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Construction and Effect Assessment of Art Teaching Platform Integrating Visual Exploration Framework

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Abstract. To enhance the colour learning experience of computer vision art and further expand the aesthetic function of art teaching. This article develops a computer art-style classification experience project based on CAD technology. A high-frequency error correction analysis of visual algorithms was conducted. By analyzing the visual style characteristics of original artworks, a visual exploration framework for art teaching has been constructed. In the process of collecting characteristic data for art teaching, the optimization of platform performance for art teaching benefits was studied, further improving the performance of art teaching. In the process of enhancing the results of art teaching platforms, student satisfaction, and substantial vitality possibilities have been greatly improved. The experimental results have generally helped improve the digitalization level of art teaching classrooms and provided support for students' possibilities of art teaching on multiple platforms.

Keywords: CAD Technology; Art Teaching Platform; Visual Error Correction; Algorithm Optimization; Instructional Effect Assessment
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1 INTRODUCTION

In higher education, students have vivid and intuitive learning styles, intuitive thinking, unstable attention, and limited working memory abilities. It is also necessary to consider the interactive impact of teaching strategies on knowledge types and complexity. Virtual reality technology has been widely applied in college art teaching, and its interactive and imaginative characteristics are conducive to stimulating the learning interest of college students, enhancing the learning experience, improving learning effectiveness, and overcoming the high cost and difficulties of constructing real work scenes [1]. However, the integration of virtual reality technology and teaching is not yet deep enough, and there are still problems, such as a lack of effective teaching strategy guidance. It is necessary to explore further effective teaching strategy design and usage methods for the application of virtual technology in art. The results indicate that scaffold-based teaching strategies, such as advance organizers, teaching explanations, and teaching demonstrations, can improve the effectiveness of virtual learning, manifested in increased academic performance and satisfaction and reduced cognitive load. The teaching strategies and different presentation forms of art and fine arts have varying degrees of impact on the effectiveness of virtual learning. As a pre-organizer of the scaffold, teaching strategies such as explanation and demonstration can promote students' learning. Based on this, this study suggests that university teachers should pay attention to using virtual art teaching strategies to improve students' virtual learning outcomes. In addition, college students have better results in learning procedural and less complex knowledge in virtual art and design environments [2]. To further explore the effectiveness of the above strategies in virtual learning for college students, this study is based on cognitive load theory, constructivist theory, and output theory. For example, adjusting the complexity of virtual knowledge based on cognitive load and designing virtual program knowledge based on work scenarios. Conduct in-depth research on virtual practical art teaching, with a focus on studying teaching strategies as scaffolds. Based on teaching objectives and the learning characteristics of college students, find the optimal combination of virtual teaching strategies. Virtual art environment designers should develop virtual resources that are suitable for the learning characteristics of college students to assist in designing teaching strategies. Develop evaluation criteria for the effectiveness of virtual teaching applications, support the construction of virtual learning content and platforms, and improve the effectiveness of virtual teaching strategies. There are differences in the impact of different types of art teaching strategies on grade transfer and retention. Colleges and universities can provide comprehensive support to cultivate a teaching staff with virtual teaching capabilities.

With the increasing maturity of AI and CAD technologies, integrating them into art teaching platforms can not only provide powerful creative tools for artists and students but also improve learning efficiency and creative quality through intelligent assistance. Based on AI-assisted design, students can use CAD tools for precise drawing and adjustment, transforming the design from concept to physical object, and improving the precision and completion of work. At the same time, it further expands to the construction and effectiveness evaluation of an art teaching platform integrating CAD (computer-aided design) technology. Using AI algorithms such as support vector machine (SVM), deep learning, etc., to analyze user input or sketches, automatically generate preliminary design drafts, including colour matching suggestions, composition optimization, etc., to reduce the burden on students in the early stages of design. Some studies are exploring digital media art creation based on artificial intelligence computer-aided technology. It aims to analyze how this integrated technology promotes innovation and development in art teaching and evaluate its practical application effects [3]. The algorithm optimization ability of AI combined with the precise design function of CAD can help students better understand the basic elements of art, such as spatial structure, color matching, and light and shadow effects, while stimulating innovative thinking and promoting personalized artistic expression [4].

