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Landscape Planning and Visualization Instructional Method Based on CAD and GIS Technology

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Abstract. The primary aim of this study is to investigate methods for seamlessly integrating CAD and GIS technologies into landscape planning, design, and visualization pedagogy, thereby elevating teaching quality and efficiency. Initially, this article delves into the practical applications and strengths of CAD and GIS technologies within the realm of landscape planning. The study explored the visualization analysis framework under optimized landscape algorithms. The goal design of intelligent landscape planning has strengthened the functionality of the original plan and verified the model through simulation. Visual strategies were set for landscape planning by evaluating the effectiveness of the original model. The study used the example full optimization algorithm to optimize the layout options of landscape layout, which significantly improved design efficiency. The rationality of student education resources has been laid out through the introduction of new technologies.

Keywords: CAD; GIS Technology; Particle Swarm Optimization Algorithm; Landscape Planning And Design; Visual Teaching
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1 INTRODUCTION

With the increasing development of urban landscape planning and design, urban water landscape construction has gradually shown its complexity and multi-dimensional nature. Urban water landscape, as an important component of the urban ecosystem, has long been a focus of attention for water conservancy workers. This often leads to a point-like and fragmented development trend in the construction of urban landscapes, failing to utilize their ecological and recreational functions fully. In Chen's [1] research process, the first step is to start with the macro-regional landscape space, focusing on optimizing the regional water system structure, solving water system ecological problems, and laying a solid foundation for the basic construction of the landscape. This not only helps to improve the quality of the urban ecological environment but also provides citizens with rich leisure and recreational spaces, promoting sustainable development of the city. Therefore, in response to this situation, we propose the concept of "urban landscape system planning." The core of this concept lies in creating a water landscape system with good ecological effects and urban recreational functions through green network construction.

The traditional education model often overemphasizes theoretical teaching and neglects the importance of practical experience and student participation, which undoubtedly limits students' ability to transform theoretical knowledge into practical design applications. During the experiment, Fei et al. [2] used advanced eye-tracking devices to record real-time eye movement data of participants while watching different landscapes. They use eye-tracking technology to reveal the positive impact of landscape environment on individual mental health recovery through in-depth analysis of individual eye movement behaviour. This technology not only provides us with a new research perspective but also transforms a large amount of eye-tracking data into intuitive and easy-to-understand eye-tracking heatmaps through data visualization technology, making the research results more vivid and easy to understand. These findings not only reveal the intrinsic connection between landscape environment and individual mental health recovery but also provide us with a new perspective to deeply understand the sports behaviour characteristics of individuals when viewing landscapes. Furthermore, as technology progresses, effectively leveraging modern technological advancements to enhance teaching outcomes emerges as a prevalent challenge.

Accurately estimating regional 3DGV based on satellite images has always been a challenge for the industry. Hong et al. [3] studied multi-objective optimization problems through parameterized design in design practice, in order to understand the operational techniques of parameterized planning in panoramic structural layout practice. A detailed discussion was conducted on parameterized landscape architecture design from the design patterns of specific practical stages. The integration of parameter control and optimization behaviour brings new efficiency, new methods, and new thinking patterns to design. In terms of planning exercises, the design practice is taken as the object, and the main objectives are set through a large amount of simulation calculations and data evaluation work. Practice has proven that parameterized design can greatly improve design efficiency, shorten design cycles, and quantify relevant content in rational design. In practical applications, the parameterization design problem of anisotropic curves and surfaces often becomes an important factor that restricts design efficiency and effectiveness. This criterion is not only a natural extension of the PBH criterion but also makes it easier to identify the parameters of pseudo-linear systems in a broad sense, greatly simplifying complex computational processes. Huang et al. [4] conducted in-depth modelling and analysis of design objects using computer parameterization techniques. For complex nonlinear systems, they proposed necessary conditions for determining parameters. On this basis, they deeply analyzed the logical relationship between these parameters and variable factors, and formulated them, providing a solid theoretical basis for subsequent parametric design. They have established complete parameter optimization methods for environmental landscape design in first-order, second-order, high-order, and generalized nonlinear models. This method not only improves the accuracy and efficiency of design but also better simulates the system dynamics process of dynamic changes in the environment. With the rapid development of technology, analysis tools such as spatial databases, physical environment models, visualization techniques, and geographic information systems are becoming increasingly sophisticated, providing more powerful and efficient decision support for landscape planning. In the field of landscape planning, planners need to make wise decisions on the optimal combination of land use and its spatial layout in the landscape based on a series of detailed, accurate, and diverse spatial information. This allows for a more comprehensive understanding of the spatial distribution and changes in these parameters, providing a more scientific basis for planning. This means that these advanced technological means can be utilized to build a multi-dimensional spatial database that includes biologically significant physical environmental parameters such as annual average rainfall, minimum temperature, soil moisture, etc [5].

