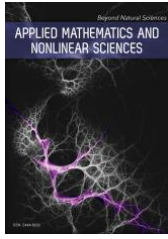# Central Lancashire Online Knowledge (CLoK)

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The Application and Effectiveness of Interdisciplinary Integration Education in Teaching Interior Design and Environmental Design

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Abstract

The innovative interdisciplinary integration teaching of interior design and environmental design courses results from the interaction between the development of disciplines and the needs of the times, individual aesthetic needs, and the optimization of the human habitat. Based on the STEAM teaching theory, the article analyzes the advantages of interdisciplinary integration teaching and establishes the teaching mode for interior design and environmental design courses. Students of interior design at a university were selected as the research object, and a system for evaluating teaching quality was established. The weights of evaluation indexes were solved using the rough set method, and the fuzzy comprehensive evaluation method was combined with it to conduct a thorough evaluation of the interdisciplinary, integrated teaching mode. A comparison experiment was conducted to analyze the effectiveness of the multidisciplinary integration teaching mode. After conducting the teaching comparison experiment, the mean value of the posttest scores for core literacy students in class A is 27.22 points higher than that of class B. The difference in occupational physical, mental, and behavioral literacy weighting is only 0.13%, and the overall evaluation score for the quality of interdisciplinary integrated teaching is 8.183. Introducing multidisciplinary integration teaching can improve students' interior design abilities and help improve the quality of training in interior design and environmental design talents in colleges and universities.

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1   Introduction

Since the second half of the 20th century, with the natural sciences, social sciences and humanities disciplines in a high degree of refinement and specialization at the same time, the development of interdisciplinary research has become a general consensus in the field of higher education around the world [1]. Interdisciplinary research is the process of answering questions, solving problems, and dealing with issues, and for some overly complex or broad issues that cannot be explained only by a single discipline, it is necessary to base on disciplines, and integrate insights through the contents of two and more disciplines or professional knowledge systems, so as to achieve a more comprehensive understanding and cognition. The most effective approach to interdisciplinary education is to allow students to build interdisciplinary pathways by choosing courses that are meaningful to them [2-4].

The interior design and environmental design education systems are nearly mature, with very well-developed theoretical systems, and have demonstrated many outstanding practical achievements. The high level of complexity and difficulty of these two disciplines is extremely challenging for design educators [5-7]. They not only need to have in-depth understanding of their own disciplines, but also need to strengthen their knowledge of some peripheral disciplines and even make flexible applications. Teaching content and teaching methods should be improved continuously with the changes of time and space [8-9]. In recent years, with the development and application of mobile communication, artificial intelligence, virtual reality, big data and other emerging technologies, interior design and environmental design has emerged as a series of inter-disciplinary, multidisciplinary, comprehensive design that expresses major social and cultural themes, greatly expanding the boundaries and horizons of the existing design disciplines [10-11]. But at the same time, there are some corresponding problems such as the discipline system, discipline attributes, curriculum system, training mode, etc. There is no uniform standard and it is relatively backward, which need to be solved urgently [12-13]. Therefore, it is necessary to adapt to the development of educational reform and discipline construction needs, strengthen interdisciplinary research, and constantly expand the breadth and depth of educational research. In recent years, domestic universities continue to promote the practice and research of "interdisciplinary integration" design professional education model, which plays a positive role in the cultivation of comprehensive talents in society [14-15].

Interdisciplinary education occupies an increasingly important position in the contemporary education system, especially in the field of design education, where its importance and application are becoming more and more evident. Rek-Lipczyńska, A et al. attempted to incorporate interdisciplinary concepts into the teaching and learning of interior design and found that the learning outcomes of interior design need to be extended through architecture and urban planning as well as horticulture, and verified this finding through the practical approach, providing the interior design students with more opportunities for development and a platform for continued growth [16]. Makki, A et al. explored how to introduce an interdisciplinary collaborative design approach in improving the interior design studio program and created multiple strategies for effective collaborative environments to advance that goal, which in turn improved students' ability to acquire knowledge and creativity, and develop critical thinking skills [17]. Celadyn,M proposed a new concept of integrated design curriculum, which was applied to the sustainable teaching of interior architectural design, and introduced an interdisciplinary environmental responsibility-oriented design workshop in the teaching process, and verified the effectiveness of the proposed teaching reform method through empirical analysis, which not only deepened the students' understanding of the principles of sustainability and its application methods, but also mastered the practical skills [18]. The proposed teaching reform method is validated through empirical analysis.

