

# Research on the Application of ChatGPT Technology in Landscape Ecology Teaching

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## Abstract

As an emerging branch of ecology, landscape ecology is distinguished by its focus on addressing ecological issues at large spatial and temporal scales. It has not only made continuous progress in conceptual frameworks, theoretical systems, and quantitative methods, but has also demonstrated extensive application value in extensive fields such as urban and rural planning, forest and pasture management, environmental protection, and tourism design. This discipline has introduced novel modes of thinking and research methodologies into the field of ecology, driving its ongoing advancement. Generative artificial intelligence, represented by ChatGPT, can accomplish complex tasks such as information retrieval, problem-solving, content creation, and code generation through an open-ended dialogue with its robust natural language processing capabilities. Its capabilities increasingly approximate human intelligence and even extend or partially substitute it, exhibiting broad and flexible applicability. Integrating ChatGPT technology into the teaching practice of “Landscape Ecology” represents an interdisciplinary pedagogical innovation, introducing fresh perspectives, methods, and challenges to the curriculum. This study takes the specific application of ChatGPT technology in “Landscape Ecology” classrooms as an example to deeply explore and understand the promotion and application of new AI intelligent technologies in professional university courses.

## Keywords

Landscape Ecology, ChatGPT Technology, Teaching Practice, AI Intelligence

## 1. Introduction

As a flagship representative of generative artificial intelligence technology, ChatGPT has garnered widespread attention and high-level recognition from po-

litical, academic, and industrial circles since its inception (Ding & Zhong, 2024). The functional characteristics of ChatGPT-like products, such as emergent intelligence, strong cognitive capabilities, and high versatility, have transformed the traditional monolithic teaching structure in education (Dai et al., 2023; Li et al., 2024). If embedded into the entire process of “learning-teaching-management-evaluation,” it will profoundly reshape the concepts, methods, content, structures, and forms of education, bringing unprecedented opportunities and challenges to contemporary education. This will further propel the digital transformation of education into new domains, emerging tracks, uncharted territories, and unexplored frontiers.

Currently, numerous scholars have explored the impact of ChatGPT on the teaching of foundational university courses, with some even suggesting that ChatGPT will accelerate educational transformation (Dai & Qin, 2024). Landscape ecology, a branch of macroecology that matured in the late 1970s, focuses on studying the structure, function, and dynamic characteristics of landscapes. It emphasizes the analysis of spatial structure, functional coordination, and dynamic changes in heterogeneous surface spatial units composed of different ecosystems, with particular attention to the interaction between spatial patterns and ecological processes. How to further introduce ChatGPT technology into university specialized courses is currently a crucial aspect of higher education reform and practice, representing a significant breakthrough from traditional teaching methods. Therefore, this paper thoroughly explores the specific application and practice of ChatGPT technology in the teaching of university specialized courses by conducting a detailed analysis of its positive effects, potential, and feasibility, as well as the possible challenges and risks in the teaching application of the “Landscape Ecology” course.

## **2. Current Status of Teaching Practices for the “Landscape Ecology” Course in Higher Education Institutions**

In recent years, with the continuous development of spatial information technologies such as remote sensing and geographic information systems, the application fields of landscape ecology have continued to expand, posing significant challenges to the teaching model of the “Landscape Ecology” course (Zhang et al., 2023). Traditional landscape ecology courses still exhibit many non-negligible shortcomings in classroom organization and teaching methods. Furthermore, the teaching content often fails to align with practical demands, unable to meet the needs of students and society for landscape ecology knowledge and skills, thus urgently requiring reform and innovation.

### **2.1. The Teaching Content Is Overly Complex, and the Teaching Materials Lack Timeliness**

Currently, the teaching of most “Landscape Ecology” courses still follows the general pedagogical approach of ecology-related specialized courses, primarily rely-

ing on selected textbooks for theoretical instruction in Chinese. This approach severely overlooks the advantages and characteristics of landscape ecology, such as its cutting-edge nature, interdisciplinary integration, and practical applicability (Peng, 2011). In recent years, with the continuous expansion and deepening of research in the field of landscape ecology, the course content has also been progressively enriched and extended. The existing textbooks have gradually revealed their limitations in addressing the new developments within the discipline. To better align with teaching demands and disciplinary trends, there is an urgent need to supplement the textbooks with extensive coverage of the latest research findings, theoretical advancements, and practical application cases in landscape ecology, thereby incorporating cutting-edge knowledge. Additionally, it is essential to enhance the integration of landscape ecology with other fields, such as geographic information systems, environmental science, urban planning, and other related disciplines. This will enable students to acquire a more comprehensive and systematic understanding of landscape ecology's knowledge and skills, fostering interdisciplinary competencies to better address the complex and dynamic ecological and environmental challenges as well as societal needs in the future.

