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Development of Landscape Planning and Design Course Based on Design Thinking Process Combined with the Applications to Enhance Students' Learning Achievement and the Innovative Ability of Landscape Planning and Design

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Abstract

Background and Aim: Based on relevant policies and literature, such as higher education planning at home and abroad, policies of the Chinese Ministry of Education, educational concepts, cognitive learning theories, project-based learning methods, teaching strategies, and teaching evaluations, researchers interviewed teachers and students on the current Landscape Planning and Design course. This research and development aimed 1 to study the background information focusing on course components of the landscape planning and design course to enhance students' learning achievement and the innovative ability of landscape planning and design. 2) To develop a Landscape planning and design course based on the design thinking process, combined with the applications. 3) To determine the effectiveness of implementing the landscape planning course based on the Design thinking process, combined with the applications.

Materials and Methods: This research aimed to develop a landscape planning and design course based on the design thinking process integrated with applications, to enhance students' learning achievement and innovative ability. A sample of 30 junior students in environmental design was studied using a one-group post-test-only design. They are derived from using a cluster random sampling method. The experimental design adopted in this research was a one-group post-test only design. The research instruments for each Phase of the study were as follows: Phase I: Interview forms for teachers and students on course-related questions. Phase II: 1) Landscape planning and design course based on the Design thinking process, combined with the applications. 2) 8 lesson plans of the Landscape planning and design course. 3) An evaluation of innovative ability. 4) A learning achievement test. 5)Satisfaction questionnaire. The data were analyzed by using mean, standard deviation, and the one-sample t-test.

Results: The results of this research were as follows: 1) The researcher reviewed the related documents about the Landscape planning and design course and interviewed the 7 teachers and 15 students for problems of the landscape planning and design course, and the information gathered was used to develop the course. 2) The researcher invited 5 experts to evaluate the Landscape Planning and Design course development in five aspects: Course objectives, Course content, Course instructional strategies, Course media and resources, and Course evaluation to test the quality of the course developed. 3) After implementing through landscape planning and design course based on design thinking process combined with the applications, students' the innovative ability (Knowledge) was higher than the determined criterion of 70% at a significance level of .05 (M = 24.17 out of 30, SD = 5.35, t = 3.242, p = 0.003); students' the innovative ability (Skills) was higher than the determined criterion of 70% at a significance level of .05 (M = 80.60 out of 100, SD = 7.89, t = 7.363, p = 0.000). 4) The mean scores of students' satisfaction after implementing through the landscape planning and design course based on the design thinking process combined with the applications were 47.43 from a possible full mark of 50 and the standard deviation was 3.16 which was statistically higher than the criterion of 70% at the .05 level of statistical significance (t = 21.559, p = .000).

Conclusion: This research confirms the effectiveness of the teaching model based on the Design thinking process, combined with the applications to enhance students' learning achievement and the innovative ability of landscape planning and design.

Keywords: Landscape Planning and Design Course; Design Thinking; Applications; Learning Achievement; Innovative Ability

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Introduction

In the context of the rapid evolution of the landscape planning and design field, the traditional curriculum system has increasingly struggled to meet the industry's demand for innovative and interdisciplinary professionals. As pointed out by Guo Jianpeng (2019), with the deepening emphasis on concepts such as ecology, culture, and sustainable development, interdisciplinary integration has become an inevitable trend in education, and landscape planning and design education urgently needs to keep pace with the times. A closer examination of the current curriculum system reveals structural contradictions and functional deficiencies that demand immediate attention.

Significant inadequacies exist in terms of interdisciplinary integration within traditional courses. As a comprehensive discipline, landscape planning and design requires the integration of knowledge from multiple fields, including ecology, sociology, and computer science. However, existing courses overly prioritize the teaching of artistic design and engineering technology (Guo Jianpeng, 2019). This singular knowledge transfer model leaves students ill-equipped with the multi-dimensional analytical and problem-solving capabilities necessary when confronted with complex projects such as ecological restoration and cultural heritage conservation. Xu Weiqin (2021), through a follow-up survey of graduates' employment situations, found that students who could flexibly apply diverse knowledge in interdisciplinary projects were more likely to gain a competitive edge in their careers. This finding further underscores the critical importance of interdisciplinary integration in landscape planning and design education.

The issue of curriculum content lag is also pronounced. Gong Yilu, Huang Lechang, and Bi Shanhua (2020) emphasized that the industry has widely adopted new digital design tools and ecological restoration technologies. Nevertheless, the curriculum system still contains a substantial amount of outdated content, failing to incorporate the latest industry achievements promptly. For instance, some courses lack systematic explanations of new theories and methods related to national strategies such as urban renewal and rural revitalization. As a result, students' knowledge structures are severely disconnected from industry practices, making it difficult for them to meet the practical requirements of professional positions.

The limitations of teaching methods hinder the cultivation of students' innovative abilities. The traditional teacher-centered teaching approach overlooks the dominant role of students in the learning process (Guo Jianpeng, 2019). In this model, students passively receive knowledge, and their abilities to think independently and solve problems creatively are not effectively developed. Additionally, the weakness of practical teaching is a major shortcoming of the current curriculum. Students lack opportunities to engage in real-world projects, preventing them from translating theoretical knowledge into practical operational skills and resulting in difficulties in quickly adapting to the work environment after graduation (Xu Weiqin, 2021).

