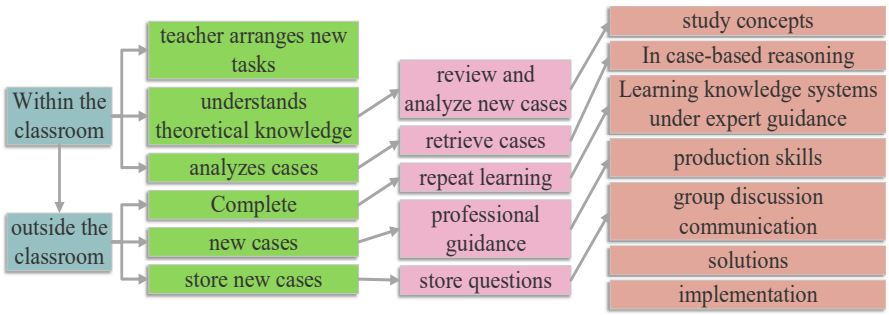

Fig. 1. Learning model and learning platform diagram of case-based reasoning method

As shown in the above figure, the teaching case suitable for Illustration Design is established through retrieving similar cases and modifying cases in each chapter of Illustration Design. In the teaching process, learners carry out description, exhibition, decomposition, reasoning and consolidation and form their own solutions through independently exploring similar cases. Students apply these learning results or methods again in the new cases and propose solutions to new cases. Under the teacher's guidance, the cases can become the works of this chapter. With the help of the teaching platform, the content and speed of learning link can be grasped, and the learning process of mutual help and interaction can be achieved smoothly.

3.1 3D virtual scene generation based on wall painting technology

According to the features of illustration technology teaching course, 3D visualization scene modeling method can be used to construct 3D virtual scene. During generating 3D virtual scene in accordance with design plane draft, the CAD software - SketchUp oriented to design process can be applied. The software owns thorough draft creation and editing function, adopts the interaction mode of free-hand sketch, simplifies icons of some tools and menu commands, and retains the common straight line, rectangle, arc and other drawing tools. Most models can be made through path following and model interlacing model. For operation convenience, when the designer adopts the software to construct the complex 3D scene, most draft elements can be added in the scene through interaction icon like picture splicing, except some flexible elements which need to be drawn. Meanwhile, the top view mode similar to 3D software is applied to generate 3D scene as required by the design draft for the draft elements corresponding to editing operation such as move, rotate and zoom. Thus, when the draft is applied to establish 3D scene, firstly, the appropriate model structure and the objects of common models should be confirmed. It is required to create corresponding draft elements and process draft elements into corresponding mathematical expressions according to conceptual model description of scenes so as to achieve simulation of 3D scene with draft elements. For example, for the design of one wall, grid processing and editing of draft in local wall adjustment modeling algorithm established by the study on five-layer wall information model of Guan [12] and literature is used for description. The wall draft editing area is divided into small squares whose wall thickness is the length of side (as shown in Fig.2).