The application of this technology not only enhances students' design experience but also enables them to have a deeper understanding of the practical operations and impacts of landscape planning. Li's [6] research delves into intelligent landscape design and land planning based on neural networks and wireless sensor networks, demonstrating the enormous potential of digital technology in landscape design. Digital generation and construction are landscape design and construction activities that utilize relevant digital technology groups. Among them, parametric design, as an important part of digital landscape design, has brought significant changes to modern urban landscape planning and design. Reasonable planning and design of urban landscapes are of great significance for the utilization of urban land resources. It can not only alleviate the problem of land resource waste but also optimize resource utilization, and enhance the overall image and quality of the city. Liu et al. [7]'s research is based on the concept of ecological environment restoration, exploring urban development strategies and overall urban planning, and determining the guiding principles and goals of planning.

In particular, the landscape layout optimization algorithm combines the advantages of these two technologies and can realize the optimal layout of landscape planning more efficiently. The primary objective of this study is to investigate more effective ways of integrating CAD and GIS technologies into landscape planning, design, and visualization instruction, aiming to enhance teaching quality and efficiency. Through the adoption of cutting-edge technological solutions, we anticipate enabling students to gain a deeper understanding of landscape planning principles, fostering their hands-on skills, and consequently advancing the field of landscape planning education.

The study's contributions and innovations are primarily manifested in several ways.

Firstly, this article comprehensively examines the precise applications and benefits of CAD and GIS technology within landscape planning, offering a significant reference point for experts in corresponding fields.

Innovatively integrate CAD and GIS technology into teaching practice, and put forward a novel teaching mode, aiming at improving students' practical ability and technical level.

Introducing the PSO algorithm into the teaching of landscape planning not only enhances students' computing ability but also provides them with a brand-new design optimization idea.

By designing and executing a model simulation experiment, this study introduces scientific evaluation techniques and hands-on insights to inform the educational reform of landscape planning, thereby fostering educational model innovation and advancement.

Initially, this article delves into the detailed utilization and benefits of CAD and GIS technology within landscape planning. Subsequently, it deliberates on methods to seamlessly blend these two technologies into landscape planning, design, and visualization education. Lastly, the efficacy and practicality of the proposed teaching approach are validated through meticulously designed model simulation experiments.

As for research methodologies, a multifaceted approach is adopted for comprehensive exploration. By compiling and analyzing pertinent literature, we gain insights into the current research landscape and emerging trends in this domain. Case studies enable us to extract valuable experiences, pitfalls, and exemplary practices from actual projects. Empirical investigations confirm the impact and effectiveness of our proposed teaching methodology in real-world educational settings. Additionally, we have devised a sequence of model simulation experiments to objectively measure the tangible outcomes of incorporating new technologies into the classroom.

2 RELATED WORK

Traditional urban landscape planning and design methods often have limitations, making it difficult to fully integrate design ideas into the planning process, and also unable to efficiently, intuitively, and harmoniously display the planning effects of multiple schemes and large scenes. Virtual reality technology, with its powerful 3D visualization capabilities, enables designers to present planning schemes more intuitively, facilitating in-depth integration and optimization of the schemes. This interactive adjustment method not only improves design efficiency but also enhances the accuracy and reliability of the design [8]. In addition, as an effective means of urban ecological restoration, green infrastructure (GI) plays an increasingly prominent role in urban landscape planning. Minixhofer and Stangl [9] conducted a systematic literature review on this topic, analyzing a large number of peer-reviewed publications and exploring the scope of soil-related ES covered by GI measures in urban areas. This discovery provides direction for our future research and highlights the potential value of virtual reality technology in exploring the relationship between GI measures and soil-related ES in depth. Shan and Sun's research [10] delved into the auxiliary usage patterns and detailed optimization processes of this technology in landscape design and validated them through comparative experiments of indoor and outdoor landscape design. In response to the poor energy-saving effect of traditional methods, they have optimized the energy-saving design of the data acquisition system. Traditional data collectors use visual image comparison to collect data, which leads to high power consumption. Secondly, they analyzed the specific optimization process of combining VR and VR-GIS and improved the accuracy and scientificity of the design by integrating geographic information system data. Based on VR technology, landscape design planning was carried out. By constructing a virtual environment, designers can interact and modify in real-time in the virtual space, thereby presenting the design effect more intuitively. Through this platform, designers can more conveniently perform 3D modelling, material mapping, light and shadow rendering and other operations, thereby improving the precision and visual effects of design. On this basis, Wen et al. [11] further utilized the Lumion virtual reality (VR) platform to provide auxiliary use and detail optimization for landscape design. The experimental results show that this method performs well in visual modelling, with an error stable between 1% and 3%, and good stability. At the same time, the average rendering time of batch-processing objects is also controlled within a relatively short time, demonstrating its efficiency. The results show that current research mainly focuses on pollution control and landscape regeneration design in landfill sites. Further analysis of publications and research discipline trends indicates that future research on landscape regeneration in landfills will place greater emphasis on the ecological restoration of the site.