To address these challenges, the development of a new landscape planning and design course based on the design thinking process is imperative. This new course will prioritize interdisciplinary integration, constructing a knowledge system that encompasses ecology, sociology, culturology, and computer science, thereby enabling students to form a systematic and comprehensive professional understanding. In terms of teaching methods, it will introduce project-based learning, case analysis, and group discussion models to stimulate students' learning interests and innovative thinking. Through the expansion of internships, training, and industry exchange activities, the course will enhance students' practical abilities and comprehensive qualities (Gong Yilu, Huang Lechang, and Bi Shanhua, 2020).

The new course aims to cultivate landscape planning and design professionals with an innovative spirit, practical ability, and social responsibility. By optimizing the curriculum system, innovating teaching methods, and strengthening practical teaching, it will provide students with higher-quality educational services, assist them in realizing their values in the industry, and contribute to the sustainable development of the landscape planning and design field.

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Objectives

1. To study the background information and problems, focusing on course components relevant to the Landscape planning and design course based on the design thinking process, combined with the applications.

2. To develop a Landscape planning and design course based on the design thinking process combined with the applications.

3. To develop and evaluate a landscape planning and design course that integrates design thinking and applications to improve students' learning achievement, innovative ability, and satisfaction.

Literature review

1. Curriculum development theory

The word "curriculum" first appeared in the English educator Spencer's essay "What Knowledge is Most Valuable" (1859), and is derived from the Latin word "currere", meaning "race track". Race-course.) The most common definition of curriculum is "course of study". Different scholars have different philosophical values, and therefore different understandings of knowledge and learning theories, and therefore different understandings of the essence of the curriculum, including the emphasis on the experience and content of learning, the process of organizing the experience, or the timing and planning of the subject, and so on. Therefore, the interpretation of the essential connotation of curriculum is still diversified to this day [Wang et al, 2019]. American scholar R.D.V. Scotter once pointed out that curriculum is one of the most commonly used but the most poorly defined educational terms. Therefore, the definition of curriculum is broadly divided into three categories:

1) Curriculum as a subject

2) Curriculum as an objective or a program

According to H. Taba, an expert in curriculum theory, the curriculum is a learning plan; according to P. Oliva, the curriculum is a set of behavioral goals; and according to M. Johson, the curriculum is a set of organized and conscious learning outcomes. These types of definitions separate curriculum goals and plans from the curriculum process and place one-sided emphasis on the former, ignoring the reality of learners' experiences.

3) Curriculum as learners' experience or experiences

Dewey, an American educator, regarded curriculum as the experience acquired by students under the guidance of teachers, and the outstanding feature of this definition of curriculum is that it puts students' direct experience at the center of the curriculum.

Therefore, the definition of curriculum in this paper is a set of plans and settings that consists of certain nurturing goals, specific knowledge experiences, and expected ways of learning activities, which implies a rich, basic yet creative and potential set of plans and settings. The curriculum is a body of knowledge and its means of acquisition that is suited to the laws of physical and mental development of the student, connects the student's direct and indirect experiences, and guides the overall development of the student's personality.

2. Design thinking

Design is the product of the unity of science and art. At the level of thinking, design thinking necessarily includes scientific thinking and artistic thinking. Characteristics of these two types of thinking. The problem that design thinking aims to solve is to create new and unprecedented things or forms and solve problems that have not been solved before. Design thinking is creative thinking, but also a kind of strategic thinking. Dimension is a necessary condition for solving innovative problems, from logo design to system design and space design, which are essentially strategic. Design thinking in practice. It is manifested as user-centric, entering the real world to find new perspectives, gaining new insights, redefining problems, and expanding ways of thinking; inviting users, partners, and stakeholders to participate in change, Leather; High-speed iteration, continuous exploration in practice and feedback, continuous improvement of solutions. (Tian Ran, 2013)

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Design thinking is a human-centered, innovative approach to solving complex problems that leverages the designer's understanding and approach to match technical feasibility, business strategy, and user needs, thereby translating into customer value and market opportunities. As a way of thinking, it is generally considered to have the nature of comprehensive processing ability, able to understand the context in which problems arise, able to generate insights and solutions, and able to rationally analyze and find the most appropriate solutions. (Zhao Lianbang, 2020)

The course case studied in this paper integrates design thinking into landscape planning and design curriculum teaching, utilizing design thinking methodology to enhance the teaching design capabilities of environmental design professionals, and improve students' academic performance and innovation ability in landscape planning and design.

3. The applied education

The educational application supported by the teaching process is not only to impart knowledge to learners, but also to evaluate the learning effect of learners. Dr Fang Haiguang's process of teaching activities based on educational application includes the stage of lesson preparation and pre-study, the stage of teaching new knowledge, and the stage of connection and assessment (Fang Haiguang, 2006)

1)Preparation and pre-study stage

The basic problem that should be solved by the design of educational applications is the design of teaching content and teaching process, i.e., in the stage of lesson preparation with educational applications, consider in what form and in what order the teaching content should be presented, as well as how to realize and how to control the teaching process of the educational applications.

2)New knowledge teaching stage

In the stage of teaching new knowledge, the teacher organizes and coordinates the teaching as a comprehensive process of teaching, discussion, guidance, induction, analysis, demonstration, observation, experiment, practice, etc. This is also the most important part of the educational application.

