www.cad-journal.net
Computer-Aided Design and Applications

Interactive Design Model in Computer-Aided Environmental Teaching and Learning

Mengdi Gao[1] and Chenyu Hu[2]

[1,2] School of Art, Mokwon University, Daejeon 35349, Korea, [1]mdd1130@naver.com, [2]4201457@mokwon.ac.kr

Corresponding author: Mengdi Gao, mdd1130@naver.com

Abstract. This article aims to explore the application of the interactive design model in environmental design teaching and its influence on students' learning effect, innovation ability, and practical ability. Through practical teaching cases, this article compares and analyzes the instructional effects of traditional teaching modes and interactive design models. The research adopts a combination of quantitative and qualitative methods, including multi-dimensional indicators such as student performance, homework completion, classroom participation, student feedback, and design work assessment. The results show that the interactive design model has significantly improved students' learning enthusiasm and participation, their design works are more creative and practical, and their teamwork and communication skills have also been improved. This study verifies the advantages of the interactive design model in environmental design teaching and provides beneficial enlightenment for future teaching reform. The research conclusion emphasizes the positive influence of the interactive design model on the cultivation of students' abilities and looks forward to its application prospect in other teaching fields.

Keywords: Interactive Design Model; Environmental Design Teaching; Teaching Effectiveness; Innovation Ability; Practical Ability
DOI: https://doi.org/10.14733/cadaps.2025.S4.195-210

1 INTRODUCTION

Due to the rapid development of information technology, computer-aided design (CAD) has found widespread application in environmental design, significantly enhancing design efficiency. Using CAD technology, environmental designers can make more accurate spatial planning, material selection, and effect preview so as to provide better service for customers [1]. However, although CAD technology has achieved remarkable results in practical application, its application in the field of education, especially in environmental design teaching, still faces many challenges [2]. Therefore, it is of great theoretical and practical significance to explore how to combine CAD technology with interactive design concepts to innovate instructional methods and improve instructional effects [3]. Computer-aided environmental design (CAED), from the initial 3D drawing to the current 3D modeling and virtual reality, CAD technology has been iteratively upgraded, providing more abundant and powerful design tools for environmental designers. However, the development of these technologies is not fully reflected in the teaching process, and traditional instructional methods often focus on imparting theoretical knowledge, ignoring the cultivation of practical operation and innovative ability [4]. Interactive design emphasizes the interactive experience between users and products. Introducing this concept into environmental design teaching can greatly enhance students' learning enthusiasm and participation. Through interactive design, students can practice in the virtual environment and feel the design results intuitively, so as to better understand and master the design principles and methods [5].

In CAED teaching, the interactive design pattern encourages students to deepen their understanding of design problems through immediate feedback and iterative modifications. This mode not only improves design efficiency but also promotes the flexibility of design thinking. In CAED teaching, using this method can help students extract key features from complex design parameters and understand how these features affect the overall design effect. The customized large-scale architectural image database mentioned in the study provides rich visual resources and data support for teaching [6]. As mentioned earlier, disentanglement representation learning provides a new perspective for the structural interpretation of conceptual design spaces. Through supervised and unsupervised disentanglement learning, students can systematically explore different design concepts, discover potential design patterns and trends, and broaden their design thinking. In interactive design mode, students can use these image data for design comparison, style imitation, or innovative experiments, thereby deepening their understanding of design space in practice. Through software tools such as parametric design software and virtual reality environments, students can intuitively explore different design variables and parameters, observe changes in design results in real-time, and deepen their understanding and mastery of design space. Supervised learning guides students to gradually master design skills through clear goals and evaluation criteria [7]. By combining these two learning methods, students can engage in targeted learning under the guidance of teachers, while maintaining openness and exploration in the design space. In CAED teaching, supervised learning and unsupervised learning can complement each other and jointly promote the improvement of students' design abilities. These databases not only have a high degree of visual diversity but also cover a wide range of design styles and scenarios, providing students with rich design inspiration and references [8].

Against the backdrop of rapidly advancing technology, the country's emphasis on the field of education is increasing day by day. Special emphasis is placed on the cultivation of students' comprehensive literacy, among which ecological aesthetic education, as a bridge connecting humans and nature in harmonious coexistence, has become increasingly important. In this context, some scholars have delved into teaching plans that combine ecological aesthetic education with interactive design patterns in computer-aided environmental design teaching, aiming to provide students with a more vivid, interactive, and innovative learning environment. This immersive learning experience greatly enriches students' perception of ecological beauty, prompting them to pay more attention to the harmonious coexistence of nature and artificial environment in design [9]. In daily educational practice, ecological aesthetic education should be integrated into various disciplines, especially in the field of environmental art and design, which is directly related to the relationship between humans and nature. Computer-aided environmental design teaching uses technologies such as virtual reality (VR) and augmented reality (AR) to enable students to experience the design effects in different ecological environments firsthand. In the environmental art and design course, the deep integration of ecological aesthetic education and professional knowledge is achieved by guiding students to analyze the current ecological environment, explore ecological design concepts, and use digital tools for design practice. Not only is it an expansion of traditional education models, but it is also a positive response to future sustainable development education [10]. The interactive design pattern encourages students to cross disciplinary boundaries and integrate knowledge from multiple fields such as ecology, aesthetics, and design. In this process, students need to constantly think about how to achieve innovation and practicality in design while protecting the ecological environment, in order to stimulate their innovative thinking and problem-solving abilities.