With the continuous deepening of art education reform, higher requirements have been put forward for the creation of art teaching contexts: attention should be paid to the interaction between students' bodies and the environment in the teaching context, and the participation of students' bodies in classroom teaching activities should be emphasized. Therefore, creating virtual art teaching scenarios through somatosensory interaction can provide a solution for achieving embodied teaching scenarios [5]. The embodied cognition theory, which adheres to the viewpoint of "cognition rooted in the body," provides a theoretical basis for promoting the optimization and upgrading of teaching contexts. Starting from the construction of abstract design models, this study gradually realizes the specific design of virtual art teaching scenarios and verifies their effectiveness in teaching practice. Firstly, the theoretical basis for creating virtual teaching scenarios should be analyzed [6]. In particular, somatosensory VR can highlight the interaction between users and contexts. There are many successful application cases in disciplines such as art, which provide a broader development space for embodied learning. However, influenced by the traditional teaching concept of "disembodied," art classrooms often lack the creation of teaching contexts that emphasize physical cognition. With the development of emerging technologies such as artificial intelligence, big data, and virtual reality (VR), these technologies have greatly enriched the means to support the creation of art teaching scenarios [7]. Afterward, the design strategy elements, further refined based on the Kano model classification, will be applied to summarize which elements will bring better experiences to the situational subjects, analyze which elements should be emphasized in the design, and better guide the later design. This art model goes from abstract to concrete, including the determination of situational subject needs and situational goals, information architecture design, visual interface design, and so on. The levels are interrelated and logically reasonable [8]. Abstracting design dimensions from design principles, and then extracting design strategy elements from successful cases by reading a large number of excellent literature. And analyze the relationship between embodied cognition theory, situational cognition theory, and flow experience theory. These two aspects lay the foundation for the design of virtual teaching scenarios [9]. By reviewing existing literature, analyzing the structural elements of virtual teaching scenarios, and identifying the elements and their relationships that should be considered in design. Build a virtual art teaching scenario design model. Integrating the artistic framework of the user experience element model with the SECI knowledge transformation process and the design principles and strategic elements mentioned above, a virtual teaching scenario design model is constructed [10]. The research introduces several novel aspects:

(1) It incorporates CAD technology into art teaching, achieving a profound integration of traditional art and modern science and technology.

(2) It establishes an art teaching platform based on CAD technology, offering a fresh teaching and learning environment.

(3) This platform consolidates diverse art teaching resources, such as tutorials, cases, and materials, facilitating easy access and learning for students.

(4) It provides visual teaching aids to enhance students' understanding and mastery of fundamental fine arts knowledge.

The article structure is outlined as follows: Initially, it expounds on the research background, significance, and purpose of the art teaching platform integrating CAD technology. Subsequently, it discusses the current state of CAD technology and art teaching, along with an analysis of related research. Then, it delves into the detailed construction process of the art teaching platform integrating CAD technology, encompassing design principles, functional modules, and technical implementation. Following this, it assesses the instructional effect of the platform, including the evaluation scheme, data collection and analysis, and a discussion of the assessment results. Lastly, it summarizes the key findings, contributions, and limitations of the study, while also prospecting future research directions.

2 LITERATURE REVIEW

Before discussing the construction of an integrated CAD technology art teaching platform, it is necessary to review the application of CAD technology in education and the current status of art teaching. When building an art teaching platform that integrates CAD technology, Li and Wenjie [11] made the Chinese painting style conversion function a featured module of the platform. The platform can further integrate user interaction functions, allowing students to adjust parameters such as colour saturation and light and shadow effect in the conversion process to explore different styles of realistic images. At the same time, through the precise drawing function of CAD technology, students can create new works based on converted realistic images, combining traditional elements with modern design to create unique styles. Convert Chinese ink paintings and other blurred boundary artworks into high-definition and realistic images. This module is not limited to traditional image style conversion but utilizes GAN technology, specially optimized boundary-enhanced GAN. Users can not only learn the painting techniques of Chinese painting on the platform but also intuitively experience the collision of traditional art and modern technology through this feature, inspiring creative inspiration. This interactive learning experience not only enhances the fun of learning but also cultivates students' aesthetic ability and innovative thinking. In addition, the platform can also establish online communication communities to encourage students to share their work, receive feedback and suggestions from teachers, classmates, and artificial intelligence teaching assistants, and form a virtuous learning cycle. In terms of effectiveness evaluation, the platform can introduce artificial intelligence image recognition and evaluation technology to conduct a multidimensional evaluation of student works, including similarity with original Chinese paintings, the authenticity of converted images, creativity, etc.