3)Evaluation stage of practice

Classroom practice assessment is the consolidation of knowledge and teaching feedback stage, the design of the application of the teaching link should be consistent with two principles: one is closely related to the focus of the new knowledge and teaching the difficult points, cleverly designed from easy to difficult hierarchical form of practice, and the other is to give full play to the sound and shape of the multimedia advantages of the computer to improve students' motivation to learn, according to the teaching needs of the increase in the practice, to reflect the quality of the classroom to the efficiency of the teaching principles. Teaching principles. To have a basis for evaluation, the application of practice modules to determine the learner's mastery of knowledge, and on this basis, to identify learning obstacles and proposed solutions.

4. Design thinking process combined with the applications

As design thinking has gained increasing attention in the field of education, some teachers have begun to experiment with design thinking as a theoretical framework for redesigning curriculum instruction. The School of Education at the University of Virginia has developed a design-thinking-based curriculum for teacher educators, in which teacher educators are encouraged to use design thinking to design lessons for learners, who are required to design the lesson in advance, engage the learners in the process, and evaluate the effectiveness of the lesson.

The Australian government has launched a project on "Applying Design Thinking to Transform Interdisciplinary Pedagogy", which uses the Design Thinking model developed by Stanford University to guide the learning of teacher educators and encourages tertiary teachers to be able to apply Design Thinking to improve their curriculum design. Don Buckly, Professor of Educational Technology at Columbia University's School of Education, and co-founder of the American design firm Aruliden, initiated a project called "Tools for Schools", which is dedicated to integrating design into education, and enabling teachers and students to understand that design thinking is an effective tool for problem solving, and that it can be used as a tool to solve problems, and that design thinking is an effective tool to solve problems. L. Dym proposes a project-based learning approach to develop engineering design thinking in learners (Clive L.

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Dym et al, 2005). Gavin Melles argues that design thinking is a human-centred problem-solving process that is effective in providing solutions for improvement and product innovation, and has carried out practical research in design thinking courses at Swinburne University of Technology in Australia and Swinburne University of Technology in Hong Kong (Gavin Melles et al, 2012).

So, using applications in class has gradually become a new way of studying. Based on design thinking process combine with the applications is the new teaching method, broke the traditional teaching mode, to provide new forms for college classroom teaching, promote the innovation of classroom teaching in training students' interest in learning, training students' thinking ability, strengthen students' autonomous learning ability, and improve the learning efficiency of the role of to be reckoned with, and at the same time with the development of times, Promote the support of emerging technologies for learning.

Based on the design thinking process combine with the applications refers to the researcher applies design thinking to teach the students, and students use the applications as tools for learning about landscape planning and design, and are able to design landscapes.

5. The innovation ability

Scholar Qing Bo believed that innovative ability is closely related to education. The greatest contribution of education to a person's life is to help discover curiosity and cultivate the intuition to find creative answers. Innovative ability is not limited to technological innovation but also includes the application of rationality and the creation of lifestyles. In education, it is essential to focus on cultivating students' curiosity and exploratory spirit, encouraging them to intentionally create in their lives rather than merely passively accepting. For instance, carrying out inquiry-based learning activities allows students to autonomously explore topics of interest and cultivates their awareness and ability to innovate and create using knowledge in their lives. (Qing and Wang, 2015)

Innovative is the activity of new human beings for the sake of their own needs, constantly expanding the process and result of the process and result of the world and its cognition and behavior, or specifically, innovation refers to the movement of people for a certain purpose, the law that does not belong to things, and the whole of things or some beneficial part of them, so that they can be more involved in the movement. (Li Meixia, 2022).

Innovation refers to the behavior of using existing thinking patterns to put forward insights different from conventional or ordinary people's thinking, using existing knowledge and materials, in a specific environment, by idealized needs or to meet social needs, and improving or creating new things, including but not limited to various products, methods, elements, paths, environments, etc., and can obtain certain beneficial effects.(He Kun, Zhao Yang, Zhang Zhiguo & Bai Lu, 2014)

Innovative ability refers to the ability to continuously provide new ideas, theories, new methods, and new inventions with economic, social, and ecological value in technology and various practical fields. Innovation ability is the behavior of using existing knowledge and materials to improve or create new things (including products, methods, elements, paths, and environments) in a specific environment based on idealized needs or to meet social needs, and can obtain certain beneficial effects.

Conceptual Framework

In this research, the independent variable was the implementation of the landscape planning and design course based on the Design thinking process, combined with the applications, and the dependent variables were students' innovative ability and students' satisfaction.

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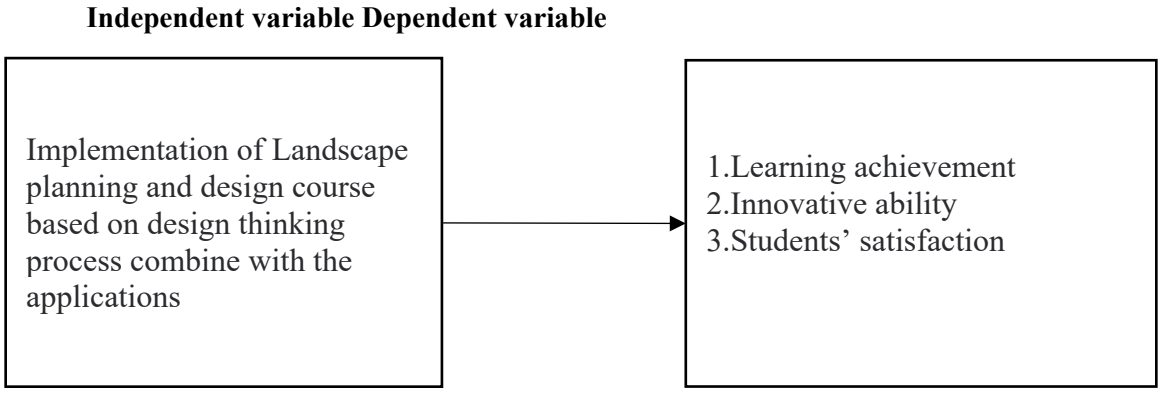

Figure 1 The figure of the Research Conceptual Framework

Methodology

Phase 1: Studying background information, important problems, and related research

Study related literature on the Landscape planning and design course and interview the teachers and student teachers of related majors of Zhoukou Normal University.

