Multimedia Teaching Platform for Urban Planning Utilizing 3D Technology

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Xuhui Wang
Northwest University, Xi'an, China

Quan Zhang
Xi'an city planning design and research institute, Xi'an, China

Yanyi Chen(✉), Shihao Liang
Chang'an University, Xi'an China
839377053@qq.com

Abstract—In recent years, 3D technology based on computer and Internet has achieved high-speed development. People have realized direct and stereo observation of realistic world. Three-dimensional and visualized characteristics of the technology fit well with the teaching objective of college of architecture specialized courses. Thus, 3D model has profound practical significance for its application in urban green space system and urban rural overall planning. With "urban-rural master plan" as an experimental course, this paper design the "urban-rural master plan" multimedia teaching platform based on 3D technology and practice of the teaching platform in course teaching. This paper has applied control experiment method and statistical method to make comparative analysis on the teaching effect difference of multimedia teaching platform based on 3D application in "urban-rural master plan" as experimental course. The purpose of the technology is to provide theoretical and data support for 3D technology application in "urban-rural master plan" and other college architecture major courses.

Keywords—Urban green space system, Urban-rural master plan, Multimedia teaching

1 Introduction

3D model, also known as three-dimensional and stereo model, has objects including building, people and vegetation mainly applied in architecture and mechanical fields [1]. Fast development of 3D technology has made the approximately real virtual world come true. People can obtain experiences that they can hardly have in objective world, which has fundamentally broadened people's life. It is inevitable to apply the increasingly mature technology to educational teaching field. At present, some 3D teaching systems with basic functions have been applied to the teaching in medicine [2], architecture, and other major fields of study. For example, introduction of 3D

stereo instruction film and 3D stereo interactive courseware is manifestation of 3D technology in teaching field [3].

Emerging of 3D intelligent teaching has great significance on current teaching environment, which has created analogue simulation environment for natural science basic teaching and brought revolutionary change to experiment teaching. A brand-new experience for students in visual or sensory aspects, free from time and classroom environment limits, can help students to obtain maximum knowledge information within the shortest time and effectively improve the quality of students' learning activity. However, old 3D intelligent teaching has obvious defects in interface humanization, teacher-student interaction and preciseness of design procedure. In this teaching system, teachers can teach only by continuously demonstrating and students are hard to comprehensively understand the overall digital animation production. 3D intelligent teaching system still tends to be uniform with non-3D teaching system in form and application effect [4]. Based on this issue, this article has conducted researches for the purpose of developing a 3D multimedia teaching platform with more significant 3D effect and stronger man-machine interaction in order to satisfy the demands of college teaching mode reform.

2 State of the art

The increasingly mature 3D technology is being applied to various domains with progress. Domestic and foreign scholars keep exploring to introduce 3D technology into urban planning. Chang et al. [5] have conducted relevant analysis on 3D urban planning digital application and proposed that dynamic urban planning should not be limited to two-dimensional plan function partition. Instead, 3D technology should be used to achieve the overall urban form and space planning. Hasper et al. [6] has emphatically researched the development situation of three-dimensional urban model, deeply analyzed the effect of this model in practical application and proposed problems of three-dimensional urban model, believed space quantitative analysis is the direction of the further model development. Specific to teaching aspect, the intelligent teaching system based on 3D technology that is designed and developed by domestic and foreign scholars have achieved good effect in architecture, medical and other professional teaching. 3D multimedia teaching platform can provide timely, effective and comprehensive learning assistance through computer system. Liu and He [7] have applied 3D virtual reality technology to architecture design and urban planning teaching. Lens motion from any angles and shooting scales and real time switch of various environment effects can be achieved architecture tours in order to bring all-dimensional immersive visual and hearing feeling. Research results show that 3D technology can improve students' learning interest. Mcmenamin, etc. [8] has tried to apply 3D technology to human body projected teaching. Report details how additive manufacturing or three-dimensional (3D) printing allows the creation of reproductions of projected human cadaver and other anatomical specimens that obviates many of the above issues. These 3D prints are high resolution, accurate color reproductions of projections based on data acquired by surface scanning or CT imaging. The technolo-

gy has achieved good teaching effect. Researchers [9] have conducted studies on engineering course by introducing virtual reality technology and 3D technology to develop 3D virtual simulation series with direct effect, strong interaction with course evaluation module. The application of this system has greatly enriched teaching resources of network technical course, promoted teaching efficiency improvement and provided good thoughts for design and practice in this paper.