In art teaching, similarity measurement is not only the key to evaluating the similarity between students' works and standard examples but also an important tool for providing creative guidance. The development and widespread application of virtual reality technology in education and teaching meet the practical needs of educational development and the requirements of educational informatization construction. Through a review of the research background and current status both domestically and internationally, Li [12] found that instructional design incorporating generative learning strategies has the potential to promote the effectiveness of immersive teaching. After analyzing the applicability of generative learning strategies, the learning characteristics of middle school students, and the subject curriculum, it was decided to use generative summarization and drawing strategies for teaching and integrate suitable strategies into the teaching design of immersive virtual reality. These six dimensions are the evaluation indicators for this study to determine whether generative learning strategies can improve the effectiveness of immersive teaching. Experimental teaching determines the use of generative learning strategies as the independent variable, and six dimensions of learning interest, learning motivation, learning satisfaction, flow experience, cognitive load, and academic performance as the dependent variables. Among them, academic performance is divided into objective and subjective question answers according to question types. The strategies of generative summarization and drawing have a significant promoting effect on immersive virtual reality teaching. Compared with continuous and complete learning of immersive teaching, the three research questions are whether the use of generative drawing strategies improves the quality of immersive teaching and whether generative learning strategies promote the occurrence path of immersive learning. After comparing data from three experimental classes, Lin et al. [13] found that compared to the control group without the use of strategies, generative summarization strategies and drawing strategies not only reduce cognitive load that is not conducive to immersive teaching, but also steadily improve learning experience and objective question scores, but have no significant effect on objective question scores. Conduct empirical research on the theme of whether generative learning strategies promote the improvement of immersive teaching quality in middle school classrooms. Conduct a survey on the current situation of virtual reality education based on three questions, conduct on-site interviews with teachers and students, and ultimately select eighth-grade middle school students for immersive virtual reality geography teaching. Its immersive, interactive, and imaginative nature allows students to immerse themselves in the learning object and teaching process. These data-driven insights can provide strong support for teachers to develop personalized teaching plans. Liu et al. [14] integrated real-time data streams (such as students' creative process records on the platform, interactions with teachers and classmates, etc.) into the ID3 algorithm, which can achieve dynamic monitoring and evaluation of students' learning status. This instant feedback mechanism helps teachers promptly identify and solve problems encountered by students in the learning process, adjust teaching strategies, and motivate students to maintain a positive learning attitude. On the art teaching platform integrating CAD technology, students' submitted works can automatically extract key feature parameters through the platform's built-in image processing and analysis functions, further enriching the evaluation dataset and making the evaluation results more comprehensive and objective. In addition, data flow analysis can reveal students' interest preferences and skill development trends at different learning stages, providing a basis for personalized learning path planning. At the same time, new art education teaching models and methods have emerged, but virtual reality technology has not had a clear promoting effect on teaching effectiveness. Long [15] can achieve any envisioned art education and teaching environment through virtual reality technology. By comparing and analyzing the learning experience and academic performance of the strategy and painting strategy, the results show that there is no significant difference between these two strategies in immersive learning.

3 CONSTRUCTION OF PLATFORM INTEGRATING CAD TECHNOLOGY

The scanning line algorithm and Weiler-Atherton algorithm are also introduced to accurately handle the cutting and intersection test of graphics and ensure that users can get accurate and timely feedback in the creative process.

When implementing these algorithms, we pay attention to the readability and maintainability of the code and adopt the modular design idea. Each algorithm is encapsulated into an independent module, which can not only improve the reusability of the code but also help the subsequent maintenance and expansion.