### **2.2. The Teaching Method Is Monotonous, and Classroom Engagement Is Low**

In China's current domestic education system, there exist rather evident issues in the teaching methodology of the "Landscape Ecology" course. Specifically, the instruction predominantly follows traditional lecture-based approaches, where teachers unilaterally impart theoretical knowledge to students in the classroom—ranging from concepts to principles, and from theories to case studies—leaving students largely in a passive reception mode. This teaching model lacks necessary interactivity, with relatively limited exchanges and discussions between teachers and students or among students themselves. Consequently, students struggle to genuinely engage in the knowledge construction process, unable to fully express their insights or raise questions, which hinders the cultivation of innovative thinking and practical skills. This also significantly diminishes the effectiveness of teaching. Additionally, the instructional methods remain overly conventional, failing to adequately leverage internet technologies and multimedia tools. Teachers often lack enthusiasm in their delivery, and the teaching process becomes excessively theoretical and abstract, failing to spark students' interest in learning (Chen et al., 2021).

### **2.3. Theoretical Teaching Predominates, with Weak Integration of Practical Application**

For a long time, China's higher education in landscape ecology has exhibited a phenomenon of "emphasizing theory while neglecting practice." Academic performance assessment is typically dominated by closed-book final exams, with no practical teaching components incorporated (Cai, 2017). In current teaching prac-

tices, this adopted instructional model has failed to achieve the expected learning outcomes, resulting in students' evident deficiencies in mastering and comprehending knowledge. To enhance teaching quality and promote students' academic progress, it is imperative to conduct an in-depth analysis and timely adjustment of this teaching model to better meet students' learning needs.

### **3. Research on the Application of ChatGPT in Landscape Ecology Education**

#### **3.1. Optimize Teaching Content and Enhance the Timeliness of Knowledge**

##### 1) Customized Instructional Design

Depending on different teaching objectives, ChatGPT can assist teachers in customizing instructional designs and content (Jia et al., 2024). For example: creating teaching designs that include lecture notes on the "patch-corridor-matrix theory" and analyses of key and difficult points (Table 1). ChatGPT possesses robust content analysis capabilities (Yang, 2024), enabling it to deeply explore the internal logic of complex teaching materials. By precisely dissecting the connections and context between knowledge points, it can ingeniously design distinctive teaching plans, providing novel and efficient planning for teaching activities to enhance instructional quality. This effectively improves lesson preparation efficiency and the level of teaching plan design.

##### 2) Expanding teaching resources and introducing cutting-edge knowledge

ChatGPT can analyze and process a large number of teaching materials and video resources, automatically generating various course-related educational resources (Qiu, 2024). At the same time, it integrates knowledge from multiple fields such as landscape ecology, geography, and urban-rural planning to promote interdisciplinary learning (He et al., 2024), including timely updates to teaching content by incorporating cutting-edge materials and hot topics, ensuring the classroom remains dynamic and up-to-date.

#### **3.2. Enrich Teaching Methods to Enhance Learning Motivation**

##### 1) Assisting teachers in instruction

ChatGPT is capable of engaging in continuous multi-turn dialogues, a feature that may provide teachers with teaching inspiration and insights (Qiao, 2024). This characteristic can assist teachers in generating new ideas during lesson preparation and stimulate them to explore and experiment with innovative teaching methods (Liu & Song, 2024). Through multiple iterations of command modifications, the responses can be refined to achieve precise final answers. For example, when inputting the instruction "How to introduce the corridor section in a landscape ecology course?", ChatGPT is provided with clear content scope and objectives, enabling it to generate unique classroom introductions for teachers (Table 2). This approach can help teachers quickly develop new teaching ideas.