In a word, introducing 3D technology to college for specialty teaching which requires for direction and special feeling has become an obvious trend. Multimedia teaching platform based on 3D technology is playing more important role in college teaching with great significance to improve teaching quality and stimulate students' learning interest. But regarding current 3D technology application in architecture teaching, there are some defects. Firstly, due to diverse architecture types including residence, office building, hospital, hotel, warehouse, factory, and comprehensive building, there exist large differences between the building mass, function, system, products and environmental indexes during teaching process. Buildings are not completely similar. There are a lot of architecture mainly with strong professionalism and huge information. Secondly, there are a lot of different periods in the life cycle of a building including investigation, planning, design, consultation, construction, adjustment, supervision, decoration and quality maintenance with numerous information, major changes, participants, management, materials, drawings and difficult information standards. Architecture information and data are huge and complicated [10]. Therefore, 3D teaching technology has high requirements for teaching software when applied to major architecture. There exist defects in current software as follows: tools are not basic and original, data universality is poor and backward, information is closed, information extraction and modification is not convenient, information transmission is slow, knowledge application is hard, decision support is poor etc. They have seriously restricted the lecturing efficiency and teaching content manifestation. It is hard to establish a whole set of all-stage dynamic courseware system. Thus, we have proposed a 3D technology architecture software system based on above points.

The multimedia teaching platform based on 3D technology that is designed in this paper has three innovation points as follows: firstly, each basic architecture data module system can be minimally classified to establish different architecture module based on basic functions and obtain professional data with architecture data module as a management unit in order to provide necessary basic data for "urban-rural master plan" course learning. On the other hand, 3D multimedia teaching platform designed in this paper has basic interactive functions to achieve student-teacher and student-student multi-interaction in order to achieve better teaching effect. Meanwhile, this research has provided a comprehensive 3D architecture software system in which each building is made by different basic building functions (function zone) with the basic function of completing an independent purpose or demand. Through concluding the architectural basic demands of each kind of building, this system can conduct the minimum classification of these typical buildings and standardize into 3D architecture software.

3 Theoretical construction

The key of generating 3D model is to capture induction signals. Selection of proper scanning methods can help to accelerate 3D model building and display in induction screen within short time. This paper has selected infrared induction screen as the display end of 3D model. Selected infrared geminate transistor as induction component, realize circuit simplification through binary control method to improve the utilization of components and parts, and construct a multimedia teaching platform based on 3D technology.

3.1 Realization of infrared induction screen

Infrared induction screen [12] can be realized by installing a frame before display form together with a complicated circuit board. Infrared transmitting tubes and infrared receiving tubes are distributed horizontally and vertically on the screen to constitute crossed infrared ray matrix correspondingly. Accurate coordinate will be generated and exercised with relevant action if infrared geminate transistors can be distributed horizontally and vertically sense the position of touch points.

Realization of infrared induction screen requires a lot of infrared transmitting tubes and infrared receiving tubes. Assume the length of induction screen as L, width as D, the diameter of infrared transmitting tubes and infrared receiving tubes as 3mm to maximize the resolution of induction screen. The number of infrared geminate transistors required is (L+D)/3. Take 70 inch 16:9 screen as an example, the length is 1550mm, width of 872mm, then the logarithm of diode required to produce 70 inch induction screen is (1550+872)/ 3≈807

To realize the control of numerous infrared geminate transistors this article has used binary control method to set up circuit, i.e. each unit circuit under control of two gate control line but each line has the gating of 16 routes. By increasing gating line of single circuit, this method can greatly reduce the control lines required by the whole system. Ordinary organizational method requires N control lines but only M circuits are required to control circuit by using binary method as shown in Formula (1):

$$M=16+N/16 \tag{1}$$

This method shows its advantages with the increase of N. If we still take 70 inch 16:9 screen as the example, the number of control signal required by using binary method will be 16+807/16≈66. In other words, only 66 control signals are required to realize the gating control of 70 inch induction screen.