In the process of building a digital platform for landscape architecture, it is particularly important to deeply analyze the mechanism of digital design for landscape architecture and build an efficient landscape image display system. Based on previous research results and the rapid development of mobile edge computing technology, Wu and Yan [12] proposed an innovative digital landscape design scheme based on edge computing. By combining Roberts edge detection and Laplace operator, this scheme can achieve high-level stable preservation of landscape images, avoiding information loss or distortion problems that may occur during image processing. Through edge computing, real-time analysis and processing can be carried out at the source of data, which greatly improves the speed and efficiency of data processing, and also reduces the delay and cost of data transmission. This scheme cleverly utilizes discrete elevation calculation technology, not only retaining the basic framework of landscape design images but also ensuring the accuracy and completeness of image data. To verify the effectiveness of the scheme, Yu et al. [13] designed a geographic information system specifically designed for garden management systems. Real-time monitoring and protection of environmental factors such as soil and microorganisms have also been achieved through the use of Web Service technology. The experimental results show that the discrete elevation calculation algorithm can effectively avoid the problem of low visual rendering rate in the process of 3D image generation. Urban landscaping, as an important component of modern cities, is closely linked to the prosperity and progress of the city. As a new form of landscaping, urban landscaping aims to mobilize the power of the entire urban area to achieve landscape beautification and environmental improvement.

Zhang and Deng [14] delved into the key role of colour matching in landscape design in their research. They believe that through clever colour application, not only can the artistic appeal of the landscape be enhanced, but also people's aesthetic experience can be enhanced. Through factor analysis of each variable, they revealed the psychological structure of urban residents, as well as the impact of colour psychological effects and colour grouping on the emotional phenomenon of scenic spot colours. In order to gain a deeper understanding of the emotional guiding role of colour in landscape design, Zhang and Deng started with colour extraction in landscape architecture and explored how colour affects the emotional atmosphere of street space design through in-depth research on the "emotional structure of the environment". This provides a clear direction for shaping colour themes in different landscape gardens. They used the SD method to conduct a detailed evaluation of colour space perception and developed a colour-emotional effect scale. Research has found that the emotional phenomenon of colour in street space not only affects the main line of the emotional structure of gardens. By cleverly using colours, designers can create a peaceful, lively, or romantic spatial atmosphere, allowing people to experience different emotions in it. It invisibly guides the design of spatial colour context and the establishment of spatial emotional relationships. On the other hand, with the rapid advancement of urbanization, urban landscape ecological design has become an indispensable part of urban planning [15].

3 APPLICATION OF CAD AND GIS TECHNOLOGY IN LANDSCAPE PLANNING

3.1 Application of CAD in Landscape Planning

Additionally, CAD technology significantly boosts design efficiency and minimizes the time and effort invested in hand-drawn sketches. Furthermore, CAD's ability to export various file formats facilitates seamless communication and collaboration between designers, clients, construction units, and other stakeholders.

Within the realm of landscape planning, CAD technology finds extensive application in terrain analysis, plant arrangement, garden pathway design, water feature design, and more (refer to Table 1).

Application aspect	*The concrete function and description of CAD technology*
Landform analysis	Terrain modelling: Using CAD technology, designers can create a 3D terrain model to show the terrain's ups and downs visually. Terrain data analysis: analyze the elevation, slope and aspect of the terrain through CAD software to provide accurate basic data for subsequent planning and design.
	Terrain visualization: generate contour map, terrain profile map, etc., to help designers better understand terrain characteristics.
Plant configuration	Drawing of plant distribution map: Designers can use CAD to accurately draw the distribution positions of various plants to ensure the accuracy and aesthetics of plant configuration.
	Calculation of plant number and species: Through CAD software, designers can accurately calculate the number and species of plants needed, which is convenient for purchasing and planting.
	Plant configuration optimization: Using CAD technology, designers can easily adjust the plant configuration scheme to achieve the best landscape effect.
Garden road design	Garden road plan drawing: CAD technology can help designers draw the garden road plan accurately, including details such as route, width and turning radius.
	Drawing the profile of the garden road: Through CAD software, the designer can generate the profile of the garden road to ensure the rationality of the garden road design and driving comfort.
	Garden road landscape design: Using CAD technology, designers can combine elements such as topography and plants to design the landscape around the garden road.
Waterbody design	Drawing water plan: CAD technology can help designers draw water plans accurately, including parameters such as shape, size and depth.
	Water profile and hydraulic analysis: Through CAD software, designers can generate water profiles and conduct hydraulic analysis to ensure the rationality and safety of water design. Integration of water body and surrounding landscape: Using CAD technology, designers can organically integrate water body with surrounding topography, plants, buildings and other elements to create a natural and harmonious

	waterscape effect.

Table 1: Application of CAD technology in landscape planning.

Table 1 describes in detail all aspects and specific applications of CAD in landscape planning, including terrain analysis, plant configuration, garden road design and water body design. Through this table, we can better understand the importance and practicability of CAD in landscape planning.

3.2 Application of GIS Technology in Landscape Planning

GIS technology also plays an important role in landscape planning. GIS technology can integrate, store, analyze and visualize various spatial data, and provide scientific decision support for landscape planning. Through GIS, designers can easily obtain and process geospatial data, such as terrain elevation, soil types, climate conditions, etc. These data are very important for making a reasonable landscape planning scheme.