This research aims to explore interactive design models in CAED teaching, with the following research objectives: to analyze the existing issues and challenges in current environmental design teaching; to construct a computer-aided environmental teaching model based on interactive design; to empirically validate the effectiveness of this model and propose improvement suggestions.

The innovations of this research are mainly embodied in two aspects: firstly, introducing the concept of interactive design into CAED teaching, proposing a new teaching mode; secondly, empirically validating the effectiveness of this teaching mode, providing practical evidence for the reform of environmental design teaching.

This article is divided into seven sections. Section 1 is the introduction, outlining the research background, significance, objectives, innovations, and paper structure. Section 2 is the literature review, reviewing relevant research on CAED, interactive design theory, and their applications in education. Section 3 analyzes the issues and challenges in CAED teaching. Section 4 constructs a computer-aided environmental teaching model based on interactive design. Section 5 empirically validates the effectiveness of the model through case studies. Section 6 presents discussions and analyses. Section 7 is the conclusion and outlook, summarizing the research findings and pointing out future research directions.

2 RELATED WORK

CAED is a product that combines environmental design with computer technology. It utilizes the powerful computing and graphics processing capabilities of computers to assist designers in spatial planning, material selection, lighting effect simulation, and more. The development of CAED technology has greatly improved the efficiency and quality of environmental design, enabling designers to express their design intentions faster and more accurately. Interaction design is a human-centred design philosophy that emphasizes the interactive experience between users and products. In interactive design, users no longer passively receive product information, but actively interact with the product through the user interface to meet their own needs. The theory of interaction design includes user behaviour analysis, interaction interface design, user experience evaluation, etc. In recent years, the concept of interaction design has gradually been introduced into the field of education, especially in environmental design teaching. Sędzicki et al. [11] introduced interactive design to create a more vivid and intuitive teaching environment, allowing students to learn and master knowledge through practice. In addition, interactive design can also stimulate students' interest and enthusiasm for learning, and improve their innovation and practical abilities. At present, the application of CAED and interaction design in education has been studied.

Introducing interactive design patterns in computer-aided environment design teaching means that students are no longer passive recipients of knowledge, but active participants in the design process. In the later stages of design, the introduction of 3D Max elevated the teaching format from a two-dimensional plane to a three-dimensional space. As the starting point of design teaching, AutoCAD, with its powerful drawing and positioning functions, helps students construct accurate 2D drawings from the conceptual stage. Through real-time feedback, immediate modifications, and collaborative work, students can gain a more intuitive understanding of design concepts, explore different design solutions, and continuously iterate and optimize in practice. By combining with interactive design patterns, Song and Jing [12] enable students to gain a more intuitive understanding of design layouts and spatial relationships, laying a solid foundation for subsequent 3D modelling. SketchUp, with its simplicity and powerful features, has become an ideal tool to support the entire process of landscape design teaching. By combining with interactive design patterns, students can adjust design elements in real time, observe changes in design effects, and make more accurate and optimized decisions. This mode not only enhances the interactivity and fun of learning but also cultivates students' innovative thinking and problem-solving abilities. Wu and Yan [13] utilize the rich material library, lighting effects, and rendering capabilities of 3D Max to create realistic landscape design scenes. It allows students to easily sketch, 3D model, specify materials, and render scenes at any design stage. More importantly, SketchUp's interactive design interface encourages students to engage in rapid iteration and creative design, promoting collaboration and communication among students.

In the process of building a digital platform for landscape architecture, Zhang et al. [14] deeply analyzed the core mechanism of digital landscape design, aiming to stably and vividly display the image of landscape architecture. This teaching plan not only utilizes discrete elevation calculation technology to accurately construct the framework of landscape design images but also ensures the accurate transmission of spatial information. On this basis, an innovative teaching scheme of digital landscape architecture design based on mobile edge computing is proposed. It effectively solves the problems of image jitter and low visual rendering that may occur in traditional methods, providing teachers and students with a smoother and more realistic interactive experience. From the preliminary concept to the detailed 3D modelling, students can see the design changes in real time, and through the support of an edge computing algorithm, adjust and optimize the design details in real time to ensure that each step achieves the best effect. We also innovatively introduced Roberts edge detection and Laplacian operator for advanced processing of landscape images to enhance their detail representation and stability. In order to further enhance the educational and practical value of the platform, Zhang et al. [15] integrated interactive design patterns into computer-aided environment design teaching. This instant feedback mechanism greatly enhances students' interest and creativity in learning, while also deepening their understanding of landscape design principles and practical skills. Under the framework of interactive design mode, this teaching plan encourages students to participate in the entire process of landscape design through computer-aided design software such as AutoCAD, 3D Max, or SketchUp. The experimental results show that the discrete elevation algorithm significantly reduces the low visual rendering phenomenon when generating 3D images, while the edge computing algorithm effectively avoids image jitter and ensures image clarity and stability.