1. Target group

The target group was 7 teachers in Environmental Design at Zhoukou Normal University.

The target group was 15 senior students in Environmental Design at Zhoukou Normal University. They are derived from purposive sampling.

2. Research instrument

There were two interview forms， one for students and another for teachers.

Data collection and analysis of the Landscape planning and design course based on the Design thinking process, combined with the applications by using content analysis.

3. Data analysis

1) The data on existing problems is collected by an interviewing process and the voice record tool.

2) The content analysis is used for analyzing and summarizing collected data.

Phase 2: Developing the Landscape planning and design course

The purpose of this phase was to design the draft course document and determine the quality of the draft course document before its implementation.

1. Developing a Landscape planning and design course based on the design thinking process, combined with the applications. This step aimed to develop the draft course according to the results from the first phase. The components of the draft course consisted of: 1) Determine objectives of the course; 2) Select course content; 3) Determine instructional strategy; 4) Select media and resources; 5) Determine evaluation methods.

2. Determining the quality of developing a Landscape planning and design course based on the design thinking process combined with the applications. This step aimed to determine the quality of the draft course document before its implementation. The draft course document was evaluated by five experts regarding the appropriateness and consistency of each component of the draft course. Firstly, an appropriateness evaluation involved an appropriateness evaluation of each component of the draft course document, including 1) the objectives of the course, 2) the course contents, 3) instructional strategies, 4) media resources, and 5) course evaluation. Secondly, consistency evaluation involved the internal consistency among the components of the draft course document. Experts' recommendations were used to revise the course document.

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3. Constructing 8 lesson plans, consider the overall structure and format of each lesson; Constructing and examining the quality of the Evaluation form of the Learning Achievement test; Constructing and examining the Evaluation form of the innovative ability; Constructing and examining the quality of the Satisfaction Questionnaire about the Landscape planning and design course.

1. Target group

The five experts who evaluated the draft course consisted of 2 specialists in the course field, 2 specialists in instruction relevant to computational thinking, and 1 specialist in the measurement and evaluation field.

2. Research instrument

The instrument used for evaluating the draft course document was the appropriateness and consistency evaluation form.

3. Data analysis

The researcher offered the course evaluation form to a group of experts to examine or evaluate the draft course document. After gathering the data, the collected data were analyzed for the appropriateness and the consistency of the course document.

Phase 3: Implementing the Landscape planning and design course

1. Population and sample

The population was 120 Junior students from Zhoukou Normal University majoring in Environmental Design.

The sample was 30 Junior students from Zhoukou Normal University majoring in Environmental Design. They are derived from using a cluster random sampling method.

2. Research Instruments

Instruments for data collection consisted of three parts:

Learning Achievement Test. The test includes 30 multiple-choice questions about the mastery of the Landscape planning and design course, covering the knowledge learned in the course.

Evaluation form of the innovative ability. The Skills are evaluated by the Evaluation form of innovative ability, which consists of 5 aspects: (1) Innovative awareness, (2) design thinking, (3) innovative skills, (4) Research and Analysis, (5) Collaboration and Communication.

Satisfaction Questionnaire about the Landscape planning and design Course. The main purpose of this questionnaire is to explore the impact of Landscape planning and design courses based on the design thinking process, combined with the applications, on students' innovation ability. This questionnaire consists of 10 questions, covering satisfaction with the landscape planning and design course, the programming design thinking process, and its applications.

Relying on research results for data collection to determine the effectiveness of implementing the Landscape planning and design Course based on the design thinking process, combined with the applications to enhance students' learning achievement and innovative ability.

3. Data collection

The course was implemented for the samples in the first semester of the 2024-2025 academic year. The procedures of data collection during the course implementation process were as follows:

1) The samples that were assigned to the experimental group are taught by using instruction through the developed Landscape planning and design Course. This group was taught through 8 lesson plans, and the allocated time for instruction was two months.

During instruction through the course implementation process, the researcher observed and recorded data, including the teaching process, the learning process, classroom atmosphere, students' behavior, and teachers' behavior that occurred in the classroom.

2) After finishing the instruction, the samples received the post-test by using the instruments.

3) The samples are given the student teachers' satisfaction questionnaire to express their opinion on the course.

4. Data analysis

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In this research, quantitative data were analyzed using the statistical program in line with the research objectives.

1) Statistics used to determine the different significance at the .05 level of scores on Student teachers' innovation ability after learning through the Landscape planning and design Course by using a one-sample t-test.

2) Statistics used to assess the students' satisfaction with the Landscape planning and design Course by using the arithmetic mean, standard deviation, and one-sample t-test to compare students' satisfaction with the criterion of 70%.