In this article, an innovative deep memory network model integrating transcendental knowledge is proposed, aiming at combining the transcendental knowledge in comments to realize the fine emotional analysis of students' teaching assessment at the aspect level. This model not only digs deeply into the emotional information in the assessment text but also makes full use of the prior knowledge, such as the professional knowledge in the teaching field and the common modes of students' assessment, thus significantly improving the accuracy and depth of emotional analysis. As shown in Figure 1, the model realizes the effective integration of prior knowledge and assessment data by constructing a complex neural network architecture and provides a new and more refined perspective and method for the emotional analysis of students' teaching assessment.

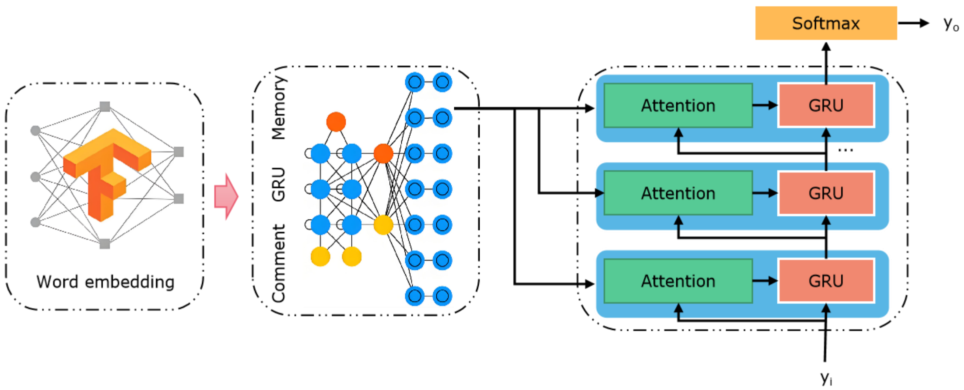

Figure 1: Deep memory network with prior knowledge.

Assuming the class label C_i for the tuple X, we make a naive presumption that the attribute values are mutually independent, implying no dependency between $A_1, A_2, \cdots, A_n$ attributes and their conditional independence. Thus, the posterior probability of X under C_i condition can be transformed into:

$$P(X|C_i) = \prod_{k=1}^{n} P(x_k|C_i) = P(x_1|C_i) \times P(x_2|C_i) \times \cdots \times P(x_n|C_i) \quad (1)$$

The probability $P(x_1|C_i), P(x_2|C_i), \cdots, (x_n|C_i)$ can be easily estimated from the training tuple, which x_k represents the value of attribute A_k for the tuple X.

To predict the class label of the class tuple X belongs to $P(X|C_i)P(C_i)$ is computed for each class C_i. The NBC prediction tuple X 's class label is C_i, if and only if:

$$P(X|C_i)P(C_i) > P(X|C_j)P(C_j) \quad 1 \le j \le m \quad (2)$$

That is, the predicted class label is the class C_i which maximizes the $P(X|C_i)P(C_i)$ value.

The shared network part is denoted as H. The encoder can be expressed as follows:

$$\mu = f_1(H(X)) \tag{3}$$

The discriminator D can be formulated as:

$$\log \sigma^2 = f_2(H(X)) \tag{4}$$

$$D = f_3(H(X)) \tag{5}$$

Where f represents distinct mappings of the network's final layer.

To address the issue of fuzzy synthesis in art images, image fidelity is evaluated through an inference network that assigns "true" labels to real training samples (x) and "false" labels to generated samples (x_f). The introspective adversarial losses for both the inference and generation networks are expressed as follows:

$$L_{adv}^{G} = L_{KL}(z_{a,f}) \tag{6}$$

Where $z_{a,f}$ denotes the authenticity unit of the generated sample.

Art images are different from ordinary texture patterns, which are unique in that a certain part of them often contains clear meaning and unique visual characteristics. In the process of creation, artists will also portray these relatively independent parts as separate performance objects. Therefore, during the construction of the art teaching platform's algorithm, we can focus on areas with independent meanings and notable visual characteristics, treating them as the smallest unit for style learning without considering the entire image. To ensure colour consistency between the transformed and original images, we employ an identity loss:

$$L_{identity}(G_1) = E_{x\sim p_{data}(x)}\left[\left\|G_1(x) - x\right\|_1\right] \tag{7}$$

Where $x \sim p_{data}(x)$ represents the picture originating from the source domain X that is to be transformed, and $G_1(x)$ denotes the synthetic result generated by G_1.