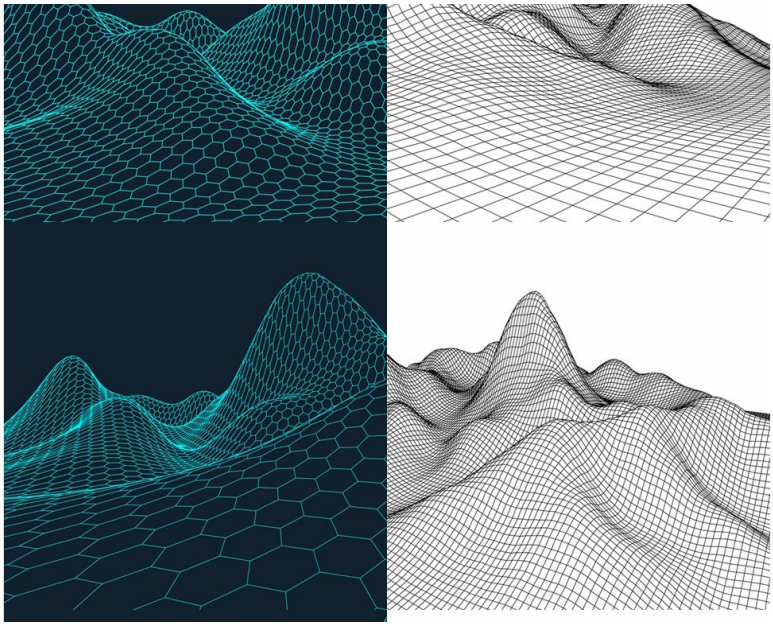

Fig. 2. Grid drawing method of wall draft

The straight line wall can be conveniently described as the straight line wall $L = (\mathrm{h}, \mathrm{P1}, \mathrm{P2}, \mathrm{ID})$. Wherein, P represents the two points that the mouse passes, i.e. the starting point and ending point; h is the wall height; ID refers to the wall between P1 and P2. Later, the wall shift and deletion are conducted. The designer draws the wall through moving the mouse. The path that the mouse passes can be expressed and stores with a series of sampling points. For some draft elements needing to be designed, it is just necessary to operate in the mathematical model. If a curving wall needs to be designed, the appropriate mathematical model of curving wall can be used, such as Bezier curve model, as shown in Fig.3. It is supposed that two points P_0 and P_1 are taken.

$$B(\mathrm{t}) = \mathrm{P}_0 + (\mathrm{P}_1 - \mathrm{P}_0)\,\mathrm{t} = (1-\mathrm{t})\,\mathrm{P}_0 + \mathrm{t}P_1, \quad \mathrm{t} \in [0, 1] \tag{1}$$

Wherein, t is time. Through adjusting the coordinate positions of A, B and C, the users just need to add a Bezier curve section where three control points (A, B, C) shown in Fig.3(a) share the line, and can construct any wall draft of curving walls through adjusting the position of three control points.

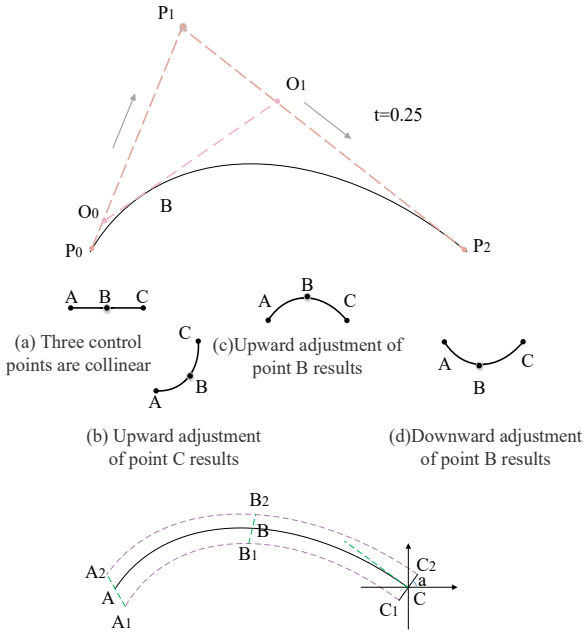

Fig. 3. Diagram of virtual design of curving wall

For instance, when $\mathrm{t}=1$, $B'(1) = 2(\mathrm{C}-\mathrm{P})$ vector can be gained, as shown in Fig.3. Then, the slope of tangent line CD can be gained, and α angle can be figured out. The space coordinates $C_2.x$, $C_2.y$ and $C_2.z$ of C_2 can be gained.

$$C_2.x = C.x + w\cos\alpha \tag{2}$$

$$C_2.y = C.y + w\sin\alpha \tag{3}$$

$$C_2.z = 0 \tag{4}$$

Other points are similar. Other design elements can achieve 3D virtual scene generation of design elements through simplification with the above mathematical model. In one word, the theory modeling as mentioned above can be applied to form 3D visual scene based on the draft. For wall painting design draft, the theoretical model can be referred to establish 3D virtual scene.