The existing research has made some achievements in CAED teaching and interactive design application, but there are still some shortcomings: First, the research on the specific application mode and effect assessment of CAED in teaching is not deep enough; Second, there is relatively little research on how to effectively integrate the interactive design concept into the teaching of CAED. This article introduces the concept of interactive design in the teaching of CAED, constructs a new teaching mode, and verifies its effectiveness through empirical research.

3 INTERACTIVE DESIGN MODEL CONSTRUCTION

3.1 Interactive Design Principle and User (Student) Demand Analysis

The construction of an interactive design model depends on the principles of cognitive psychology and educational technology. Cognitive psychology provides the theoretical basis of the human cognitive process, which can help us understand the cognitive characteristics and needs of students in the learning process. Educational technology provides theoretical and practical guidance for applying technical means to education. In terms of specific composition, the interactive design model includes key elements such as user (student) demand analysis, interactive interface and function design, and integration of instructional content and activities. First of all, an in-depth analysis of users' needs is needed to understand their pain points and needs in the learning process. Secondly, interactive interfaces and functions according to users' needs are needed to ensure that students can operate and learn conveniently. Finally, the instructional content and activities are integrated so that students can practice and learn in an interactive environment.

When building an interactive design model, the basic design principles and strategies followed in this article are shown in Table 1:

Basic Design Principles	*Specific Strategies*	*Detailed Classification*
Interface Design is Concise and Clear	Use clear layouts and intuitive icons	Visual Design

	Reduce unnecessary visual elements and distractions	Information Architecture
	Provide clear operational feedback and guidance	User Feedback
Diversified Interaction Modes	Support multiple input methods (such as keyboard, mouse, touchscreen, etc.)	Input Diversity
	Provide personalized interaction options and settings	Personalized Customization
	Allow students to choose interaction methods according to their learning styles and preferences	Learning Style Adaptation
Tight and Orderly Integration of Teaching Content and Activities	Ensure logical correlation between instructional content and interactive activities.	Content and Activity Correlation
	Design a coherent learning path and staged goals	Learning Path Design
	Provide systematic learning resources and support.	Resources and Support

Table 1: Basic Design Principles and Strategies for Interactive Design Model.

In addition, before constructing the interactive design model, this article makes an in-depth analysis of users' needs. This includes understanding their study habits, preferences, pain points, and difficulties they may encounter in the learning process, as shown in Table 2:

User Need Dimension	*Specific Analysis Results*	*Detailed Classification*
Learning Habits	Most users prefer to study in the evening	Time Preference
	Users like to learn through a combination of videos, graphics, and text	Content Format Preference
	Users tend to learn independently but also need some guidance and feedback.	Learning Style Preference
Learning Preferences	Users prefer a clean and straightforward interface design	Interface Design Preference
	Users enjoy diverse interaction methods such as dragging, clicking, etc.	Interaction Method Preference
	Users hope that learning content can be personalized to match their learning styles and needs.	Individuation Needs
Learning Pain Points	When encountering difficult problems, users hope to receive timely answers and	Need for Problem-Solving Assistance

	assistance	
	Users feel that existing teaching resources are not systematic enough to form a complete knowledge system	Need for Systematic Teaching Resources
	Users easily get distracted during the learning process and need reminders and constraints	Need for Learning Focus
Learning Difficulties	Users report that some learning content is difficult to understand and requires more examples and explanations	Difficulty in Content Understanding
	Users have difficulties in time management and need guidance on learning paths and staged goals.	Difficulty in Time Management
	Users lack motivation during the learning process and need incentive and reward mechanisms.	Need for Learning Motivation

Table 2: Analysis of the results of user needs for the interactive design model.

Through demand analysis, we can better understand the needs and expectations of users, so as to provide them with more intimate and effective teaching services.

3.2 Specific Design and Methods of the Model

This section designs the interactive interface and functions according to the results of user demand analysis. Interface design should pay attention to user experience and ease of use to ensure that students can operate and learn conveniently. Functional design should meet students' learning needs and instructional objectives and provide rich and varied learning resources and practical activities.

Constructing an interactive design model involves data fusion of multiple sensors, so this article uses a multi-sensor fusion algorithm. Multi-sensor fusion algorithms can comprehensively process the data from different sensors and improve the accuracy and robustness of target tracking. In multi-sensor systems, because of the differences in sampling frequency, response time, and data format of different sensors, data synchronization and calibration are necessary steps before fusion. In order to achieve data synchronization, this article uses a time stamp, trigger signal, or external clock to align the data of different sensors. Data calibration involves linear transformation, nonlinear correction, or model-based calibration methods to ensure the accuracy and consistency of sensor data.

Feature extraction is another key technology in multi-sensor fusion algorithms. The original data often contains a lot of redundant information and noise so that direct fusion processing may lead to inaccurate results. Therefore, it is necessary to extract representative feature information from the original data, which can reflect the essential attributes of the data and is of great significance to the subsequent fusion processing. Feature extraction methods can be selected according to specific application scenarios and data characteristics. This article adopts the K-means algorithm in the clustering analysis method.