Results

Phase 1: Study the background information, focusing on course components and existing problems

The purpose of this phase was to investigate and review the relevant literature about the current course components of the Landscape planning and design course, and existing problems. Background information focusing on course components: 2) Design thinking, 3) Application education, 4) The innovation ability, 5) Existing problems, as well as studying the related research, such as the relevant documents and current situation. The findings of this phase, which were used in designing a course, were presented as follows:

1. The findings of studying the relevant documents on the Landscape planning and design course

Summarize the process and successful experience of relevant literature cases. Through an in-depth understanding of relevant teaching strategies, teaching effectiveness, and case studies, a solid theoretical and practical foundation has been laid for the construction of effective teaching strategies in the future.

2. The findings of interviewing the teachers and student teachers of Landscape planning and design at Zhoukou Normal University

The researcher applied course development content to teaching, conducted research on different teaching methods, collected data from 7 other teachers in the same subject, and ultimately formed a new curriculum system for the landscape planning and design course based on the design thinking process combined with the applications, to improve students' innovation ability. Based on the above course problems, solutions were proposed, and corresponding teaching plans were formulated.

Phase 2: Developing a landscape planning and design course based on the design thinking process, combined with the applications.

1. The findings of the course development

The draft course document consists of 5 components:

1) Course objective

This course objective is innovative teaching strategies, based on the design thinking process, combined with applications to enhance students' learning achievement and the innovative ability of .landscape planning and design

To study the background information, focus on .1the course components relevant to the .Landscape planning and design course

To develop .2a Landscape planning and design course based on the ,design thinking process combined.with the applications

To determine the effectiveness of implementing the Landscape planning and design course .3 based onthe ,design thinking process combined with the applications.

The objective of the old course is to let students master the basic theories and methods of landscape planning and design, and to train professionals who can complete the design tasks according to the conventional process. The goal of the new course is to cultivate interdisciplinary landscape architects with innovative thinking, interdisciplinary knowledge integration ability, and social responsibility. Students

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are not only required to master professional skills, but also to use design thinking to discover, analyse, and solve practical problems in a complex social background, so as to create greater social value through design.

2) Course content

Compared with the current curriculum, the new curriculum has the following significant advantages in terms of content:

① Classification of environmental resources;
② Skills of environmentally sensitive areas;
③ Implementation methods of landscape resource planning;
④ Sustainable development;
⑤ Landscape site analysis;
⑥ Inventory, analysis, and synthesis of project sites;
⑦ Train of thought development;
⑧ Landscape resource planning and overall planning.

The content of the current course is relatively fixed, mostly focusing on classical theories and traditional design techniques, which makes it difficult to keep up with the rapid development of the landscape industry, such as the emerging ecological restoration landscape and digital landscape design. The new course is closely combined with the forefront of the industry, and timely includes the application of ecological and environmental protection new materials, the application of big data analysis in landscape planning, and other content, so that students are exposed to the latest industry knowledge and technology, to ensure that what they learn is used.

3) Teaching strategy

New teaching steps based on the Design thinking process, combined with the applications:Teaching steps.

Step 1. Project Introduction and Field Research: Start with a real-world project. Guide students to research the site, collect data, communicate with clients, and set design goals.

Step 2. Integrated Teaching of Theory and Cases: Link the project to theory and cases. Analyze similar projects' experiences to help students apply theory in practice.

Step 3. Group Collaboration Design: Students work in groups on different project aspects. Teachers organize discussions and offer guidance.

Step 4. Parallel Teaching of Software Skills and Design: Teach software as needed in design. For example, when drawing plans, teach CAD; for renderings, teach Photoshop and SketchUp.

Step 5. Mid-term Report and Feedback: Groups report progress. Invite experts and clients for feedback, and students improve their designs.

Step 6. Final Result Presentation and Evaluation: Students present final results, including concepts and feasibility analysis. Evaluate with a combination of teacher, peer, expert, and client reviews.

Compared with the old course, the teaching strategy of the new course has been improved:

① **Enhanced Practical Ability**： Real-world projects let students apply theory to practice and solve practical problems.

② **Cultivation of Teamwork Spirit**： Group work helps students cooperate, use their strengths, and develop teamwork and communication skills.

③ **Improved Practicality of Software Skills**： Learning software according to design needs helps students unders**tand functions and improve proficiency.**

④ **Diversified Evaluation System**： **Combining multiple evaluations provides comprehensive and objective feedback for students' growth.**

4) Material and resources

The material and resources for the new course are:

① Basta, C. & Moroni, S. (2013). Ethics, Design and Planning of the Built Environment. Albany: Springer.

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5) Evaluation methods

The evaluation methods for the new course are:

① Test for Learning achievement of the students about landscape planning and design;
② Evaluation form for innovative ability of landscape planning and design of students;
③ Questionnaire for students' satisfaction with the Landscape planning and design course.

2. The findings of the course document evaluation by experts

This step aimed to determine the quality of the draft course before its implementation. The draft course was evaluated by experts regarding the appropriateness of the draft course. The findings of the course evaluation, which were collected and analysed, indicate that the experts rated the overall course development at a very high level, with a mean score of 4.88 and a standard deviation of 0.27.

3. The evaluation of lesson plans by experts

This step aimed to determine the quality of the lesson plans before their implementation. The lesson plans were evaluated by experts regarding the appropriateness of the lesson plans. The findings of the lesson plans evaluation, which were collected and analyzed, indicate that the experts rated the overall lesson plans at a very high level, with a mean score of 4.99 and a standard deviation of 0.30.