A wall painting technology and device (patent application No.: CN107225904A) were adopted in this study. The process is as follows: set up element position of each partition for partition drawing according to 3D virtual scene procedure so as to achieve the drawing process conveniently and accurately. The process can be referred to the patent (patent application No.: CN107225904A).

4 Teaching Example and Teaching Effect

In view of the content of Illustration Design, the total class period was set to 56. In teaching implementation process, the teaching and learning platform especially for art courses as shown in Fig.4, and the learning software system especially for art courses in the graph and image laboratory were fully utilized to carry out teaching practice for one semester. In the teaching process, campus resource library was fully applied, and students could learn on each function module of the learning platform and interact and communicate with the teacher in real time. The teacher should help students make their learning process smooth, organize cooperation and exchange and guide them to choose and implement professional contents. In view of course requirements of Illustration Design, case operation link could be enhanced in each chapter according to case-based reasoning method. Fig.4 shows the structure of illustration design teaching module based on wall painting technology.

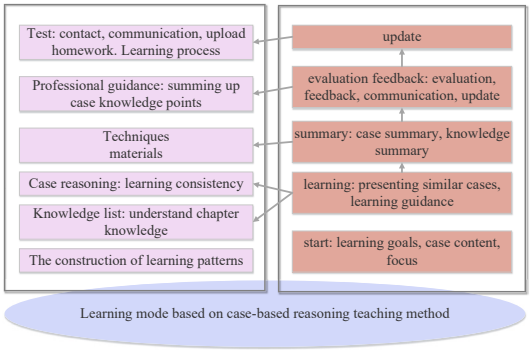

Fig. 4. Structure of illustration design teaching module based on wall painting technology

4.1 Teaching example

The teaching mode designed could make students fully exercise knowledge points, considers the tools and the contents of 3D virtual elements, and carefully focuses on learners' mastery of relevant elements in the last lesson. It should make learners independently operate design elements of virtual wall painting technology so that they could design basis elements smoothly. Proficient use of design elements of virtual wall painting technology is a learning content of learners. In case study, the teacher should give learners advice and necessary guidance from professional perspective.

For example, the teaching mode constructed for the chapter "Tulip Illustration Painting" is shown in Fig.5. The similar case is lotus case learned in the last lesson in which Bezier tool was also applied. Other chapters in the course were also subject to the mode in Fig.5.

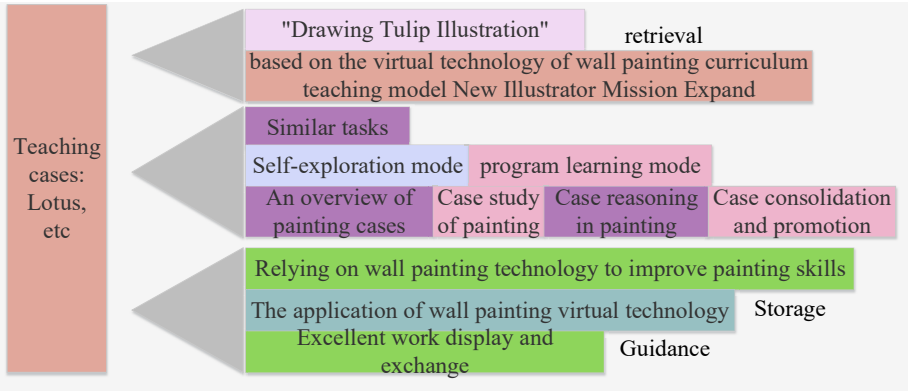

Fig. 5. Illustration Design teaching case based on virtual wall painting technology

4.2 Teaching effect

To test the teaching effect of the whole virtual teaching system, two parallel classes were chosen (30 students in each class), and they were classified into experimental group and control group. The questionnaire was applied to survey satisfaction of students who used virtual teaching system and did not use it. The results are shown in Table 1 and Fig.6. The teaching effect evaluation of virtual teaching mode was also investigated, as shown in Table 2.