To achieve this function, a deep learning algorithm is adopted in the study, especially the paper platform, which also realizes the function of style transfer so that students can try and experience different creative styles. In order to integrate a neural network (CNN) to extract image features, the transformation between different styles must be realized through training models. In order to further improve the performance of the platform, the algorithm is deeply optimized. Firstly, the data structure is optimized, and a more suitable data structure is selected to reduce unnecessary calculation and memory overhead. Secondly, the parallel calculation of the algorithm is realized by using multithreading technology, which greatly improves the calculation efficiency and enables the platform to respond to the user's operation more quickly. Finally, the cache mechanism is introduced to store commonly used calculation results and intermediate data so as to reduce the overhead of repeated calculation and data access and further improve the performance of the platform. Figure 2 is a schematic diagram of the interactive interface of art design. Figure 3 shows the three-dimensional simulation effect of the art design of the platform.

Figure 4 illustrates that artwork images are inherently affected by the surrounding environment during collection, resulting in notable characteristics such as low contrast, low signal-to-noise ratio, and uneven brightness. Environmental factors contributing to these issues may include poor lighting conditions, limitations of shooting equipment, or the preservation state of the artwork itself, such as fading and stains. Consequently, special attention must be given to effectively enhancing contrast, reducing noise, and correcting brightness during image processing and analysis to ensure that subsequent image recognition, restoration, or enhancement work yields the desired results.

Figure 2: Schematic diagram of the interactive interface of art design

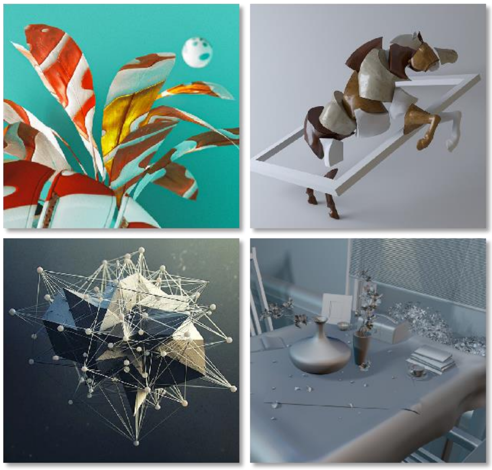

Figure 3: Three-dimensional renderings

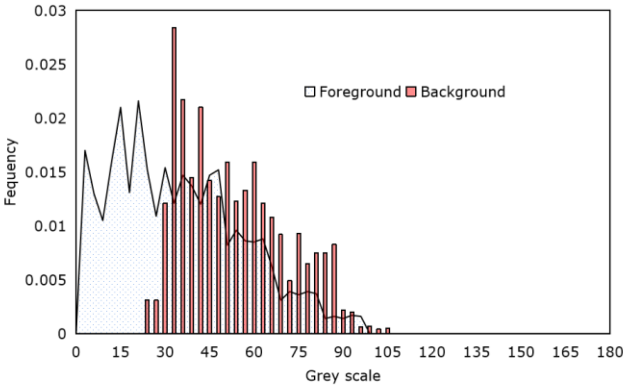

Figure 4: Gray distribution of foreground area and background area.

If the SVM pool contains more than one SVM, it becomes essential to select and combine suitable SVM using Adaboost to create a more robust classifier:

$$f(x) = \sum_{m=0}^{k} \alpha_m f_m(x) \tag{8}$$

α_m represents the weight assigned to each SVM, while $f_m(x)$ denoting the corresponding linear SVM. Suppose the motion description results in m sub-categories, each containing $c_1, c_2, \cdots, c_m$ categories, satisfying the subsequent formula:

$$\sum_{i=1}^{m} c_i = N \tag{9}$$

For each subclass c_i with distinct motion descriptions, constructing a multi-class classifier within each subclass suffices, eliminating the need to build classifiers for any two classes.