In the K-means algorithm, Euclidean distance is used to calculate the distance between the object and the cluster centre:

$$d\ \ p,q\ \ =\sqrt{\sum_{i=1}^{n}\ q_i,p_i\ ^{2}} \tag{1}$$

Given two data points, p and q, and the dimension of the data point, n, the updating formula for the cluster centre m_k is provided for each class C_k:

$$m_k=\frac{1}{\left|C_k\right|}\sum_{p\in C_k}p \tag{2}$$

Where $\left|C_k\right|$ is the number of objects in class C_k.

The goal of the K-means algorithm is to minimize the sum of the distances from each point to its cluster centre, that is, to minimize the following objective functions:

$$SSE=\sum_{k=1}^{K}\sum_{p\in C_k}\left\|p-m_k\right\|^2 \tag{3}$$

Among them, K are the number of classes, C_k the k class, m_k is the cluster center of class C_k, and p the object in class C_k.

By iteratively optimizing the above objective function, the K-means algorithm can find a more reasonable clustering structure in the data.

After extracting the features, it is necessary to fuse the feature layers. Feature layer fusion is a process of synthesizing and integrating feature information from different sensors in order to get a more comprehensive and accurate feature representation. In a multi-sensor fusion algorithm, decision-making level fusion is the final fusion level. At this level, according to the data characteristics obtained by feature layer fusion, the decision is made by discrimination, classification, and logical operation. Decision-making layer fusion has higher flexibility and anti-interference ability; even if some sensors fail or fail, it can still give reasonable decision-making results. In order to realize decision-making level fusion, this article adopts the neural network method. This method can be selected and optimized according to specific application scenarios and decision-making objectives. A neural network is a computational model that simulates the connection mode of human brain neurons. It makes decisions by learning the complex relationship between input data and output data. In the neural network, the activation function formula is as follows:

$$f\ \ x\ \ =\frac{1}{1+e^{-x}} \tag{4}$$

The sigmoid activation function is used to map the input of neurons between 0 and 1, as shown in Figure 1.

For the i neuron of l layer, its output $a_i^{\ l}$ can be expressed as:

$$a_i^{\ l}\ =f\left(\sum_{j=1}^{n}\omega_{ij}^{\ l}a_j^{\ l-1}\ +b_i^{\ l}\right) \tag{5}$$

Where $\omega_{ij}^{\ l}$ is the weight from the j neuron in the $l-1$ layer to the i neuron in the l layer, $b_i^{\ l}$ is the offset of the i neuron in the l layer, and n is the number of neurons in the $l-1$ layer.

For classification problems, the commonly used loss function is cross-entropy loss:

$$\varepsilon L\ \ y,y\ \ =-\sum_{i}y_i\log\ \hat{y}_i \tag{6}$$

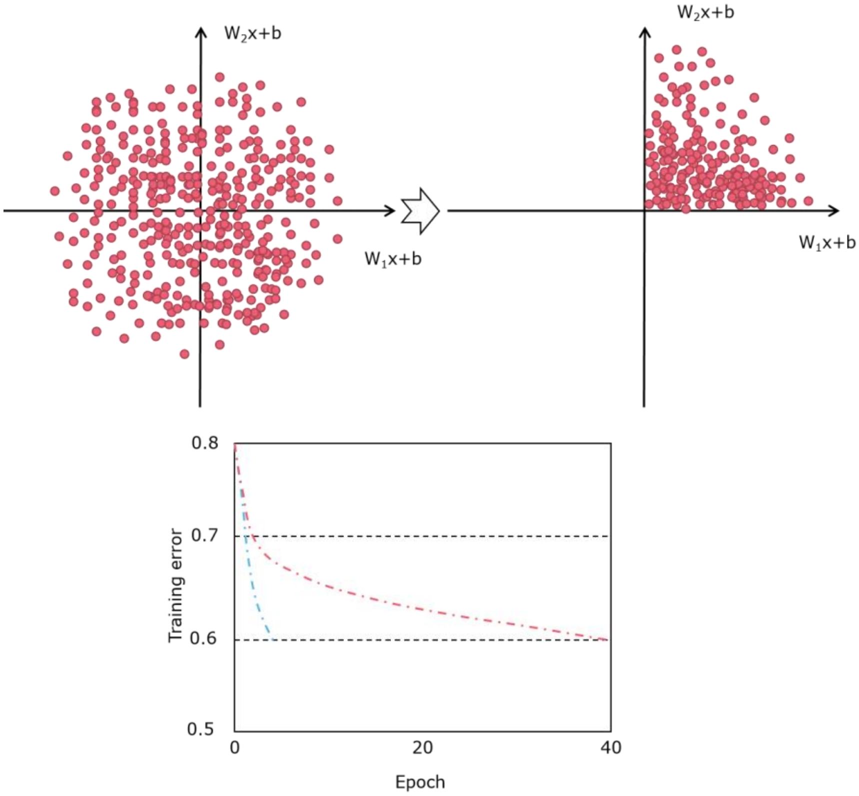

Figure 1: Activation function.