4. The findings of the Evaluation of the innovation ability by experts

This step aimed to determine the quality of the innovation ability, including five aspects:(1) Innovative awareness, (2) Design thinking, (3) Innovative skills， (4) Research and Analysis， and (5) Collaboration and Communication. The innovation ability was evaluated by experts regarding the reliability and consistency of the innovation ability. The findings of the innovation ability evaluation, which were collected and analyzed, indicate that the experts rated the IOC equal to 1.00 for every item and reliability equal to 0.76.

Phase 3 Implementation of the landscape planning and design course based on the design thinking process, combined with the applications through the teaching and learning process.

The findings of a comparison of students' innovation ability after learning through a landscape planning and design course based on the design thinking process, combined with the applications.

Table 1 The findings of comparing students' innovation ability (Knowledge) after implementing the landscape planning and design course based on the design thinking process, combined with the applications, with a criterion set at 70%. (To compare the knowledge of the Learning AchievementTest before and after implementing the landscape planning and design course based on the design thinking process, combined with the applications.)

Group	n	Pretest scores		Posttest scores		*t*	*p*
		M	*SD*	*M*	*SD*		
Experimental group	30	18.10	3.43	24.17	5.35	3.242**	0.003

***p*<0.01

As presented in Table 1, the mean scores of pretests of students' LearningAchievementTest were 18.10 (SD =3.43) and post-test of students' LearningAchievementTest were 24.17 (SD = 5.35).

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Moreover, it aimed to examine the different scores of before-and-after learning through the landscape planning and design course based on the design thinking process, combined with the applications to enhance students' learning achievement and the innovative ability of landscape planning and design. The findings of this table revealed that after learning through a landscape planning and design course based on the design thinking process combined with the applications, post-test scores of students' Learning AchievementTest were greater than pretest scores at the .01 level of statistical significance (t = 3.242, p = p=0.003). The average scores of the study developed increasingly higher than the pre-test.

Table 2 The findings of comparing students' innovation ability (the skills) after implementing the landscape planning and design course based on the design thinking process, combined with the applications, with a criterion set at 70%

Group	n	Full score	Criteria score	M	*S.D.*	*t*	*p*
Experimental group	30	100	70	80.60	7.89	7.363**	0.000

** $p<0.01$

As presented in Table 2, the mean scores of 30 junior students' learning achievement and the innovative ability of landscape planning and design after implementation of the landscape planning and design course based on learning achievement and the innovative ability of landscape planning and design were 80.60 from the full score of 100, and the standard deviation was 7.89.

Moreover, it aimed to examine the different scores after the implementation of the landscape planning and design course based on the design thinking process, combined with the applications to enhance students' learning achievement and the innovative ability of landscape planning and design. The findings of this table revealed that after the implementation of the landscape planning and design course based on the design thinking process combined with the applications, students' learning achievement and the innovative ability of landscape planning and design post-test scores were greater than the criterion of 70% (70) at .01 level of statistical significance (t = 7.363, p =0.001). The average scores of the study developed increasingly higher than the 70% criterion.

Table 3 The findings of comparing the students' satisfaction after implementing the landscape planning and design course based on the design thinking process, combined with the applications, with a criterion of 70%

Group	n	Full score	Criteria score	M	*S.D.*	*t*	*p*
Experimental group	30	50	35	47.43	3.16	21.559**	0.000

** $p<0.01$

As presented in Table 3, the mean scores of 30 Junior students' satisfaction after learning through landscape planning and design course based on design thinking process combined with the applications was 47.43 from the full score of 50, and the standard deviation was 3.16 which was statistically higher than the criterion of 70% (35) at .01 level of statistical significance (t = 21.559, p <0.01).

Discussion

In the field of landscape planning and design education research, existing literature predominantly focuses on the optimization of traditional teaching models or the integration of single-disciplinary knowledge. There is a notable lack of exploration into the construction of curriculum systems driven by

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design thinking processes and deeply integrated with practical applications. Most studies lack a quantitative assessment of students' innovative ability cultivation and fail to explicitly analyze the correlation between students' curriculum satisfaction and industry-demand benchmarks (Smith, 2020; Johnson, 2021). This study fills these gaps in the literature from multiple dimensions by constructing a landscape planning and design curriculum system based on design thinking processes, combined with practical applications.

In terms of research methods and outcomes, this study employed a single-group post-test design, conducting experiments on 30 first-year students. By comparing students' innovative abilities with a 70% benchmark and evaluating curriculum satisfaction against the same 70% benchmark, it provides a quantitative analysis paradigm for research in this field. Previous literature often remained at the level of theoretical elaboration or qualitative evaluation, lacking empirical data support (Brown, 2019). This study confirms that the curriculum model integrating design thinking processes with practical applications can significantly enhance students' innovative abilities and practical skills, breaking through the limitations of traditional courses that emphasize theory over practice and vague paths for cultivating students' innovative abilities. Moreover, this research is the first to deeply integrate the systematic steps of design thinking (such as observation, empathy, problem definition, etc.) into landscape planning and design courses, providing an operational framework for interdisciplinary integration and project-based teaching, and complementing the lack of detailed curriculum implementation strategies in existing literature.

For educators, this study holds significant practical guiding implications. In terms of curriculum design, it is recommended that educators draw on the design-thinking-centered curriculum framework of this study and incorporate real-world projects to enhance the alignment between the curriculum and industry needs. For example, they can refer to the case studies of community landscape renovation and urban waterfront landscape design in this research to design curriculum content that includes field research, user-need analysis, and iterative optimization of design schemes, thereby cultivating students' ability to solve complex practical problems.