The generalization capability of SVM relies on the kernel function, commonly utilizing functions derived from the linear kernel, RBF, and polynomial kernels.

Linear kernel function:

$$K(x_i, x) = \langle x_i, x \rangle \tag{10}$$

Radial basis kernel function:

$$K(x_i, x) = \exp\left(-\gamma \left\| x_i - x \right\|^2\right) \tag{11}$$

γ is the parameter to be determined. The radial basis kernel function transforms low-dimensional data into high-dimensional space for representation, addressing issues of linear inseparability in lower dimensions.

4 EXPERIMENT AND RESULT ANALYSIS

To thoroughly evaluate the performance and impact of the art teaching platform integrating CAD technology, this section outlines a series of experiments encompassing image correction, algorithm optimization, teaching design quality and efficiency, as well as student satisfaction.

4.1 Visual Error Correction Experiment

Figure 5 shows the effect comparison of the correction process. From left to right: the initial image, the filtered image and the final effect after visual error correction. Through comparison, it can be clearly seen that the corrected image effectively eliminates visual errors while retaining the artistic style and details of the original, making the picture clearer and more realistic. This result verifies that the algorithm can significantly improve the image quality while maintaining the artistic style and details, and provide students with a more accurate and real visual feedback environment.

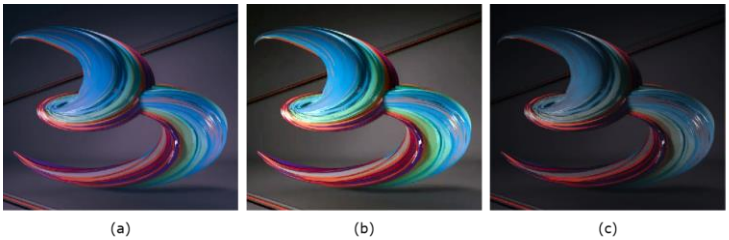

Figure 5: Effect of visual error correction.

(a) Initial image: It shows the original artwork image without any processing, which may contain various visual errors introduced during shooting, scanning or creation.

(b) Filtering effect diagram: After filtering algorithm processing, some noise and interference in the image are effectively removed, but some subtle visual errors may still remain.

(c) Correction effect diagram: On the basis of filtering, the visual error correction algorithm is further applied, the image quality is significantly improved, and the visual error is almost completely eliminated, showing a clearer and more realistic picture effect.

4.2 Algorithm Optimization Experiment

To enhance the performance and efficiency of the algorithm, this article has undertaken various optimization efforts. Specifically, the data structure has been optimized to minimize memory usage and enhance data access speed. Additionally, the algorithm logic has been parallelized to fully leverage the computing capabilities of multi-core processors. Moreover, the rendering process has been refined to enhance the speed and quality of art image rendering. As depicted in Figure 6, a comparison of the algorithm's accuracy before and after optimization reveals that the optimized algorithm notably improves processing speed while preserving high accuracy.

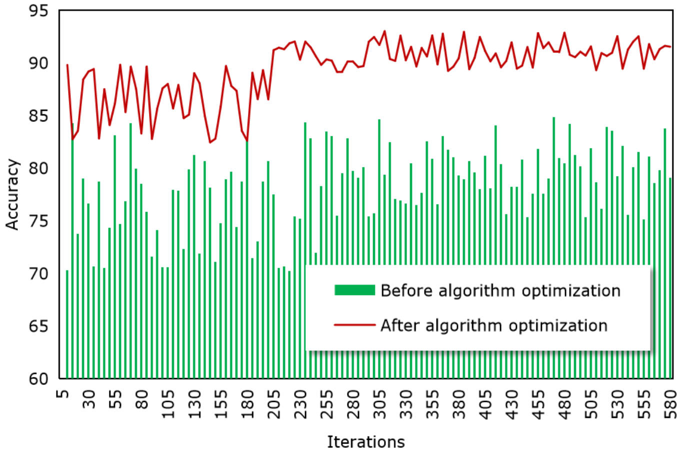

Figure 6: Accuracy before and after algorithm optimization.

Comparing the accuracy curves before and after optimization, it is evident that the optimized algorithm has significantly enhanced processing speed while maintaining high accuracy, ultimately providing students with a smoother and more efficient learning experience.