3.2 Theory construction of various basic architecture data module

The multimedia teaching platform based on 3D technology that is designed in this paper has the advantage to provide various basic architecture data. It can be realized through a kind of various basic architecture data system which includes architecture module, multi-information management and data base, aiming at minimized classifi-

cation of basic functions of different kinds of buildings in order to establish architecture model after standard processing. Architecture model is named with building functions including corridor, stair, kitchen, and toilet. With architecture data module as management unit, establish universal and basic information architecture management standard and unit so as to establish architecture big data decision-making and improve architecture standard and efficiency. The system module construction is as Fig.1:

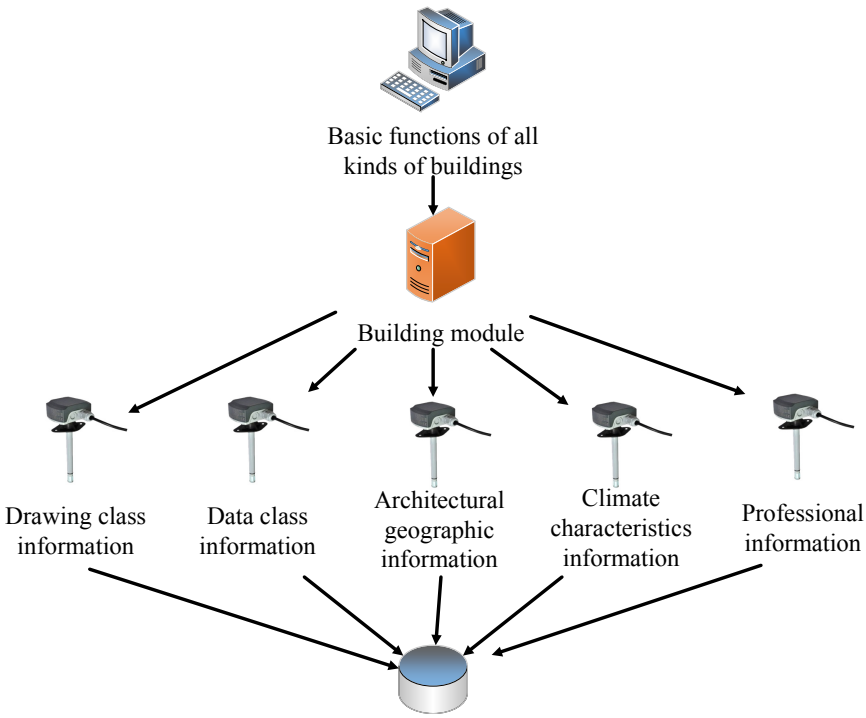

Fig. 1. Various basic architecture data module system structure drawing

It can be seen from graph 1 that basic architecture data include drawing, material, architecture geography, climate characteristics and other rich information, which are of great significance for learning architecture specialty course. Drawing information include design description, legend, equipment list, plane, system drawing, detail drawing, elevation, concept scheme design; material information include videos, images, laws and regulations, knowledge-related image-text.

4 Construction of 3D technology based on "urban-rural master plan" multimedia teaching platform

4.1 Hardware design

Hardware design of 3D multimedia teaching platform can be realized based on 3D display installations including directional lighting, projector, and infrared induction screen. The overall structural frame diagram is shown in Fig.2.

Overall structural diagram of 3D display installation and its colorized display installation are shown as Fig. 3.