Where y is the real label and $\hat{y}$ is the predicted output of the neural network. In this article, the gradient descent method is used to update the weights:

$$\omega_{ij}^{l} := \omega_{ij}^{l} - \alpha \frac{\partial L}{\partial \omega_{ij}^{l}} \tag{7}$$

Where a is the learning rate?

In the process of decision-making level fusion, this article also considers introducing an optimization algorithm to improve the accuracy and efficiency of fusion results a genetic algorithm to optimize decision rules to obtain a better fusion effect. A genetic algorithm is a heuristic search algorithm that simulates the evolutionary mechanism of natural selection and genetics to optimize the solution of the problem. Firstly, the decision rules are coded as individuals in a genetic algorithm, that is, chromosomes. Each chromosome represents a specific set of decision rules. Each gene on the chromosome can correspond to a parameter or condition in the decision rule, such as threshold, weight, etc. Then, a certain number of chromosomes are randomly generated as the initial population, and each chromosome represents a possible combination of decision rules. Then, calculate the fitness of each individual, usually expressed by the value of the objective function:

$$f\ x\ = \text{Objective function}\ x \tag{8}$$

Where x is the genotype expression of the individual? Selecting individuals to enter the next generation according to fitness:

$$P(x) = \frac{f(x)}{\sum_{i=1}^{N} f(x_i)} \tag{9}$$

Where $P(x)$ is the probability that individual x is selected, and N is the population size. Generate new individuals through crossover operation:

$$x_{new} = CROSS(x_1, x_2) \tag{10}$$

Among them, x_1 and x_2 are the selected parents and x_{new} the newly generated offspring. Randomly mutate individuals to increase population diversity;

$$x_{mutated} = MUTATE(x) \tag{11}$$

Among them, x are the original individual and $x_{mutated}$ the mutated individual.

Through the optimization of genetic algorithms, more accurate and efficient decision rules can be obtained, thus improving the effect of decision-making level fusion. This method has obvious advantages in dealing with complex multi-sensor fusion problems.

4 APPLICATION OF INTERACTIVE DESIGN MODEL IN ENVIRONMENTAL DESIGN TEACHING

4.1 Case Selection and Specific Implementation Process

In order to verify the effectiveness of the interactive design model in environmental design teaching, this section selects a representative teaching class as an application case. The students in this class are faced with problems such as the lack of close integration of theory and practice and the lack of innovative practice opportunities when studying the course of environmental design. In the process of implementation, firstly, this article customized and adjusted the interactive design model according to the instructional objectives and contents. Then, the instructional content and activities are redesigned to meet the needs of an interactive learning environment. Next, the interactive interface is developed and optimized several times to ensure its ease of use and user-friendliness. Finally, this article applies the model to practical teaching and pays close attention to students' learning experiences and feedback. Figure 2 shows some students' environmental design works.

Figure 2: Display of partial environmental design works by students.

When redesigning the teaching content and activities, this paper focuses on combining theoretical knowledge with practical operation-designing a number of practical projects, such as indoor space design and landscape design, and requiring students to practice in an interactive environment (Figure 3). At the same time, interactive links such as group discussion and case analysis have been added in practice to promote exchanges and cooperation among students.

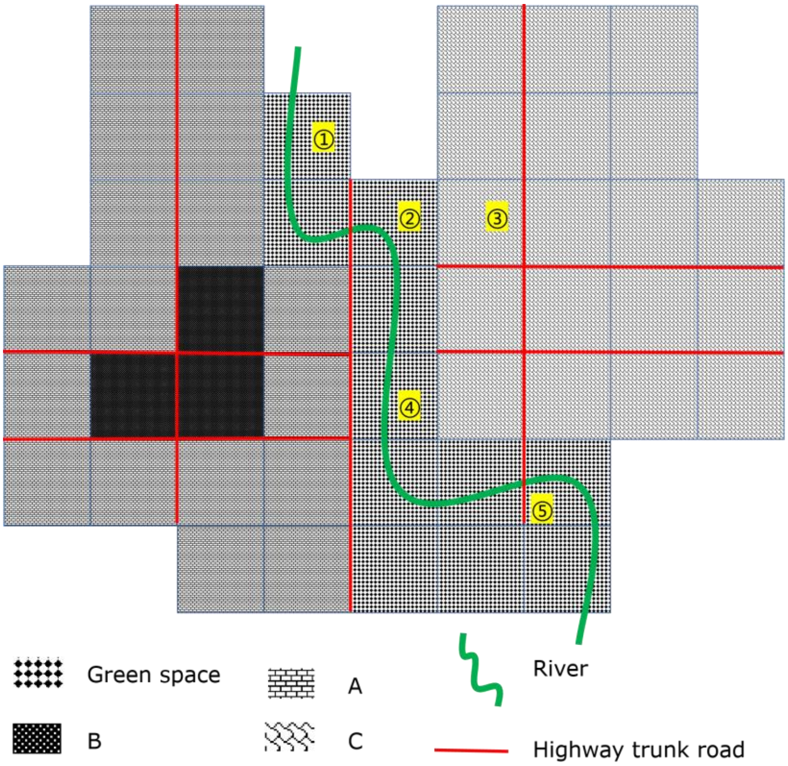

Figure 3: Plan of environmental design and planning.