**Table 1.** Example of instructional design.

User input	System-generated content
Develop a teaching design on the metapopulation theory, including teaching objectives, analysis of key and difficult points, teaching procedures, and other relevant content.	<p>I. Teaching Objectives</p> <p>1) Knowledge and Comprehension Objectives: Understand the fundamental concepts and significance of patches, corridors, and matrix. Master the characteristics and functions of patches, corridors, and matrix in landscapes.</p> <p>2) Skill Objectives: Be able to apply the patch-corridor-matrix theory to analyze landscape structure, learn to identify different landscape elements, and evaluate their ecological significance.</p> <p>3) Affective Objectives: Cultivate students' awareness and sense of responsibility toward landscape ecological conservation, and enhance their understanding of the importance of landscape diversity and ecological balance.</p>
	<p>II. Teaching Process</p> <p>1) Introduction to New Content (5 minutes): Display images of different landscapes, such as urban scenes and forested areas. Ask students to identify the distinct landscape components visible in the images and speculate on their potential functions, stimulating their curiosity and engagement.</p> <p>2) Knowledge Explanation (20 minutes):</p> <p>a) Patch Define patches as relatively homogeneous areas that differ from their surroundings, such as forest patches or farmland patches. Analyze how their shape, size, and quantity influence ecosystems.</p> <p>b) Corridor Explain the concept of corridors, such as river corridors and road corridors. Discuss their connectivity functions, roles as migration pathways for species, and compare the ecological value differences among various corridor types.</p> <p>c) Matrix Introduce the matrix as the most extensive and interconnected component of a landscape, emphasizing its foundational role in supporting overall landscape functions, such as providing habitats and maintaining ecological process stability.</p> <p>3) Case Analysis (15 minutes): Select a representative landscape case, such as an urban park. Analyze the interrelationships and ecological roles of green patches, pathway corridors, and the surrounding built matrix within the park. Explore how factors like patch size and corridor connectivity affect biodiversity and ecological functions within the park.</p> <p>4) Group Discussion (10 minutes): Present different landscape modification scenarios. Have students discuss in groups how changes in the patch-corridor-matrix structure might impact ecosystems. Each group selects a representative to share their findings, followed by teacher feedback and guidance to deepen understanding.</p> <p>5) Summary and Reflection (5 minutes): Recap the key points of the patch-corridor-matrix theory, highlighting its significance in landscape planning and ecological conservation. Prompt students to consider how they might apply this theory in daily life to improve local landscape environments.</p>
	<p>III. Assignment</p> <p>Students are required to select a landscape around their school or residential community, draw a schematic diagram of its patch-corridor-matrix structure, analyze the current status and existing issues of each element, and propose at least two recommendations for optimizing the landscape's ecological functions. The findings should be compiled into a report.</p> <p>Through this instructional design, students will gain an in-depth understanding of the patch-corridor-matrix theory, enhance their landscape ecological analysis skills, and strengthen their awareness of ecological conservation.</p>

**Table 2.** Example of instructional design.

User input	System-generated content
When teaching the corridor section in the landscape ecology course, how should it be introduced?	<p>When teaching the corridor section in the landscape ecology course, the following approaches can be used to introduce the topic, aiming to stimulate students' interest and curiosity while helping them better understand the concept and significance of corridors:</p> <p>1) Utilizing Real-Life Scenarios for Introduction</p> <p>Example: At the beginning of the class, describe some common daily scenarios to students, such as: "Have you noticed the green belts along the roads on your way to school or work? Or the park green spaces distributed along rivers in urban areas? Or the field paths connecting different farmlands in rural areas?" Guide students to reflect on the linear elements present in these scenarios.</p> <p>Question: "What roles do these linear areas play in our living environment? How do they impact the surrounding ecological environment?" Through these questions, prompt students to think critically, thereby naturally introducing the concept of corridors.</p>
	<p>II. Introduction Through Case Analysis</p> <p>Presentation of Case: Begin by presenting a specific ecological conservation case. For example, a city planned a green corridor to connect several large parks and green spaces within the urban area in order to protect wildlife habitats.</p> <p>Analysis and Discussion: Guide students to analyze the potential benefits of this green corridor, such as providing migration pathways for animals and improving the urban ecological environment. Based on student discussions, further introduce the definition, types, and functions of corridors in landscape ecology, enabling students to develop a preliminary understanding and comprehension of corridors.</p>
	<p>III. Utilizing Multimedia Resources for Introduction</p> <p>Play a video: Show a video about corridors in natural landscapes, such as rivers in forests, canyons between mountains, or animal migration routes across grasslands, allowing students to visually perceive the forms and functions of corridors in nature.</p> <p>Display images: Present pictures of different types of corridors, such as transportation corridors in cities or windbreak forest belts in coastal areas. Guide students to observe the characteristics and distribution patterns of these corridors in the images, then ask them, "By looking at these pictures, can you identify any common features among these corridors? What significant roles do they play in their respective landscapes?" This will lead students into the study of corridor-related knowledge.</p>
	<p>IV. Incorporating Historical Stories for Introduction</p> <p>Narrative Approach: Share historical stories or cultural legends related to corridors, such as the ancient Silk Road, which served not only as a trade route but also as a corridor for cultural and biological exchanges between regions. Another example is the Great Wall, which functioned as a military defense corridor in ancient times while also exerting profound impacts on the ecological environment and human activities along its path.</p> <p>Curriculum Connection: Through these narratives, guide students to reflect on the critical role corridors played in historical development. Additionally, explore how the concept and functions of corridors have evolved in modern landscape ecology, thereby smoothly transitioning into the lesson's focus on corridors.</p>