The core advantage of GIS technology lies in its powerful spatial analysis ability and visualization function. Designers can use GIS software to perform operations such as spatial overlay analysis and buffer analysis to assess the environmental impact and implementation feasibility of different planning schemes. Furthermore, GIS also supports the 3D visualization function, and designers can simulate and assess the effect of the planning scheme in 3D space, thus showing the design results more intuitively.

In landscape planning and design, GIS technology is widely used in ecological sensitivity analysis, line of sight analysis, sunshine analysis and so on (see Table 2).

Application function	*Specific description and application effect*
Ecological sensitivity analysis	Identify ecologically sensitive areas, such as wetlands and nature reserves.
	Analyze biodiversity, vegetation coverage, and hydrological conditions in sensitive areas.
	Formulate targeted ecological protection and restoration measures to ensure the coordination between planning and design and environmental protection.
Line of sight analysis	Using the visibility analysis tool of GIS, the visibility and viewing effect of landscape nodes are assessed.
	Determine key viewpoints, such as viewing platforms and important scenic spots, and optimize landscape design.
	Analyze the visual connection between landscape elements to improve the overall landscape effect.
Sunshine analysis	Simulate and assess the light and shadow effects of buildings and vegetation in different time periods.
	Analyze sunshine hours, sunshine direction, and sunshine intensity, and optimize building layout and vegetation allocation.
	Make full use of natural light in landscape design to create a comfortable, light environment.

Table 2: Detailed application of GI in landscape planning.

Table 2 describes in detail the application of GIS in landscape planning, including ecological sensitivity analysis, line-of-sight analysis and sunshine analysis. Through these functions, GIS technology provides strong technical support and decision-making basis for landscape planning and helps designers formulate more scientific and reasonable landscape planning schemes.

4 LANDSCAPE PLANNING AND DESIGN AND VISUALIZATION INSTRUCTIONAL METHOD

4.1 Overview of Traditional Instructional Methods of Landscape Planning

Traditional instructional methods of landscape planning mainly focus on imparting theoretical knowledge and training hand-drawing skills. Teachers usually teach students the principles, methods, and skills of landscape planning through classroom explanation and case analysis. Students need a lot of hand-drawing exercises to improve their design expression ability. However, this traditional instructional method has some obvious characteristics and shortcomings.

In regard to characteristics, traditional teaching methods emphasize the importance of building fundamental theories and developing hand-drawing abilities, which are vital for establishing a strong foundation for learners and refining their design expertise. Nevertheless, its flaws are becoming more evident (refer to Table 3).

Shortcomings	*Specific description*
Rely too much on paper drawings	The process of design modification and optimization is complicated and needs to be redrawn manually, which leads to inefficiency and error-prone.
Lack of modern teaching tools and means	Students' perception and presentation of design effects are limited, and it is difficult to show and understand complex design concepts fully.
It is difficult to integrate and utilize a large amount of spatial data and information	It limits the scientific and forward-looking design and cannot make full use of modern data analysis and information technology.
Single instructional method	Traditional instructional methods often adopt a single "teaching-listening" mode, which lacks diversity and interactivity and easily makes students lose interest.
Lack of practical opportunities	Traditional instructional methods pay too much attention to theoretical teaching and lack practical operation and experience, which makes it difficult for students to apply theoretical knowledge to practical situations.
Ignore students' individual differences	Traditional instructional methods often adopt a one-size-fits-all approach, ignoring students' individual differences and learning needs and failing to meet different students' learning styles and abilities.
Lack of timely feedback mechanism	In traditional instructional methods, it is often difficult for students to get feedback on their learning achievements in time, which makes it difficult to adjust learning strategies and improve learning effects.
It is difficult to cultivate students' innovative thinking.	Traditional instructional methods pay too much attention to instilling knowledge but ignore the cultivation of students' innovative thinking and problem-solving abilities.

Table 3: Deficiencies of traditional instructional method.

From Table 3, we can see that the traditional instructional methods have many limitations and need to be improved by introducing new teaching concepts and technical means.

4.2 Instructional Method of Integration of CAD and GIS Technology

The integration of CAD and GIS technology into landscape planning education can notably enhance the effectiveness of teaching and enrich students' learning journey. By incorporating CAD technology, students are able to draft and model with precision and efficiency, elevating design productivity and seamlessly translating design visions into visual representations. The introduction of GIS technology enables effortless acquisition, integration, and analysis of diverse spatial data, bolstering design decisions with a stronger scientific foundation.

In practical teaching sessions, educators can blend CAD and GIS software, serving as illustrative tools to lead students through the fundamentals and advanced usages of these technologies via hands-on exercises. Furthermore, educators can motivate students to undertake comprehensive design projects using CAD and GIS, thereby fostering practical skills and fostering innovative thinking among students.

4.3 Optimization Algorithm of Landscape Layout Based on PSO Algorithm

In landscape planning and design, the PSO algorithm can be applied to the optimization of landscape layout. By defining the appropriate fitness function and particle updating strategy, the algorithm can search for the optimal landscape layout scheme in the design space.