4.3 Design Quality and Efficiency Experiment

In order to assess the influence of the improved art teaching platform on students' design quality and efficiency, art design tasks with different difficulty levels are selected, and the design quality and completion time of students before and after using the improved teaching platform are compared. As shown in Figure 7 and Figure 8, after using the improved teaching platform, students show higher design quality and faster completion speed in design tasks with different difficulty levels.

Comparing the design quality scores of students before and after using the improved teaching platform for the same design task, it is evident that the students' design quality has significantly improved after utilizing the enhanced platform. By comparing the time required for students to complete the same design task before and after using the improved teaching platform, it can be found that the completion time of students is obviously shortened after using the improved platform, which shows that the platform has a significant effect in improving design efficiency.

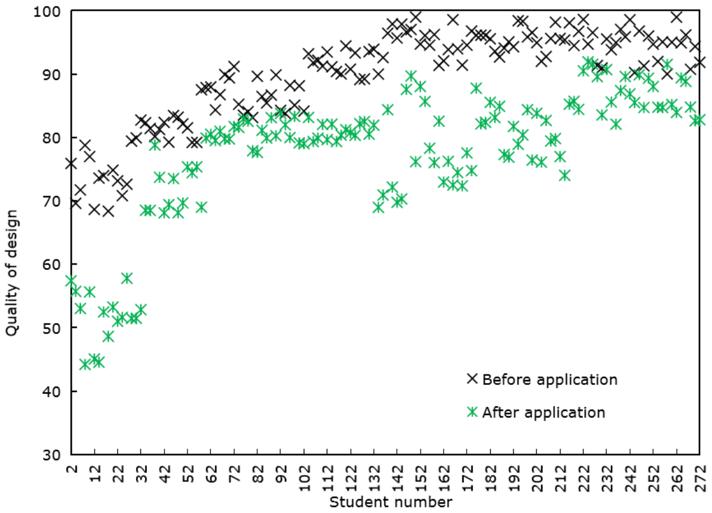

Figure 7: Design quality before and after using the improved teaching platform.

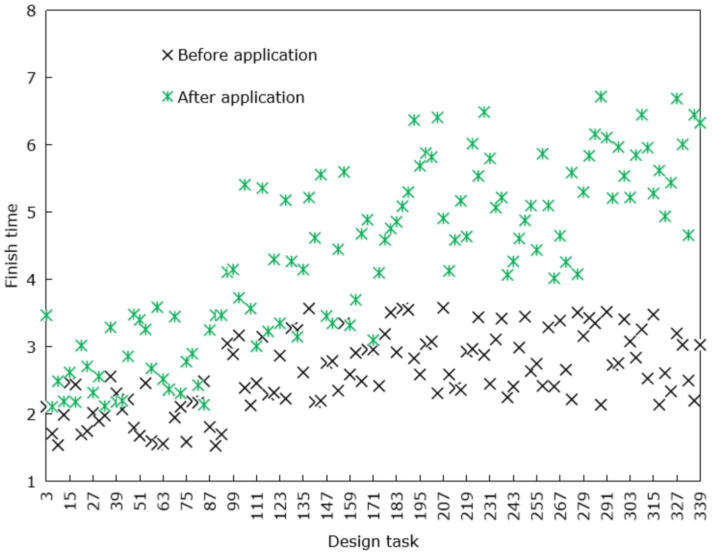

Figure 8: Completion time before and after using the improved teaching platform.

4.4 Experiment of Assessment

To get a more comprehensive understanding of students' acceptance and satisfaction with the improved art teaching platform, an assessment survey of students' satisfaction was conducted in the study. As shown in Figure 9, most students agree with the art teaching platform and think that the platform has significant help in improving design quality, improving efficiency and providing individualized learning suggestions.