## 2) Interactive course Q&A sessions

ChatGPT can engage in real-time conversations with users, leveraging its extensive knowledge base to provide classroom Q&A support (Table 3). Students can pose questions to ChatGPT at any time, obtaining prompt answers and explanations that reduce the difficulty of asking questions in class (Chen et al., 2024). This significantly enhances learners' academic performance and higher-order thinking skills while stimulating their learning interest and motivation (Li & Wang, 2023). The interactive Q&A model, through immediate feedback and communication, effectively fosters students' learning engagement and enthusiasm. By actively participating in the problem-solving process, students not only deepen their mastery of key concepts but also promote cognitive agility, thereby achieving better comprehension and absorption of the learning content.

**Table 3.** Examples of Q&A clarification.

User input	System-generated content
In landscape ecology courses, what impacts do patches have on the ecological environment?	<p>In landscape ecology, a patch refers to an independent habitat unit within the landscape, whose characteristics and configuration profoundly influence the ecological environment.</p> <p>First, the diversity and size of patches directly affect biodiversity. Different types of patches provide habitats for various species, with larger patches typically supporting more species and reducing the risk of species extinction. Second, the connectivity between patches is crucial for species migration and gene flow. Strong connectivity helps enhance genetic diversity and maintain the stability of ecological networks.</p> <p>The edge effect of patches also impacts ecological processes. Edge areas often exhibit distinct microclimates and soil conditions, which may promote the growth of certain species but could also increase the risk of invasive species colonization. Additionally, patch characteristics influence energy flow and material cycling within ecosystems, such as the distribution of water and nutrients.</p> <p>Landscape fragmentation caused by human activities is a significant issue, as it reduces connectivity between patches and elevates the risk of species extinction. Therefore, in ecological restoration and management, the rational design of patch distribution and characteristics is essential to optimize ecosystem functions and protect biodiversity.</p> <p>In summary, patches play a vital role in the ecological environment, influencing biodiversity, ecological processes, and the overall health of the landscape. Understanding these impacts is of great importance for ecological conservation and sustainable management.</p>

### 3.3. Enhancing Teaching Components to Achieve Educational Integrity

#### 1) Providing personalized teaching for students

Traditional landscape ecology education predominantly adopts a large-class format, which fails to accommodate each student's individual learning needs and habits. ChatGPT can analyze student inputs in real time to gain deep insights into each learner's inclinations, knowledge level, and interests, thereby enabling personalized education (Tao & Shen, 2024). Through meticulous analysis of various data generated during the learning process, ChatGPT can accurately assess each student's learning status, knowledge mastery, and learning habits. This makes it possible to develop customized teaching plans tailored to individual students.

Such personalized plans fully account for individual differences, guiding students to engage in self-directed learning based on their actual circumstances. Consequently, students' learning efficiency improves significantly, allowing them to absorb knowledge more effectively and achieve steady progress in learning capabilities, laying a solid foundation for future development.

#### 2) Teaching Effectiveness Evaluation and Feedback

In traditional landscape ecology instruction, teaching effectiveness is typically validated solely through students' examination scores, rendering this assessment approach overly one-dimensional. While grades can reflect students' mastery of knowledge, they fail to comprehensively evaluate students' abilities in understanding, applying, and analyzing landscape ecology concepts. By collecting and analyzing data such as students' grades and engagement levels, ChatGPT can assist instructors in monitoring classroom performance (Feng & Qu, 2023) and tracking student progress, thereby enabling targeted adjustments to teaching pace (Li et al., 2024). Furthermore, through student feedback and evaluations, instructors can leverage ChatGPT to obtain course improvement suggestions encompassing innovations in teaching methodologies, refinements in experimental content, and optimizations of instructional resources.