When redesigning instructional content and activities, this article focuses on combining theoretical knowledge with practical operation-designing a number of practical projects, such as indoor space design and landscape design, and requiring students to practice in an interactive environment. Furthermore, interactive links such as group discussion and case analysis have been added in practice to promote exchanges and cooperation among students.

4.2 Quantitative and Qualitative Analysis of Instructional Effect

After applying the interactive design model, this article actively collected students' feedback. Most students said that they participated in learning more actively in the interactive learning environment, and their practical ability and innovation abilities were significantly improved. Furthermore, they also think that the interactive interface is reasonable in design and easy to operate and learn.

In order to comprehensively assess the application effect of the interactive design model, this article makes a quantitative and qualitative analysis of the instructional effect. In the aspect of quantitative analysis, students' learning achievements are assessed by indicators such as test scores and homework completion. This section compares the students' grades and homework completion before and after applying the interactive design model. The results are shown in Figures 4 and 5.

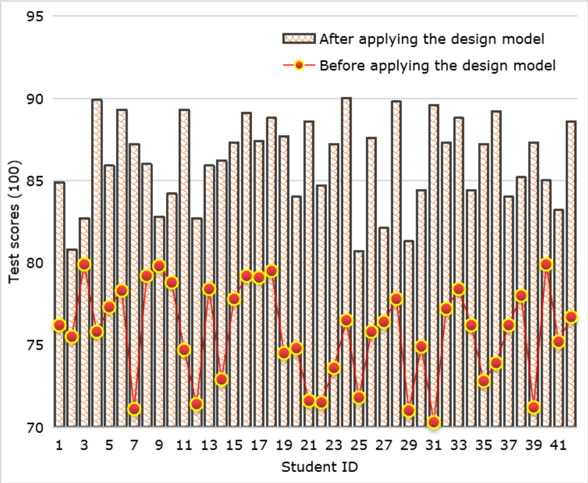

Figure 4: Examination results.

The data shows that before the interactive design model was applied, the average score of students was 75, and the distribution of scores was relatively scattered. After the interactive design model is applied, the average score of students is increased to 87, the distribution of scores is more concentrated, and the proportion of students with high grades is significantly increased.

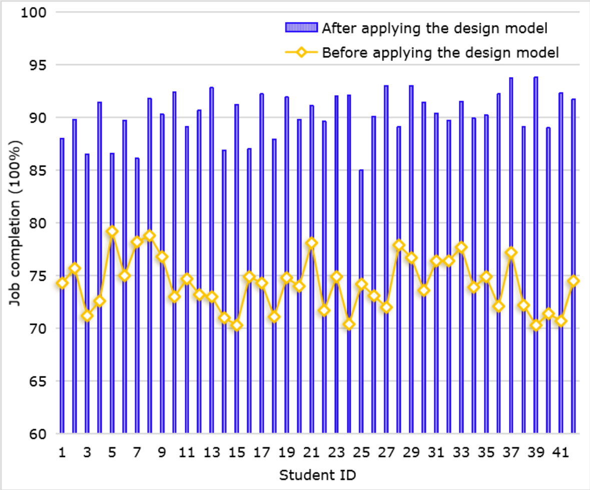

Figure 5: Completion status.

The data show that before the interactive design model was applied, the completion rate of students' homework was about 70%; that is, about 30% of students had unfinished homework or delayed submission. After applying the interactive design model, the completion rate of students' homework has increased to about 90%, and only about 10% of students occasionally have unfinished homework or delayed submission, and the quality of these students' homework has also improved.

In qualitative analysis, the instructional effect is assessed by observing students' performance in class and collecting their feedback. The results are shown in Table 3.

Assessment Dimension	*Specific Observations/Feedback Content*	*Value/Percentage (%)*
Student Classroom Engagement	Increased level of student engagement in discussions and practical activities	85.4% (significantly increased)
Discussion Engagement	Increased instances of students voluntarily speaking, asking questions, and responding to others' viewpoints	70.5% (increased)
Practical Activity Engagement	Improved student investment and willingness to collaborate in practical activities	91.2% (significantly improved)
Student Recognition of Environment	Student satisfaction and recognition of the interactive learning environment	95.1% (highly recognized)
Positive Feedback Ratio	The proportion of students expressing satisfaction with the interactive learning environment	92.3% (majority)
Suggestion for Improvement Ratio	The proportion of students providing specific suggestions for improvement (reflecting deep thinking and willingness to engage with the environment)	9.8% (minority)

Table 3: Results of qualitative analysis.

It can be observed that students' participation in the classroom has obviously improved, and they are more actively involved in discussions and practical activities. Furthermore, students' feedback also generally expressed their high recognition and satisfaction with the interactive learning environment.

The above results show that the interactive design model has obvious advantages in improving students' learning effect and stimulating their interest in learning.

In order to assess the application effect of the interactive design model more comprehensively, this section also conducted a satisfaction survey and ability improvement assessment for teachers and students. The results of the satisfaction survey are shown in Figure 6 and Figure 7 (satisfaction score range: 1-10, where 1 is very dissatisfied and 10 is very satisfied).