In the initialization stage of the algorithm, this article randomly generates a group of "particles"; each particle represents a possible landscape layout scheme and gives them random initial positions and speeds. The advantages and disadvantages of these particles are assessed by the fitness function, which comprehensively considers the aesthetics, functionality, ecology and other aspects of the landscape. Let the dimension of the initial search space be D, the total number of population particles be N, the number of iterations is K, and the particle velocity n:

$$\mathrm{V_n} \in \left[\mathrm{V_{min}}, \mathrm{V_{max}}\right] \tag{1}$$

Position of particle n:

$$\mathrm{S_n} \in \left[\mathrm{S_{mim}}, \mathrm{S_{max}}\right] \tag{2}$$

Let the fitness function be $\mathrm{Fitness}\ \mathrm{X}$, then there are:

$$\mathrm{Fitness}\ \mathrm{X}\ = f_1\ \mathrm{X}\ * f_2\ \mathrm{X}\ * \ldots * f_m\ \mathrm{X} \tag{3}$$

Among them, $f_i\ \mathrm{X}$ stands for the i assessment standard, including aesthetics, ecological connectivity, the rationality of functional regional distribution, etc.

As the algorithm iterates, every particle continuously modifies its velocity and location based on both its past best position and the overall best position of the entire population, striving to discover a superior layout plan. During the iterative stages of the algorithm, close observation must be made of the variations in the fitness value of each particle, as this serves as a crucial indicator for assessing layout optimization. The formula employed in this paper to update particle velocity and position is as follows:

$$\mathrm{v_{nd}^{k+1}} = wv_{\mathrm{nd}}^{\mathrm{k}} + \mathrm{r_1}\xi\ \mathrm{P_{nd}^{k}\text{-}S_{nd}^{k}}\ + r_2\eta \tag{4}$$

$$S_{\mathrm{nd}}^{\mathrm{k+1}} = S_{\mathrm{nd}}^{\mathrm{k}} + v_{\mathrm{nd}}^{\mathrm{k+1}} \tag{5}$$

Where k is the current iteration number? w is the inertia weight. $\mathrm{r_1}$ and $\mathrm{r_2}$ are learning factors. ξ and η are pseudo-random numbers. By constantly updating the individual and global optimal positions, the particle swarm gradually converges to a better layout scheme, and the algorithm optimization process is shown in Figure 1.

To avoid the algorithm getting stuck in a local optimum, this article employs various strategies to preserve the diversity of the particle swarm. These strategies include randomly reinitializing certain particles or introducing mutation operations. These actions assist the algorithm in escaping local optimal solutions and exploring a wider range of potential answers.

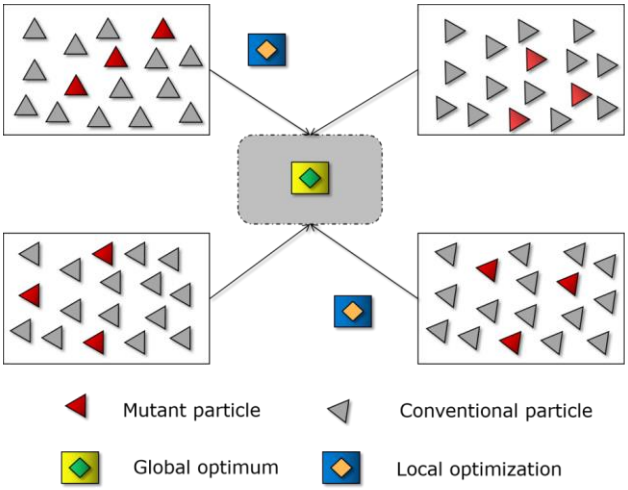

Figure 1: Algorithm optimization process diagram.

Let the historical optimal position of the particle n be $\mathrm{p}_{\mathrm{n,best}}$ and the global optimal position be $\mathrm{g}_{\mathrm{best}}$, then the updated formula is:

$$\mathrm{p}_{\mathrm{n,best}} = \begin{cases} x_n, if\ \mathrm{Fitness}\ x_n < \mathrm{Fitness}\ \mathrm{p}_{\mathrm{n,best}} \\ \mathrm{p}_{\mathrm{n,best}}\ otherwise \end{cases} \tag{6}$$

$$\mathrm{g}_{\mathrm{best}} = \begin{cases} x_n, if\ \mathrm{Fitness}\ x_n < \mathrm{Fitness}\ \mathrm{g}_{\mathrm{best}} \\ \mathrm{g}_{\mathrm{best}}\ otherwise \end{cases} \tag{7}$$

Let the maximum number of iterations be $\mathrm{MaxIter}$, the fitness threshold be $\mathrm{Threshold}$, and the fitness improvement threshold be ΔF, then the judgment formula of the termination condition is:

$$\begin{cases} Iter >= \mathrm{MaxIter} \\ \mathrm{Fitness} < \mathrm{Threshold} \\ \mathrm{Fitness}_{\mathrm{new}} - \mathrm{Fitness}_{\mathrm{old}} < \Delta \mathrm{F} \end{cases} \tag{8}$$

Where $Iter$ represents the current iteration times, $\mathrm{Fitness}$ represents the current fitness value and $\mathrm{Fitness}_{\mathrm{new}}$ and $\mathrm{Fitness}_{\mathrm{old}}$ represents the fitness values of the new generation and the previous generation respectively. When the algorithm meets the termination condition, the global optimal position is output as the final landscape layout scheme. This scheme is obtained after many iterations and optimization, and several assessment criteria are comprehensively considered, aiming at achieving the overall optimization of landscape layout.