## 4. Risks and Challenges of ChatGPT Applications in Landscape Ecology Teaching

### 4.1. Avoid Excessive Dependence

When utilizing ChatGPT technology tools, it is necessary to avoid excessive student reliance on the technology that may impair their autonomous learning motivation (Luo, 2024). As an advanced artificial intelligence language model, ChatGPT can rapidly answer various questions and provide abundant information and solutions. However, over-reliance on ChatGPT may weaken our own thinking capacity and creativity, leading us to instinctively seek answers from it when encountering problems while lacking the process of active exploration and in-depth thinking. This not only hinders knowledge accumulation and skill enhancement but may also gradually erode our ability to solve problems independently. Furthermore, the information provided by ChatGPT is not entirely accurate. Its database originates from diverse online sources of varying quality, with authenticity that cannot be fully verified (Zhou & Yao, 2024), potentially containing biases or errors. If we rely on it indiscriminately, we may receive misleading guidance. Therefore, the accuracy of the knowledge and information it provides still requires manual verification (Li & Wang, 2024).

### 4.2. Ethical Issues

ChatGPT, based on its advanced deep learning algorithms and massive data training, possesses highly realistic language generation capabilities and robust semantic comprehension, enabling it to provide efficient and convenient services across numerous scenarios. Although ChatGPT has achieved data intelligence, it cannot

yet discern emotional patterns from data, nor does it possess empathetic awareness or subjective initiative (Wang et al., 2024). From a philosophical perspective, ChatGPT's decision-making process lacks intrinsic value judgments and moral considerations, which may lead to the generation of content that contradicts fundamental human values. Sociologically, its widespread application could exacerbate social inequalities, disproportionately affecting vulnerable groups. Furthermore, from a legal standpoint, establishing regulations and oversight for ChatGPT's use to safeguard citizens' legitimate rights and interests remains a critical and urgent challenge.

### **4.3. Privacy and Security Issues**

In the current digital era, ChatGPT, as an artificial intelligence model with powerful language interaction capabilities, has drawn significant attention to its privacy and security issues. When processing conversations, ChatGPT needs to acquire users' input and contextual information, which may involve privacy and security concerns. The extensive collection of such data has raised public concerns about potential personal privacy breaches. If the data is misused, users' privacy could be severely violated, posing numerous risks. Although developers claim to implement strict protection and reasonable usage of the data, in practice, the data might be exploited for commercial purposes or inadvertently accessed by third parties. Furthermore, ChatGPT's technology itself carries certain security risks. Hackers could exploit system vulnerabilities to bypass security measures and access stored user data, not only threatening users' privacy but also potentially leading to large-scale data breaches.

## **5. Application of ChatGPT Technology in Scientific Research for the Second Classroom of "Landscape Ecology"**

ChatGPT has provided strong support for the scientific research and development of the second classroom in "Landscape Ecology". Firstly, it possesses massive data storage and processing capabilities. ChatGPT can quickly store and manage these vast amounts of data, conducting efficient analysis and mining through advanced algorithms, thereby offering researchers comprehensive and accurate data support, significantly improving research efficiency and accuracy. Secondly, ChatGPT excels in natural language processing. In the research and practice of landscape ecology, communication and interaction with various stakeholders—including researchers, policymakers, and local residents—are essential. ChatGPT's ability to understand and generate natural language facilitates more convenient and precise information dissemination. It can explain complex landscape ecology concepts and research findings in an accessible manner to non-specialists, tailored to different needs and contexts, thereby enhancing public awareness and participation in landscape conservation. Additionally, it assists researchers in tasks such as literature reviews and report writing, improving the quality and efficiency of written expression. However, there remain shortcomings in applying ChatGPT to land-

scape ecology research and development: 1) The sources and quality of data are inconsistent. If the input data contains errors or biases, ChatGPT's analysis and predictions may also exhibit deviations, compromising the scientific rigor and reliability of the research. 2) ChatGPT lacks genuine perception and emotional understanding of the real world. While it can simulate human thought processes and linguistic expression, it cannot truly experience the beauty and value of landscape ecosystems, nor fully comprehend human reverence and emotional connection to nature.

## 6. Conclusion

In the era of rapid technological advancement, ChatGPT, as an emerging artificial intelligence technology, has garnered widespread attention and in-depth discussion regarding its applications in both classroom teaching and scientific research within the field of "Landscape Ecology." ChatGPT technology demonstrates significant advantages in the teaching practice and extracurricular scientific research of "Landscape Ecology," such as robust data processing capabilities, natural language processing abilities, and learning prediction capacities, bringing new opportunities and challenges to the teaching and research of "Landscape Ecology." However, there are also evident limitations, including issues with data quality and reliability, as well as deficiencies in authentic perception and emotional understanding. In future development, it is essential to fully leverage the strengths of ChatGPT technology while continuously refining and improving its application methods and techniques, enabling it to better serve the teaching practice and scientific research of "Landscape Ecology" and contribute more significantly to the protection and sustainable development of landscape ecosystems.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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