Table 1. Teaching satisfaction survey (%)

Group	Very satisfied	Satisfied	General	Dissatisfied
Experimental group	63	23	11	0
Control group	36	37	27	0

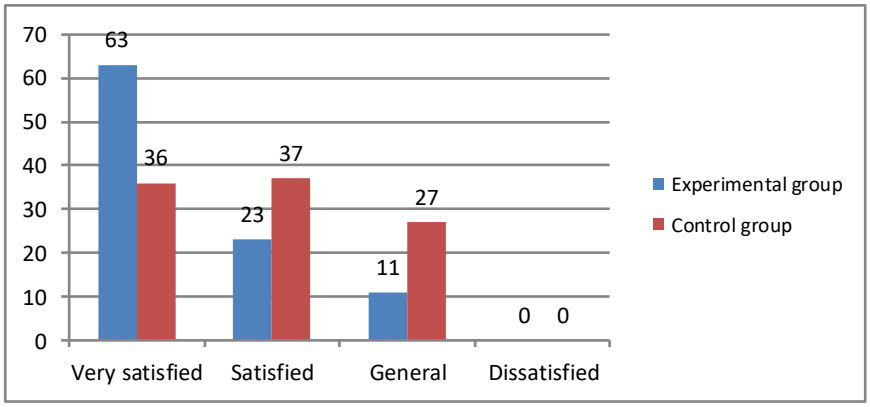

Fig. 6. Comparison of teaching satisfaction in experimental group and control group

Table 2. Teaching effect evaluation (N=30)

Survey content	Very agree	Agree	General	Disagree
Enhance knowledge mastery (%)	46.5	29.3	24.2	0
Make student-teacher relation harmonious (%)	60.5	28.5	11.0	0
Motivate learning interest (%)	45.1	47.2	3.7	0
Necessary to use continuously (%)	50.5	37.8	11.7	0

Based on Table 1, the proposed virtual teaching mode conforms to students' learning acceptance features, and students' learning satisfaction is high, indicating the teaching mode is suitable for illustration art courses. According to Table 2, the implementation of this teachings mode can make students closely combine corresponding knowledge with real Illustration Design cases and practical operation process, greatly motivates students' learning interest and enhances students' operation ability. And, students and the teacher can fully interact in the teachings process. As a result, student learning and teacher guidance can be fulfilled efficiently, and the learning efficiency improves. The model can significantly change students' passive learning state under traditional teaching mode and make learners master basic knowledge required in the design process and each detail in creation process, and cultivate their independent design ability, which thus contributes to cultivating real art design talents with high quality.

5 Conclusion

In this study, wall painting technology and virtual technology were combined, and case-based reasoning teaching mode was integrated. In addition, Illustration Design teaching mode based on virtual wall painting technology was constructed. The 2 parallel classes were chosen for the mode teaching and traditional mode teaching. Through comparison of teaching effect evaluation for the one semester, it was found that the mode well matches high requirements of Illustration Design for design

innovation ability, and obviously changes students' passive learning state under traditional teaching mode, thus contributing to training real high-quality art design talents.

The advantages of the proposed mode are as follows: the teaching mode obeys case-based reasoning teaching method, utilizes a simple and feasible wall painting technology and device, adopts 2D draft of illustration technology to transform to 3D visualization virtual scene simulation for illustration learning, and brings illustration art learners vivid case effect. Moreover, the teaching mode can arouse great learning interest of learners so that learners can profoundly experience and blend in the illustration design scene. Such efficient wall painting technology and device combine 3D visualization virtual scene simulation, achieves simple and convenient generation and improvement of Illustration Design cases, well displays Illustration Design cases makes the cases reappear and help learners easily solve implementation skills of illustration design and making. In case study, learners need to continuously solve various new cases, and grasp basic knowledge required in the design process, method and thought to solve each detailed problem in the creation implementation process through a series of processes including description, reasoning, decomposition, consolidation, acquisition and guidance of similar cases. Meanwhile, learners' independent design ability is cultivated and their art creativity can be cultivated. The mode well adapts to art creation requirements and thus can be promoted in design field involving innovation ability training.

6 Acknowledgement

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