The results of the satisfaction survey show that 70% of teachers give 8 points or above, 20% give 7 points, and the remaining 10% give 6 points or below. 85% of the students give 9 points or above, 10% give 8 points, and only 5% give 7 points or below. Figure 8 shows the comparison of students' design contents before and after applying the interactive design model. The assessment of student's ability improvement is shown in Figure 9 (full mark: 100).

The results show that the innovation ability has improved by an average of 20%, of which 60% of students' innovation ability has improved significantly, 30% of students have improved to some extent, and only 10% of students have not improved significantly.

Practical ability improvement: the average improvement is 15%, 70% of students' practical ability has been significantly improved, 20% of students have improved to some extent, and 10% of students have not improved significantly.

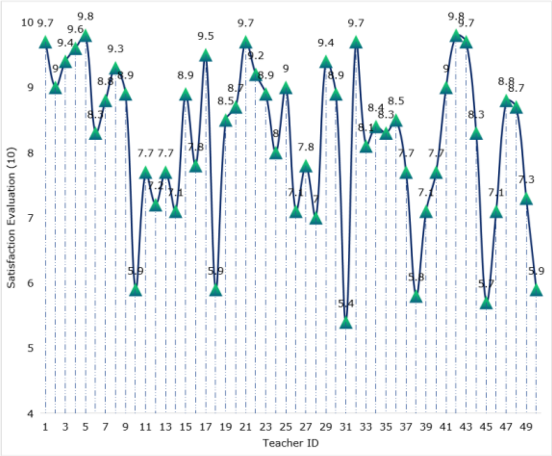

Figure 6: Teacher satisfaction assessment.

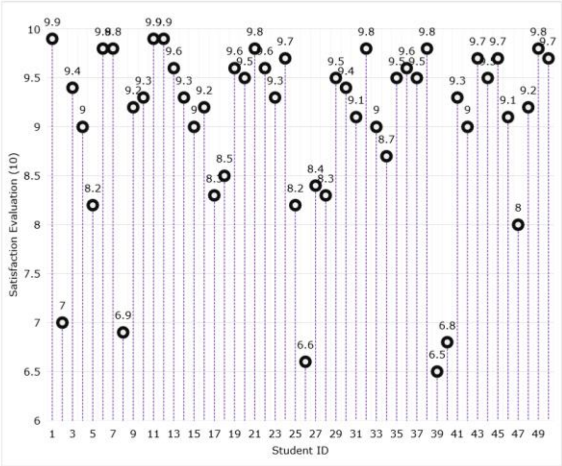

Figure 7: Student satisfaction assessment.

Figure 8: Comparison of design contents.

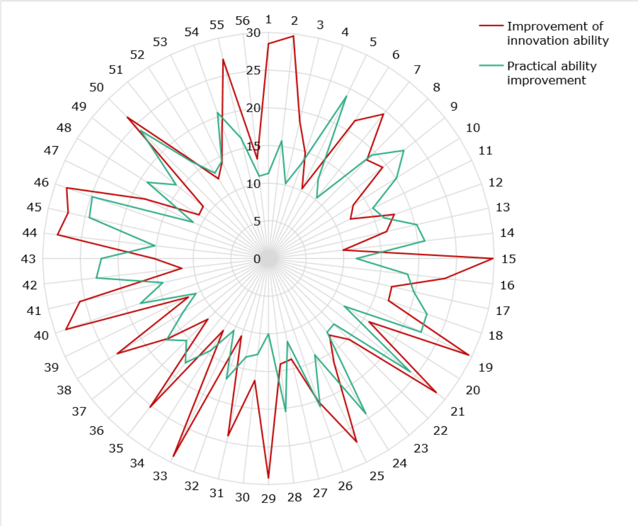

Figure 9: Assessment of students' ability improvement.

The above survey results show that after applying the interactive design model, students show higher creativity and practicality in design works and, at the same time, perform better in practical projects. Most students are satisfied or very satisfied with the interactive learning environment, and they think this learning method is more interesting and effective. In the aspect of ability improvement, by comparing students' design works and practical performance before and after application, we find that their innovation ability and practical ability have been significantly improved.

5 DISCUSSION AND ANALYSIS

Compared with the traditional teaching mode, the interactive design model has obvious advantages, which provide students with a more vivid and intuitive learning environment and help them better understand and master the design principles and methods. Furthermore, the model emphasizes the cultivation of practical operation and innovative ability, which effectively improves students' practical ability and innovative thinking. In addition, it can stimulate students' interest and enthusiasm in learning and encourage them to participate in the learning process more actively.

The application of this model provides beneficial enlightenment for the teaching reform of environmental design, emphasizing the combination of theory and practice, paying attention to students' individual differences, cultivating their innovative ability, and constantly exploring new instructional concepts and methods. It also brings innovation to instructional ideas and methods, promotes change from teacher-centered to student-centered, advocates diversified and interactive instructional methods, and pays attention to instructional assessment and feedback. In addition, the interactive design model also provides a new perspective for the cultivation of students' abilities, emphasizing the cultivation of practical ability, innovative ability, teamwork ability, and communication ability while paying attention to students' emotional development and humanistic quality, and devoting itself to cultivating design talents with all-round quality.