Regarding teaching methods, this study demonstrates that the design thinking process can effectively stimulate students' initiative and creativity. Educators can strengthen the "student-centered" teaching philosophy in the classroom and utilize design thinking tools, such as observation and empathy, to guide students in breaking away from traditional design mindsets. For instance, in the teaching of park landscape design, students are encouraged to communicate with different user groups to accurately define design problems, enabling them to propose more innovative and practical solutions.

In addition, the evaluation method of curriculum implementation effectiveness in this study also provides a reference for educators. By setting quantitative benchmarks for innovative abilities and curriculum satisfaction, teachers can promptly understand teaching effectiveness and adjust teaching strategies. For example, if students' innovative abilities do not reach the benchmark, teachers can strengthen guidance in the prototyping and testing phases; if satisfaction is low, it is necessary to optimize curriculum content and teaching methods to improve teaching quality.

Conclusion

This study has verified the effectiveness of integrating the teaching model based on the design thinking process with practical applications, which can significantly enhance students' learning outcomes and innovative capabilities in landscape planning and design. Through the evaluation of students' performance via theoretical tests and real-world projects, the results demonstrate that this model effectively achieves the in-depth integration of theoretical knowledge and practical operations, effectively enhancing students' innovative abilities and improving their professional knowledge and skill levels.

However, this study also has certain limitations. Firstly, the sample size of the study was relatively small, with only 30 students participating in the curriculum practice. A small sample size may lead to biases in the research results, making it difficult to comprehensively reflect on how students with different backgrounds and learning abilities adapt to this curriculum model and their learning effectiveness. This restricts the generalizability of the research conclusions to a larger extent (Cohen, 1988). Secondly, no

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control group was set up for comparative experiments in this study. As a result, it is impossible to accurately measure the specific advantages of the curriculum model based on the design thinking process compared with the traditional teaching model. The lack of a control experiment makes it difficult for the study to rule out the influence of other potential factors on students' learning outcomes, which, to a certain extent, weakens the persuasiveness and accuracy of the research results (Shadish et al., 2002).

Despite the above-mentioned deficiencies, the teaching model of landscape planning and design that integrates the design thinking process with applications still demonstrates significant advantages and promotional value. This curriculum has shown good learning effects in terms of knowledge comprehension and mastery, ability cultivation, and transformation of thinking patterns. It can better meet the needs of the landscape and environmental design industry for professional talents, laying a solid foundation for cultivating outstanding landscape designers with solid professional knowledge, innovative abilities, and comprehensive qualities. Future research could expand the sample range to cover students from more institutions and at various learning stages. Meanwhile, a control group should be set up, and strict experimental designs should be adopted to further verify the effectiveness and superiority of this curriculum model, thus enabling broader promotion and continuous improvement in the education of landscape and environmental design majors.

Recommendation

Recommendation for implication

1. Introduction of Quantitative Research

Currently, the paper mainly focuses on qualitative description, and quantitative research methods can be added. For example, collect quantitative data on students' knowledge mastery, innovative thinking ability, etc., before and after the course through questionnaires, and use statistical methods to analyze the significant degree of improvement in students' abilities by the curriculum model. Also, a quantitative scoring system can be applied to students' performance in project practice to more accurately evaluate the effectiveness of the course.

3. Comparative Research

Set up a control class and use the traditional curriculum model and the curriculum model based on the integration of design thinking and application for teaching, respectively. Compare and analyze the differences in learning outcomes and ability cultivation between the two groups of students, providing more powerful empirical evidence for the effectiveness of the curriculum model.

4. Diversified Case Types

In addition to common cases such as urban squares and old community renovations, more types of landscape projects can be included, such as mountain landscape planning and industrial site landscape renovation. Different types of projects face different problems and challenges, which can more comprehensively demonstrate the application effect of the curriculum model in different situations.

5. Case Tracking and Feedback

Conduct long-term tracking of the selected cases and collect actual feedback after the project implementation, such as user satisfaction surveys and evaluation of the actual operational effect of the landscape. This feedback further demonstrates the effectiveness and sustainability of the design results of students trained by the course in reality.

Recommendation for further research

1. Short-Term Proposals

(1) Aspects of Interdisciplinary Integration

① Preliminary Integration with Artificial Intelligence (AI): Within the upcoming semester, introduce simple machine - learning algorithm tools, such as basic data processing libraries in Python. Guide students to collect and conduct preliminary analyses of a small number of typical landscape case data. For instance, analyze the relationship between tourist flow data and spatial layout in urban park landscape cases, providing references for the planning of pedestrian flow guiding areas in design schemes.

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Through practical operations, enable students to initially experience the application potential of AI technology in landscape planning and cultivate their sensitivity to data-driven design.

② Initial Incorporation of Psychological Knowledge: In this semester's "Principles of Landscape Design" course, arrange 2 - 3 special lectures. Invite psychology professors or experts to explain basic psychological knowledge, especially content related to users' emotional needs, such as people's perception and preferences for space in environmental psychology. Meanwhile, assign small-scale assignments, requiring students to analyze how existing landscape spaces meet or fail to meet users' emotional needs, thus prompting students to start connecting psychological knowledge with landscape design.

(2) Application of Emerging Educational Technologies

① Tentative Application of VR/AR Technologies: Collaborate with the school's information technology center or relevant technology companies to develop 1 - 2 simple VR/AR landscape teaching cases within this semester. For example, create a VR experience scene of the campus landscape, allowing students to feel the spatial changes brought about by different combinations of landscape elements through immersive experiences. This enhances their perception of landscape spatial scale and atmosphere. Conduct group discussions during class after the experience to collect students' feedback, accumulating experience for more in-depth applications in the future.