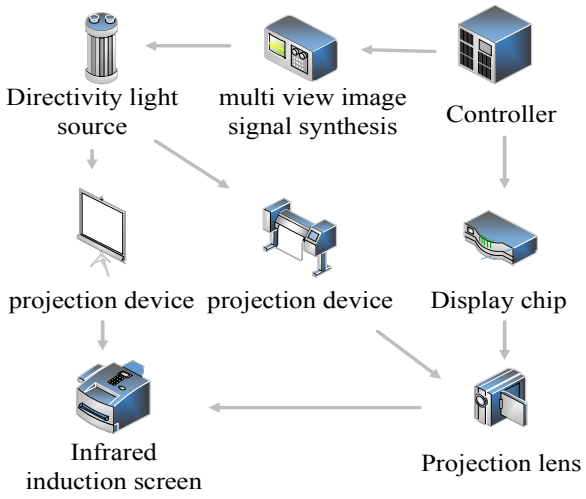

Fig. 2. Structure diagram of the system

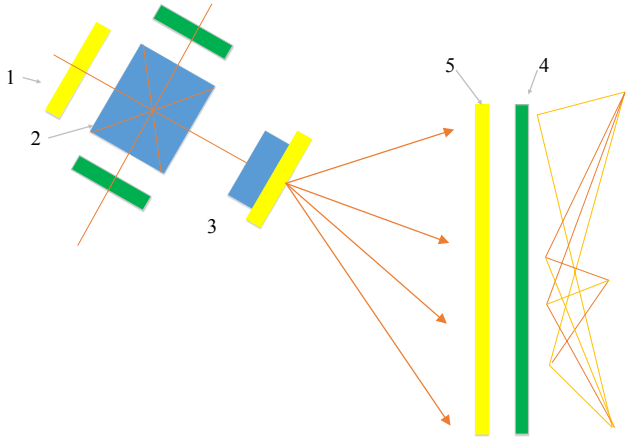

Fig. 3. Overall structural diagram of 3D display installation and its colorized display installation

As shown in Fig. 3, directional lighting includes rectangle LGP and illuminant set. Projectors include display chip 2 set in the luminous end of directional lighting 1 and projection lens 3; luminous end of projection lens 3 is infrared induction screen 4 where several pixel arrays are set to obtain naked eye 3D display. Based on projection type naked eye 3D display installation, teaching platform which combines with colorized display installation design has broken the limit of high-cost large-size display screen. It can conveniently achieve large-view naked 3D display with higher stability, faster screen refresh rate, more practicability, and higher conformity to course teaching requirements.

4.2 Function design

3D multimedia teaching platform has combined functions of 3D visualization virtual technology and intelligent interaction. Its design is shown as below.

3D model watching. Teachers and students can watch 3D model through 3D multimedia teaching platform to directly know the actual condition of the analytic target and learn about the detailed condition of course case. Students can conveniently use 3D multimedia teaching platform to watch model, strengthen classroom effect. Take a commercial building as example. Relevant 3D model is shown in Fig. 4.

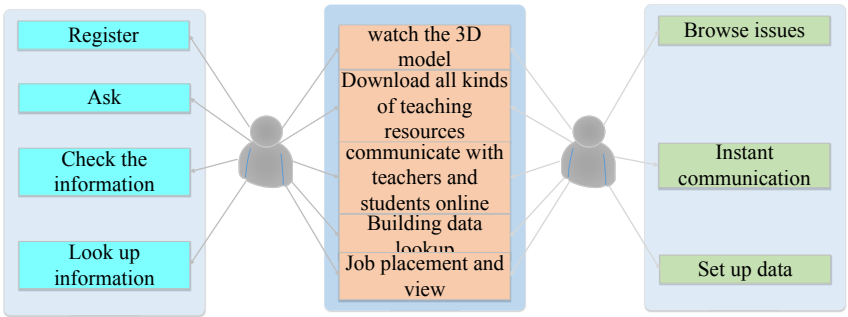

Fig. 4. 3D model of a commercial building

Download various teaching materials. Students can use the system to download theoretical teaching resources, practical teaching materials and ancillary resources, skip to relevant page through system connection and select required teaching materials to download. The database in this system operates fast with high preservation quality to realize the storage, uploading and downloading, browsing, deletion and a series of teaching materials functions.