At the same time, Li, L et al. integrated the interdisciplinary teaching method into the reform of teaching basic knowledge of architectural design for environmental design majors through a variety

of steps in order to achieve the teaching goal of providing the best platform for every environmental design professional to pursue excellence in the field, so that he or she can fully develop their own potential, and achieve great success in the future workplace [19]. Tao,Z et al. proposed a multi-scale, interdisciplinary studio teaching mode and applied it in the teaching of landscape design majors, which showed the effectiveness of the mode through experiments, it can improve students' sense of experience of the professional design process, and it has a certain practical value [20]. Carlsson, M.K et al. investigated two landscape design environmental simulation models for interdisciplinary educational experiments in environmental design and found that both models can be used in the field of landscape design to more comprehensively and accurately take into account the factors, to visualize and present the complex interactions between nature and human activities, and to effectively guide the planning decision-making process [21].

Interior design and environmental design are highly practical specialties that require students to have certain design practice abilities. However, classroom practice teaching is often a virtual subject, detached from the development needs of society. This paper takes the STEAM teaching theory as a guide, combs through the advantageous performance of interdisciplinary integration teaching in the development of discipline teaching, and analyzes the curriculum characteristics of interior design and environmental design, and establishes the teaching mode of interior ecological design based on the theory of interdisciplinary integration teaching. Taking interior design students of a university as a research sample, an evaluation index system was established from the four dimensions of students' professional ethics, professional body and mind, professional skills, and professional behaviors, and the weights of the evaluation indexes were solved by using the rough set method and combined with the fuzzy comprehensive evaluation to implement the thorough assessment of teaching quality. Comparative teaching experiments were also conducted to analyze the applicability of interdisciplinary, integrated education to teaching interior design and environmental design.

2   Construction of interdisciplinary integration teaching mode of interior environmental design

Science and technology, talent, and innovation are the keywords for the development of today's era, as well as the keywords for deepening reform in the field of education. Those disciplines with robust applications must embrace innovative thinking to cultivate high-quality and comprehensive talents. Interior design and environmental design courses are an extensive and strong emerging discipline from the perspective of developing modern information technology, optimizing human habitat environment, and improving individual aesthetics. How to cultivate a group of composite talents with humanistic feelings through innovative interdisciplinary fusion teaching is the focus of disciplinary construction, but also an inevitable path for colleges and universities to practice the innovation-driven development strategy.

2.1   Framework for integrated interdisciplinary teaching and learning

2.1.1   Theories of STEAM education

STEAM education is based on the social development of the demand for diversified and composite talents and has experienced several stages of development of STS → STEM → STEAM, which is a connotation-rich education system in the field of interdisciplinary research [22]. The framework of STEAM education is shown in Figure 1, which is mostly based on the teaching center of a specific project or problem and designing the teaching and learning situation, linking the five major disciplines of science, technology, engineering, art, and mathematics, Arts, and Mathematics to promote students' cognitive development, critical thinking and problem-solving skills. It also enhances the fun of