② Initial Exploration of Online Teaching Platform Functions: Utilize existing online teaching platforms (such as Xuetang Online, Chaoxing Learning Pass, etc.) to build a basic online learning framework for the course within this semester. Upload teaching videos, courseware, and other relevant materials, and set up simple online discussion areas and assignment submission sections. Guide students to conduct independent learning and communication through the online platform during their spare time, helping them initially adapt to the blended learning mode of online and offline integration. Teachers can also familiarize themselves with the operation and management of the online teaching platform through this process.

2. Long-Term Proposals

(1) Aspects of Interdisciplinary Integration

① Constructing a Deeply Integrated Curriculum System with AI: Over the next 2 - 3 years, gradually improve the curriculum content integrated with AI. Cooperate with the School of Computer Science to offer specialized course modules, systematically teaching the application of AI technologies, such as machine learning and deep learning, in landscape planning. This includes using AI algorithms for the generation and optimization of landscape design schemes and landscape ecological simulation. Drive students' learning through real-world projects, enabling them to master relevant technologies proficiently in practice and enhancing their design innovation capabilities.

② Comprehensive Integration of Psychology and Landscape Design Courses: Over the next 2 - 3 years, fully integrate psychological knowledge into the landscape design curriculum system. Incorporate psychology-related teaching content and practical links into both basic and core professional courses. For example, in landscape planning courses, students are required to conduct site function layout design based on the analysis of users' psychological needs; in landscape design practice courses, they are introduced to user experience surveys and feedback mechanisms, and use psychological methods to evaluate design effects, cultivating students' ability to design human-centered landscape spaces.

③ In-Depth Exploration of the Integration of Economics and Landscape Design: Over the next 3 - 5 years, conduct in-depth research and teaching practices on the integration of landscape design and economics. Collaborate with the School of Economics to offer relevant elective courses, teaching knowledge such as project cost-benefit analysis, landscape investment, and return assessment. Encourage students to participate in the economic feasibility studies of actual landscape projects, and fully consider construction costs, operation and maintenance costs, as well as the economic benefits brought by landscapes in their design schemes, maximizing landscape value.

(2) Application of Emerging Educational Technologies

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① Creating a Comprehensive VR/AR Immersive Teaching Environment: Over the next 3 - 5 years, continuously invest resources and cooperate with professional technical teams to develop a series of diverse VR/AR landscape teaching resources. Cover various types of landscape projects, such as urban parks, historical and cultural blocks, and nature reserves, providing students with comprehensive immersive learning experiences. Through interactive operations and design practices in virtual scenes, cultivate students' spatial imagination, design perception ability, and problem-solving skills in practical situations.

② In-Depth Development of Personalized Learning Paths: Over the next 3 - 5 years, based on the long-term collection and analysis of students' learning data, use big data technology and AI algorithms to formulate personalized learning paths for each student. Combine course content with students' learning progress, ability levels, and interests, intelligently recommend learning resources, assign personalized homework, and provide targeted learning guidance. Continuously optimize the algorithm model of learning paths to adapt to the dynamic learning needs of different students and improve learning effectiveness.

③ Construction of a Big Data-Driven Teaching Decision-Making Support System: Within the next 5 years, establish a complete big data-driven teaching decision-making support system. Integrate various types of data generated by students during the learning process, such as learning behavior data, homework performance data, and examination data. Use data mining and analysis techniques to gain in-depth insights into students' learning status and existing problems. Provide accurate teaching decision-making support for teachers, such as adjusting teaching content and methods, optimizing course schedules, identifying students with learning difficulties promptly, and providing interventions, comprehensively improving teaching efficiency and quality.

(3) Comparative Research on International Landscape Planning and Design Education

① Analysis and Summary of Characteristics of International Curriculum Models: Over the next 1 - 2 years, organize a dedicated research team to collect and sort out the curriculum materials of well-known institutions in Europe, America, Asia, and other regions for landscape planning and design courses integrated with design thinking and applications. Analyze the characteristics of curriculum models in different countries, including curriculum objectives, content settings, and teaching methods, through literature research, online course observation, and communication with foreign faculty members. Form detailed comparative analysis reports to provide references for subsequent curriculum reforms.

② In-Depth Comparison of Curriculum Settings, Teaching Methods, and Practical Project Arrangements: Over the next 2 - 3 years, further conduct in-depth research on the differences in curriculum settings, teaching methods, and practical project arrangements among well-known foreign institutions. Select representative foreign institution courses for case analysis, and invite foreign experts to give online or offline lectures to share teaching experiences. Organize teaching seminars for faculty teams, draw on advanced foreign experiences, and optimize and adjust local courses, such as improving teaching methods and increasing the diversity and authenticity of practical projects.

③ Construction of a Cultivation System for Cross-Cultural Landscape Design Abilities: Over the next 3 - 5 years, construct a cultivation system for cross-cultural landscape design abilities. Carry out joint teaching projects with foreign institutions, organize students to participate in international cross-cultural landscape design competitions, and enable students to exercise their cross-cultural design capabilities in practice. Offer courses related to cross-cultural landscape design, introduce landscape design concepts and methods under different cultural backgrounds, and cultivate students' global vision and cultural inclusiveness. By integrating with international standards, enhance the international influence of local landscape planning and design courses, and contribute to the international development of China's landscape planning and design education.

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