Teacher-student online Q & A. Students can propose questions online after logging in teaching system and teachers can successfully login to answer questions online. Q & A communication will be reserved in system database so that other uses can browse and study. System full-interactivity is one of main characteristics of 3D multimedia teaching platforms. Teacher-student online communication will provide great help to timely propose questions and solve problems for mutual progress during the teaching process.

Architecture data searching. Students can obtain data required from the basic architecture data module in multimedia teaching platform including drawing information, material information, geography, climate and other characteristic information.

Homework assignment and check. Teachers can assign homework on site page after logging in and students can check their homework. Both can realize real-time communication through the system to supplement inadequacies in classroom teaching and solve problems during the homework process. Functional structural diagram of 3D multimedia teaching platform is shown in Fig. 5.

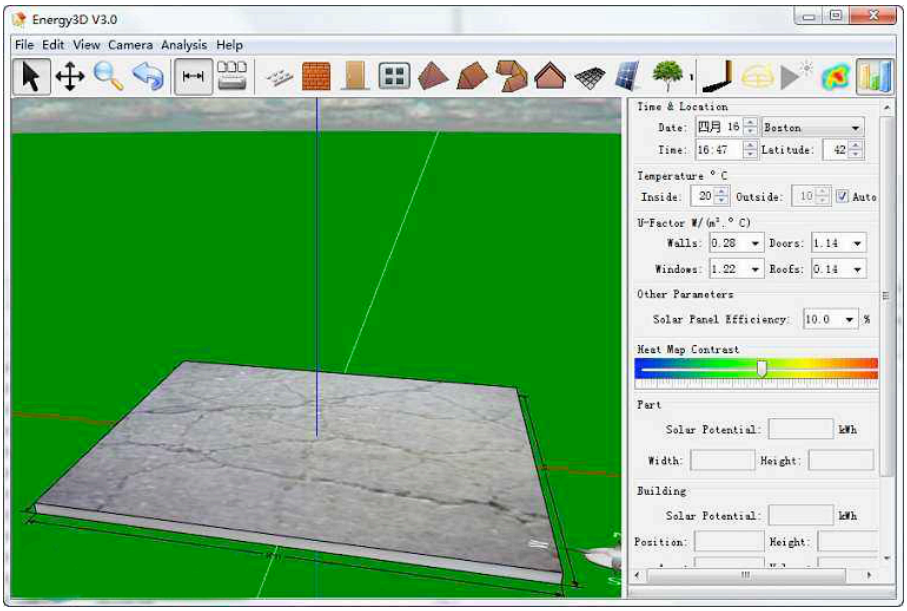

Fig. 5. Functional structural diagram of 3D multimedia teaching platform

4.3 Effect check

"Urban-rural master plan" is an important course of college architecture specialty which can get students' participation. It can satisfy the demand of carrying out experiments. The course is opened in the first term of sophomore year lasting totally 48 credit hours. Experiment research objects include 120 undergraduates in two classes of a college architecture specialty including 60 students in experimental group class and 60 students in control group class. The lecturing condition and teachers for experiment class and control class are same. There are no obvious differences of student age, gender, and performance in two classes.

Experiment group applies "Urban-rural master plan" multimedia teaching platform based on 3D technology. Teachers and students can conduct teaching activities through the platform and make full use of various functions of the system to promote teaching effect. During the experiment process, teachers can display 3D architecture model, release teaching resources, assign homework and answer questions through

this system and students can check architecture data, homework and provide timely feedback. But control group uses traditional multi-media for playing and instruction by means of images and text narration to introduce architecture characteristics, homework assignment similar with experiment group.

Experiments of 3D multimedia teaching platform in urban-rural master plan course obtain results mainly through teaching effect evaluation which is carried out by questionnaire survey and final examination:

Questionnaire survey: the paper uses self-design questionnaire method to obtain the recognition of students who have participated in experiments on 3D multimedia teaching platform. The Questionnaire contains 10 questions, including contents of learning interest, teaching effect, operability, interestingness, options including single choice and multiple choices for students to select according to their practical feeling to know their evaluation results on 3D multimedia teaching platform.