education, provides students with a richer emotional experience, and achieves the ultimate goal of leading the world with innovation by cultivating high-quality talents in the era of knowledge economy.
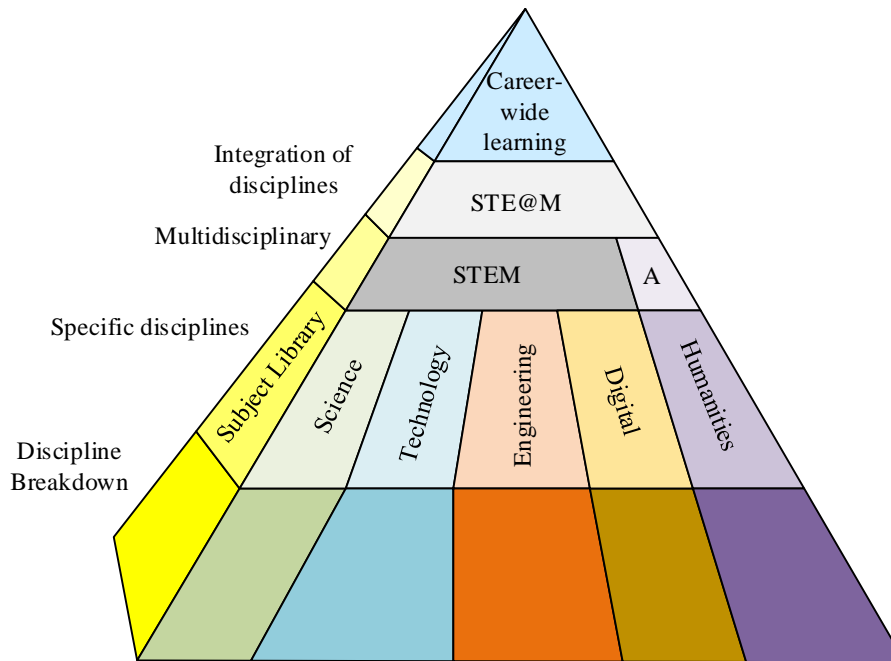

Figure 1. STEAM's education framework

STEAM education essentially follows the idea of cross-fertilization of disciplines, encouraging students to solve real-world problems through open-ended explorations and develop solutions through the engineering design process to cultivate well-rounded composite innovators. Most STEAM education starts from reality and is based on problem-oriented or project-oriented inquiry.STEAM education attaches great importance to the learning process of students' hands-on participation in practice and inquiry. It guides students to integrate and apply multidisciplinary knowledge in the activity experience. STEAM education attaches great importance to students' hands-on practice and exploration in the learning process and guides them to integrate and utilize multidisciplinary knowledge in the activity experience.

2.1.2   Advantages of interdisciplinary integration of teaching and learning

Interdisciplinary, integrated education is an educational model that integrates theoretical knowledge and practical skills from different disciplines by crossing traditional disciplines to solve complex practical problems. The core of this educational model is to promote the integration of knowledge between various disciplines, through which students' comprehensive quality, innovation, and problem-solving abilities can be cultivated. Distinguishing features of interdisciplinary education include multi-dimensional knowledge integration, a problem-centered approach to learning, an emphasis on active student learning and participation, and the promotion of critical and innovative thinking. The learning approach of interdisciplinary and integrative education enables students to more readily identify opportunities for innovation, develop creative thinking, and improve their overall quality. The performance in question is as follows:

1) Empowering students for future growth. Project-based learning is the foundation of interdisciplinary, integrated education, enabling students to visualize and bring abstract knowledge to life, making it more relevant to their daily lives. Students' ability to apply what they have learned is a skill that can be exercised, and their sense of identity with their

disciplines can be further enhanced. It enhances students' critical ability to think in a three-dimensional and multi-angle way, cope with comprehensive and complex problems, and improve the quality of their thinking through the experience of significant themes.

2) Speed up professional growth for teachers. The deeper a teacher researches in interdisciplinary education, the higher the level of their comprehensive quality, and the more problem-solving methods and strategies they may have when dealing with teaching problems in reality. To realize the empowerment of education and accelerate their professional growth.

2.2   Indoor Environment Course Teaching Model

2.2.1   Characteristics of interior environmental design courses

The teaching link of interior design and environmental design, in order to deeply promote the improvement of the teaching level, it is necessary for teachers to study the characteristics of the curriculum of interior design and environmental design, so that they can study the hidden dangers of the curriculum and deeply promote the level of design teaching [23]. At the present stage, the teaching of interior design and environmental design is mainly divided into three categories: drawing foundation class, interior program design class, and engineering technology class.