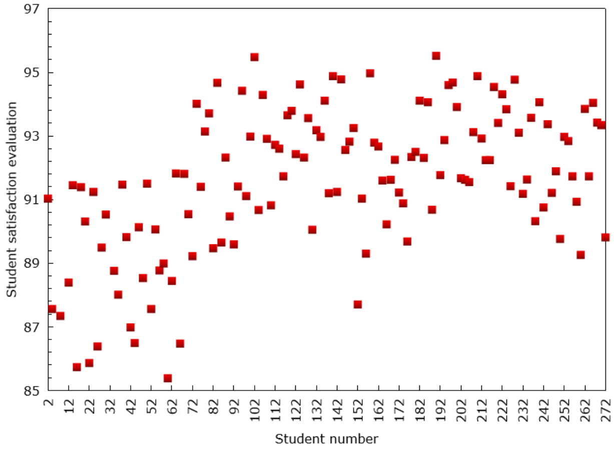

Figure 9: Student satisfaction assessment.

Through the survey and statistics of students' satisfaction, we can see that most students have a positive attitude towards the improved art teaching platform, and think that the platform has provided them with substantial help and support in many aspects.

To sum up, through a series of experiments and assessments, it is fully verified that the art teaching platform integrating CAD technology has remarkable effects in improving image quality, optimizing algorithm performance, improving teaching design quality and efficiency, and enhancing students' satisfaction. This platform not only offers students a more efficient and convenient learning environment but also introduces new possibilities in art teaching.

4.5 Discussion

From the results of visual error correction, the algorithm can effectively eliminate the visual error while maintaining the artistic style and details of the original and significantly improve the image quality. This result is very important for the art teaching platform because it provides students with a more accurate and real visual feedback environment. In art learning, accurate visual feedback is the basis for students to improve their skills and creative level. By eliminating visual errors, students can observe the differences between their own works and the original works more clearly, so as to make more targeted improvements.

The results of algorithm optimization experiments show that our optimization strategy has achieved remarkable results in improving algorithm performance and efficiency. By optimizing the data structure, parallelizing the algorithm logic and optimizing the rendering process, the processing speed of the algorithm is successfully improved while maintaining high accuracy. It means that students can use the platform to learn and create more smoothly and efficiently without worrying about performance bottlenecks or delays. This will greatly enhance students' learning experience, thus helping them to better master art skills.

In the experiment results of teaching design quality and efficiency, after using the improved art teaching platform, students show higher design quality and faster completion speed in design tasks with different difficulty levels. This result fully proves the effectiveness of our platform in improving students' design ability and efficiency. By providing rich teaching resources, intelligent creative auxiliary tools and individualized learning suggestions, our platform successfully inspires students' creative inspiration and helps them complete higher-quality design works in a shorter time.

The results of the student satisfaction assessment experiment further verify the popularity and effectiveness of our art teaching platform. Most students agree with the platform and think that it has provided them with substantial help and support in improving design quality, improving efficiency and providing individualized learning suggestions. It shows that the platform has successfully met the needs and expectations of students and brought them positive learning experiences and achievements.

In summary, through a series of experiments and assessments, the significant effects of the art teaching platform integrating CAD technology have been thoroughly verified across multiple aspects. This platform not only offers students a more efficient and convenient learning environment but also introduces new possibilities in art teaching. Looking ahead, we will continue to refine and enhance the platform's functionalities to provide a more personalized and intelligent learning experience, further nurturing students' creative potential and innovative spirit.

5 CONCLUSIONS

Through research and experimental verification of the art teaching platform integrating CAD technology, this article presents a series of conclusions with both practical significance and theoretical value. In terms of visual error correction, the proposed algorithm effectively eliminates visual errors while preserving the artistic style and details of the original work, resulting in clearer and more realistic images. Regarding algorithm optimization, significant improvements in performance and efficiency are achieved through optimizing the data structure, parallelizing algorithm logic, and enhancing the rendering process. These enhancements ensure a smoother and more efficient operation of the art teaching platform, offering students a more convenient and efficient learning experience. Additionally, this study provides valuable insights for future research and development of art teaching platforms. In terms of teaching application and students' satisfaction, the experiment proves that the improved art teaching platform has remarkable effects in improving design quality, improving instructional efficiency and enhancing students' satisfaction. Students generally believe that the platform has provided them with substantial help and support in many aspects, which further proves the effectiveness of the art teaching platform integrating CAD technology in practical teaching.

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