Final examination: after completing course contents, select 10 representative questions to test teaching effect with the highest score of 10 and lowest score of 0 including 4 urban and rural planning principle questions, 4 environmental landscape design principle questions, 1 social research question and 1 residential area design question. The exam will be carried out on the basis of students' thorough review to compare the difference of teaching effect through exam scores.

Firstly, based on questionnaire survey, comparing traditional teaching platform with 3D multimedia teaching platform as shown in Table 1.

Table 1. Comparison between traditional teaching platform with 3D multimedia teaching platform

Item	Traditional teaching platform	3D multimedia teaching platform
Time	limited in classroom	Highly flexible, covering inside and outside classroom
Dominant	teacher	student
Property	listen passively	self-directed learning

It can be seen from table 1 that compared with traditional teaching platform, 3D multimedia teaching platform has higher learner-autonomy. Students can play a dominant role in teaching process and carry out study based on their own demands and self-planning.

Secondly, regarding whether 3D multimedia teaching platform can improve students' learning interest, 51.61% (62/120) students choose "yes", 4.39% (58/120) students choose "remain to be seen, but deserve to try". For details please see Fig. 6.

At last, regarding the question "which elements of whether 3D multimedia teaching platform can attract you", 77.42% (93/120) students think "3D multimedia teaching platform can help me timely find out study materials I need". 70.97% (85/120) students think "3D multimedia teaching platform can shorten the distance with classmates". 48.39% (58/120) students think "3D multimedia teaching platform can shorten the distance with teachers". 38.71% (46/120) students think "3D multimedia teaching platform can timely solve problems during study". Survey results are shown in Fig. 7.

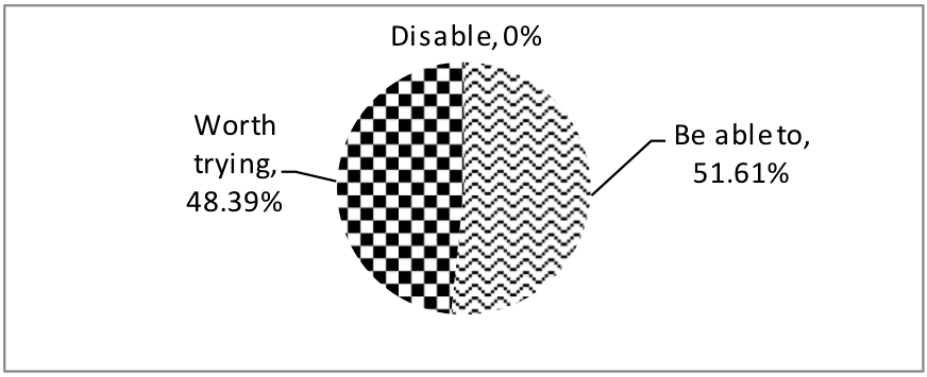

Fig. 6. Whether 3D multimedia teaching platform can improve students' learning interest

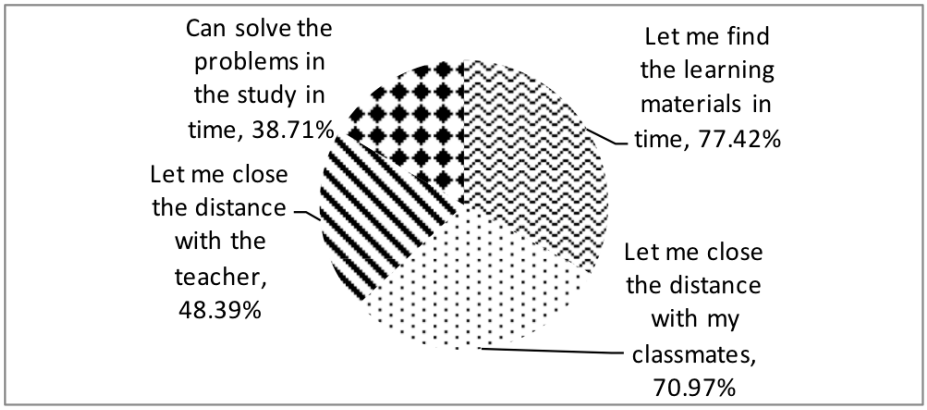

Fig. 7. Which elements of 3D multimedia teaching platform can attract you

Regarding final examination, scores of experiment group and control group are shown in table 2:

Table 2. Scores in experiment group and control group

Group	Urban and rural planning principle	Environmental landscape design principle	Residential area design	Social research	Total scores
Control group	28.50±4.55	22.34±5.68	4.78±2.33	5.24±2.02	72.48±10.54
Experimental group	32.88±2.65	29.68±4.02	7.56±1.46	6.56±1.82	82.36±8.41
P	<0.05	<0.05	<0.05	>0.05	<0.05

It can be seen from table 2 that in four modules of testing, the overall score of students in experiment group is higher than control group. The difference among scores of three modules: urban and rural planning principle questions, environmental landscape design principle and social research has statistical significance ($p<0.05$). Regar-

ding exam total score, the overall score of experiment is higher than control group. There exist obvious advantages ($p<0.05$). With the support of 3D multimedia teaching platform, the teaching effect and student scores have been improved greatly. But social research has the inadequacies that 3D multimedia teaching platform needs to improve urgently. It indicates that the platform is deviated with urban and rural actual planning to a certain degree, architecture data are not accurate and system must be optimized continuously to obtain significant effect. With continuous updating and optimization of 3D multimedia teaching platform, rich architecture data and high interactivity and other featured functions will fit well with realistic teaching and make great contribution to alleviate teacher and student burden and optimize teaching effect.

As a whole, students in experiment group have higher recognition of 3D multimedia teaching platform. Most students can accept the new teaching mode and enhance their learning interest and improve their attainment in professional courses. Through 3D multimedia teaching platform, students in architecture specialty can obtain in-depth understanding of urban-rural master plan and they can directly know relevant architecture distribution and characteristics. Moreover, after class, students and teachers can maintain communication conveniently through 3D multimedia teaching platform. Students can download relevant materials, propose questions, browse question records and complete content extension through the system. Teachers can know students' real-time trends, adjust teaching objective constantly to obtain better teaching effect. 3D multimedia teaching platform is suitable for different stages and different subjects. Ultilization of 3D model which is generated by 3D virtual technology can bring an intuitive feeling to students and achieve the objective of teaching mode reform and teaching quality improvement.

5 Conclusions

This paper has developed an "urban-rural master plan" multimedia teaching platform based on 3D technology by referring to the application of 3D teaching system in logistics and medicine specialty teaching. It introduced various basic architecture data module system for urban rural overall planning and solved problems of traditional teaching mode with bad spaciousness and intuition. 3D multimedia teaching platform designed by this paper available for building 3D model display can store abundant architecture data for architecture specialty course teaching represented by "urban-rural master plan" course. Teaching platform designed by this paper has highly intimate operation interface with strong interaction. This platform has realized man-machine interaction and interaction between people, especially between students and teachers. It can fully use teaching resources to construct the exchange channel between teaching and learning. 3D multimedia teaching platform can put 3D model overall design mode and various teaching resources in system database, strengthen teaching effect with computer technology and improve teaching quality by using functions of 3D multimedia teaching platform in each teaching step. Diverse forms and contents of 3D multimedia teaching platform can better increase teaching effect

and students can completely acquire the overall modelling thinking. The utilization of this system can enrich teaching mode and students can determine learning contents based on their own situation. Thus 3D multimedia teaching platform with a broad prospect of application can develop positive effect and impact in education and teaching. Moreover, it also has high promotion value.

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8 Authors

Xuhui Wang is a doctor in the College of Urban and Environmental Science, Northwest University, Xi'an 710127, China (wxhxbdx@sina.com).

Quan Zhang is an Associate Professor in the Xi'an City Planning Design and Research Institute, Xi'an 710064, China (Zhangquan@sina.com).

Yanyi Chen (Corresponding Author) is a Master in the School of Architecture, Chang'an University, Xi'an 710064, China (839377053@qq.com).

Shihao Liang is an Associate Professor in the School of Architecture, Chang'an University, Xi'an 710064, China (839377053@qq.com).

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