In conclusion, the ideal layout scheme undergoes visualization and post-processing, enabling a more intuitive presentation for designers and decision-makers and ultimately offering robust decision support. The entire undertaking highlights the distinctive strengths and practicality of the PSO algorithm in optimizing landscape layouts, effectively tackling intricate layout challenges, and injecting fresh perspectives and techniques into the realm of landscape planning.

In today's accelerating urbanization process, the evaluation and simulation of urban green space landscape planning schemes are particularly important. This article is based on the PSO-BP neural network model to conduct an in-depth and detailed evaluation and simulation of urban green space landscape planning schemes, aiming to explore a more scientific, comprehensive, and reasonable evaluation method. By incorporating the principles of landscape ecology into the model, we can incorporate more ecological and urban development evaluation indicators into the evaluation system, making the evaluation results more realistic and instructive. In the evaluation process, the PSO-BP neural network model can easily and effectively understand and predict human behaviour, thereby more comprehensively evaluating and predicting urban green space landscape design schemes. The impact of human activities on green landscapes and the comprehensive benefits of green ecological functions make the evaluation more comprehensive, scientific, and reasonable. This means that the model can more accurately reflect the actual situation and better adapt to different types of green landscape planning schemes.

5 MODEL SIMULATION EXPERIMENT DESIGN AND RESULT ANALYSIS

This study aims to develop a landscape spatial optimization model based on particle swarm optimization, aiming to provide scientific spatial decision support for land use management. The optimization of spatial structure is an indispensable part of land resource management, which is related to the rational allocation and efficient utilization of land resources. This model can more accurately reflect the actual situation of land resources, which helps to achieve effective coupling between quantity structure and spatial structure. In the process of model construction, we used real datasets for simulation to ensure the practicality and reliability of the model. It can not only fully utilize the quantity structure of landscape resources, but also accurately control their spatial structure, ensuring the rational allocation and efficient utilization of landscape resources. This model can find the optimal landscape pattern in complex decision-making environments by introducing a particle swarm optimization algorithm, thereby achieving optimal allocation of land resources. In addition, the study also found that under suitable optimized environments, the model can effectively stimulate the formation of landscape patterns, accurately align land quantity targets with basic spatial units, and provide strong support for regional land use spatial layout decisions. Detailed parameters for the PSO algorithm are outlined in Table 4.

Parameter name	*Common range of values*	*Value*
Population size	20-40	30
Top speed	Each dimension can take 10%-20% of the search space	10%
Inertia weight	Random values between [0.5, 1.0]	0.75
Compressibility factor	Usually, the value is 0.729	0.729
Acceleration factor 1	Usually set to 2.0.	2.0
Acceleration factor 2	Usually set to 2.0.	1.9

Table 4: Parameter settings of the PSO algorithm.

When it comes to technical specifications, we prioritize the precision and scalability of our model. By leveraging highly accurate data modelling techniques and optimizing algorithms, we ensure the authenticity and reliability of our simulation outcomes. Furthermore, our model boasts excellent expandability, allowing for flexible adjustments and optimizations based on actual teaching requirements.

During the experimentation phase, we adhered strictly to the predefined experimental design, carefully documenting every detail of the process. Here's a breakdown of our experimental steps:

Teacher's teaching stage: simulated instructors elaborate on the utilization of CAD and GIS technologies in landscape design, alongside an introduction to the fundamentals and implementation of the PSO algorithm.

Students' practical operation stage: students use CAD and GIS software to carry out actual design operations, and use the PSO algorithm to optimize the design scheme.

Design works exhibition and assessment stage: students show their own design works, and teachers and other students assess and score. Furthermore, students' design works and optimization results are displayed by visual tools, as shown in Figure 2, which shows some visual examples of students' design works.

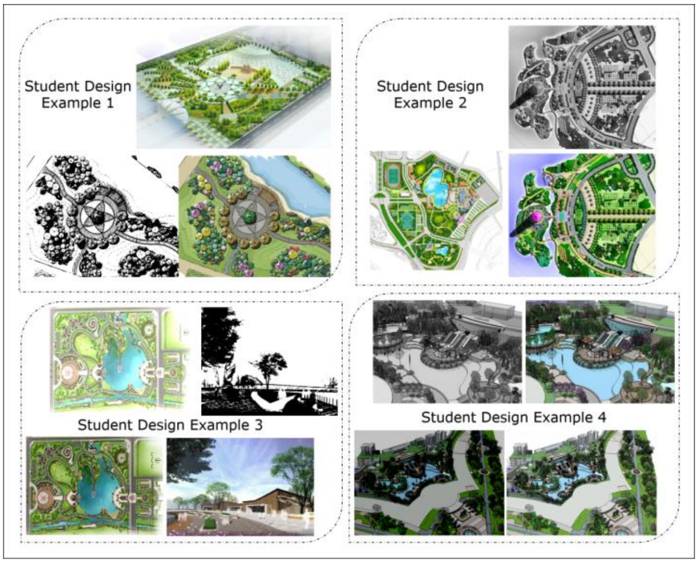

Figure 2: Visualization examples of some students' design works.