6 CONCLUSIONS

The purpose of this study is to explore the application and advantages of the interactive design model in environmental design teaching and verify its positive influence on students' learning effect, innovation ability, and practical ability through the analysis and assessment of actual cases. Looking back on the whole research process, this article strictly follows the established research objectives, and obtains the research findings with practical guiding significance by comparing and analyzing the instructional effects under the traditional teaching mode and the interactive design model. The main findings include: that the interactive design model can significantly improve students' enthusiasm and participation in learning. Through practical operation and interactive learning, students' design works are more creative and practical, and their teamwork and communication skills have also been significantly improved.

The application potential of interactive design is not limited to environmental design teaching, but it has broad application prospects in architectural design, industrial design, and even wider art and design education. Based on the current research results, future research can further explore the adaptability of interactive design models in different teaching environments and how to optimize the model further to meet different learning needs. In addition, the research on the combined application of interactive design and other emerging technologies is also a direction worthy of in-depth exploration.

Mengdi Gao, https://orcid.org/0009-0004-6639-0942
Chenyu Hu, https://orcid.org/0009-0004-7370-9181

REFERENCES

[1] Chen, J.; Stouffs, R.: Deciphering the noisy landscape: Architectural conceptual design space interpretation using disentangled representation learning, Computer-Aided Civil and Infrastructure Engineering, 38(5), 2023, 601-620. https://doi.org/10.1111/mice.12908

[2] Chen, Y.: The path and value of integrating ecological aesthetic education into the teaching of environmental art design major, Journal of Contemporary Educational Research, 7(11), 2023, 190-196. https://doi.org/10.26689/jcer.v7i11.5660

[3] Denerel, S.-B.; Anil, G.: Computer-aided drawing programs in interior architecture education, Amazonia Investiga, 10(39), 2021, 28-39. https://doi.org/10.34069/AI/2021.39.03.3

[4] Han, Y.; Zhang, K.; Xu, Y.; Wang, H.; Chai, T.: Application of parametric design in the optimization of traditional landscape architecture, Processes, 11(2), 2023, 639. https://doi.org/10.3390/pr11020639

[5] Hsu, C.-Y.; Ou, S.-J.: Innovative practice of sustainable landscape architecture education—Parametric-aided design and application, Sustainability, 14(8), 2022, 4627. https://doi.org/10.3390/su14084627

[6] Hu, S.; Meng, Q.; Xu, D.; Katib, I.; Aouad, M.: The spatial form of digital nonlinear landscape architecture design based on computer big data, Applied Mathematics and Nonlinear Sciences, 7(1), 2021, 783-790. https://doi.org/10.2478/amns.2021.1.00069

[7] Jia, J.: Computer-aided design method of parametric model for landscape planning, Computer-Aided Design and Applications, 19(S3), 2022, 55-64. https://doi.org/10.14733/cadaps.2022.S3.55-64

[8] Jiang, W.; Zhang, Y.: Application of 3D visualization in landscape design teaching, International Journal of Emerging Technologies in Learning (IJET), 14(6), 2019, 53. https://doi.org/10.3991/ijet.v14i06.10156

[9] Pando, C.-P.; Fernández, Á.-H.; Busto, P.-B.; Castaño, B.-S.: Boosting computer-aided design pedagogy using interactive self-assessment graphical tools, Computer Applications in Engineering Education, 31(1), 2023, 26-46. https://doi.org/10.1002/cae.22569

[10] Sędzicki, D.; Cudzik, J.; Bonenberg, W.; Nyka, L.: Computer-aided automated greenery design—towards a green BIM, Sustainability, 14(14), 2022, 8927. https://doi.org/10.3390/su14148927

[11] Sędzicki, D.; Cudzik, J.; Nyka, L.: Computer-aided greenery design—prototype green structure improving human health in urban ecosystem, International Journal of Environmental Research and Public Health, 20(2), 2023, 1198. https://doi.org/10.3390/ijerph20021198

[12] Song, Y.; Jing, Y.: Application Prospect of CAD-Sketchup-PS integrated software technology in landscape planning and design, Computer-Aided Design and Applications, 18(S3), 2020, 153-163. https://doi.org/10.14733/cadaps.2021.S3.153-163

[13] Wu, H.; Yan, J.: The mechanism of digitized landscape architecture design under edge computing, Plos One, 16(9), 2021, e0252087. https://doi.org/10.1371/journal.pone.0252087

[14] Zhang, Y.; Du, Z.; Hou, Y.: Creating an environmentally sustainable design practices case bank: integrating industry and teaching at the threshold, Voice of the Publisher, 9(04), 2023, 272-282. https://doi.org/10.4236/vp.2023.94021

[15] Zhang, Y.; Li, L.; Liu, B.: The discussion on interior design mode based on 3D virtual vision technology, Journal of Advanced Computational Intelligence and Intelligent Informatics, 23(3), 2019, 390-395. https://doi.org/10.20965/jaciii.2019.p0390