Data collection mainly collects data such as students' academic performance, grading of design works, and students' acceptance and satisfaction with new technologies. These data will provide an important basis for the subsequent analysis of experimental results.
Through the model simulation experiment, this section has obtained rich quantitative data and visualization results. The time taken for the PSO algorithm to generate a layout scheme is shown in Figure 3. The accuracy comparison of the algorithm is shown in Figure 4.

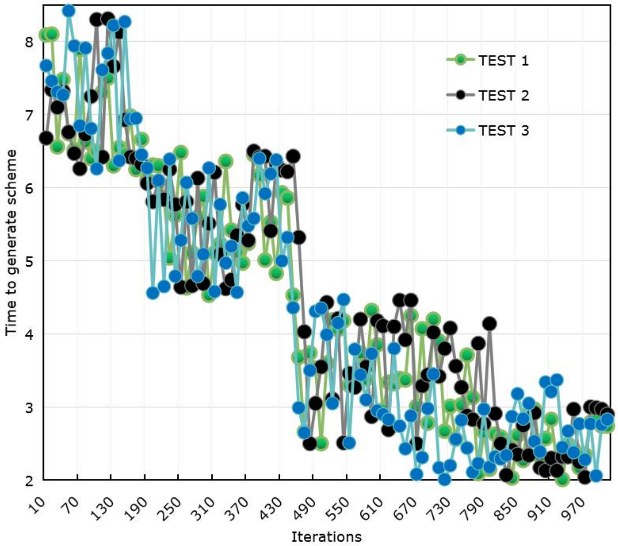

Figure 3: Time-consuming situation of generating layout scheme by PSO algorithm.

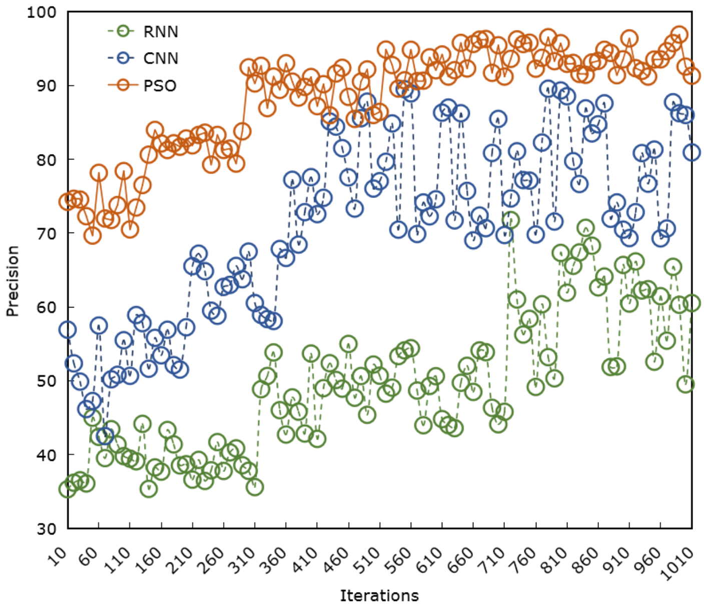

Figure 4: Accuracy comparison of the algorithm.

The score results of optimization results based on PSO in aesthetics, functionality and ecology are shown in Figure 5.

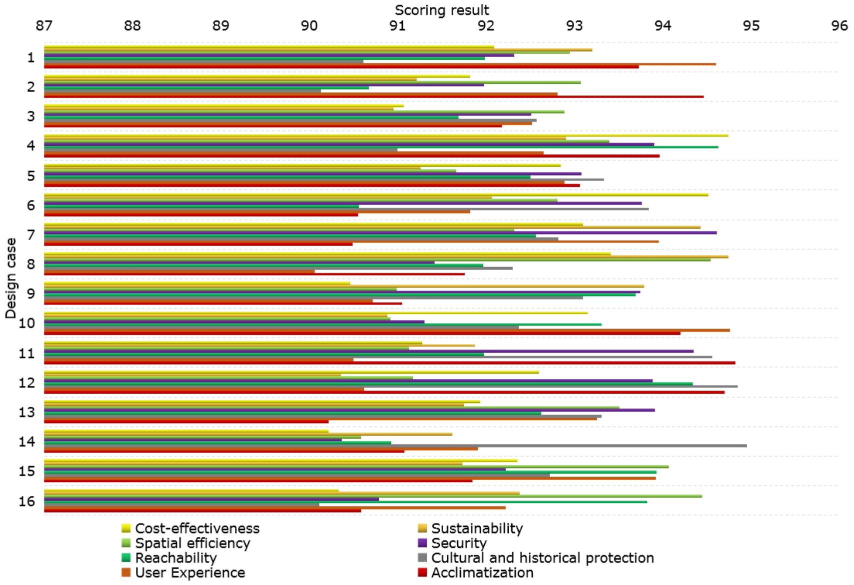

Figure 5: Scoring results of optimization results.

Furthermore, this article counts the changes in students' academic performance and compares design works before and after using the new technology, as shown in Figure 6 and Figure 7.

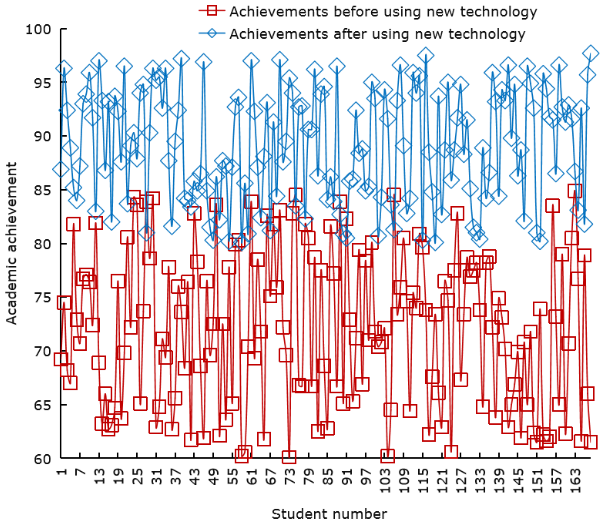

Figure 6: Comparison of students' academic performance before and after using new technology.

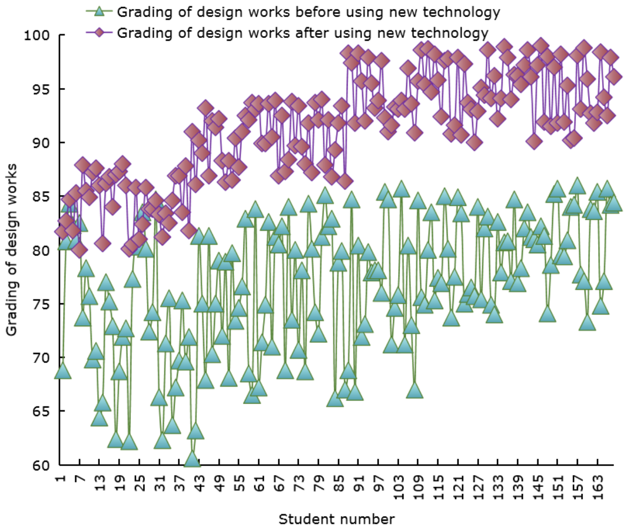

Figure 7: Comparison of the scores of students' design works before and after using new technology.

After adopting the new technology, students' academic performance has notably enhanced, with design scores generally surpassing pre-implementation levels. These data unequivocally demonstrate the teaching efficacy and excellence of the new technology.

The findings indicate that this technology has favourably impacted students' academic outcomes and design skills. By integrating CAD and GIS, students can perform precise designs and data analyses more efficiently, whereas the PSO algorithm equips them with a scientific approach to design optimization. Undoubtedly, these technological advancements have elevated students' professionalism and practical capabilities. Additionally, the introduction of this technology in education has spurred innovation in teaching models. The traditional instructional method based on theory has gradually changed into a teaching mode combining theory with practice. Students master knowledge and improve skills in practical operation, which is more in line with modern educational concepts and students' development needs.

6 CONCLUSIONS

This study delves into the utilization of CAD and GIS technologies in landscape planning, exploring how they align with contemporary teaching practices. Key findings are summarized below:

Initially, CAD technology demonstrates precision, efficiency, and versatility in landscape design. Design professionals leverage CAD software for precise terrain modelling, plant layout, garden pathways, and water feature designs, significantly enhancing design productivity and ensuring accurate drawings for future construction.

Moreover, GIS technology offers a scientific foundation for landscape planning decisions. Its robust spatial analysis capabilities and data consolidation features empower designers to conduct rigorous evaluations and plans within intricate spatial settings, particularly in ecological sensitivity, line-of-sight, and sunshine analyses.

Additionally, this study illustrates that integrating CAD and GIS technologies into landscape planning education enhances students' design proficiency and technical mastery. The incorporation of a landscape layout optimization algorithm, rooted in the PSO method, not only broadens educational content but also elevates students' hands-on skills and innovative thinking.

Lastly, through the creation and execution of model simulation experiments, this study confirms the practical effectiveness of these new technologies and teaching strategies, bolstering educational reforms in landscape planning with substantial data insights and real-world experiences.

Prospective investigations can branch out in the following directions:

(1) Broaden the scope of experimental subjects: By expanding the participant pool to encompass a wider array of student types, a more comprehensive assessment of the efficacy of these novel technologies and teaching methods can be attained.

(2) Extend technology applications: Delve deeper into the advanced uses of CAD and GIS in landscape design, and investigate ways to introduce more sophisticated optimization algorithms into the classroom to elevate teaching standards.

(3) Undertake interdisciplinary research: Amalgamate knowledge and techniques from other fields, such as computer science and data science, to foster innovation and progress in landscape planning education.

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