The first is the design of introductory drawing courses; the basic courses include modeling foundation, color foundation, perspective, and computer effect software drawing, which mainly cultivates students' interior design performance skills.

Secondly, there is the interior design course; in addition to mastering the basic process and steps of interior design, students must combine the human body needs, style changes space division, and other areas of knowledge. In addition to the fact that interior design is designed to enhance comfort and convenience, interior design students also need to communicate with clients to meet residents' needs.

The engineering and technology courses are both technically and practically demanding. Therefore, students need to base the field survey as the basis to practice as a way to realize the mastery of the technology and based on the real needs of the design of construction drawings to achieve the combination of theory and practice.

2.2.2   Teaching process of interior environmental design

To realize the interdisciplinary integration education of interior design and environmental design courses, this paper introduces the STEAM education theory to establish the multidisciplinary integration teaching model of interior design and ecological design courses as shown in Figure 2. It is mainly carried out in six steps: asking meaningful questions, creating problem situations, creating collaborative inquiry, designing works, presenting results, and conducting interactive evaluations.
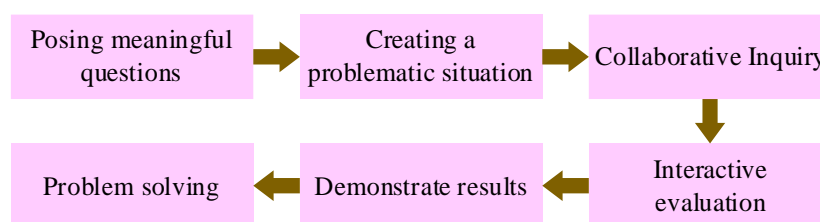
Figure 2. Based on STEAM's interior design interdisciplinary fusion mode

The instructional design program considers a meaningful, challenging, authentic, and creative problem that builds on the instructional objectives already identified during pre-preparation. The problem situation is then tailored to fit the project so that students can begin their initial understanding of the new project within the context of the problem discussion. In the teamwork environment for collaborative inquiry, in the project content, in-depth inquiry gradually conceptualized ideas about the work, and in the solution of the problem set at the same time to work together to design works, and ultimately through different forms of expression to show the results of the sharing and exchange. Teachers should do an excellent job of controlling the whole project process, including the progress, the direction of students' thinking, the classroom atmosphere, and the duration of each stage. Evaluation of students' work should be carried out by the students themselves and among themselves, which can not only help students to have a new understanding of their work but also further a deeper understanding of what they have learned.

3   Design and Evaluation of Interdisciplinary Integrated Teaching and Learning in Interior Environmental Design

Interior design and environmental design are not purely appreciative art categories. They are a practical art category that involves environmental planning and designing indoors and outdoors through artistic design. The course is always associated with practical skills and closely related to engineering technology, aesthetic and artistic functions, and art and technology characteristics. Therefore, the interior design and environmental design course is efficient. In the face of such a situation, meeting the diversified needs of the current economic and social development and comprehensively improving the design practice ability of students is the core and urgent task of interior design and professional education in the current and future.

3.1   Research on the teaching of interior environmental design

3.1.1   Selection of research subjects

With the effectiveness of the interdisciplinary integration teaching mode of interior design and environmental design courses as the research objective, this study selected 80 students majoring in interior design and environmental design at a university as the research subjects. The 80 students were randomly categorized into class A and class B on average, in which class A used the interdisciplinary integration teaching mode designed in this paper based on the theory of STEAM education to teach the interior design and environmental design course. In contrast, class B chose the traditional design course teaching mode to carry out the learning.

At the beginning of the teaching experiment, students in the two classes were tested on the dimensions of core literacy and comprehensive achievement of the interior design and environmental design course before the teaching experiment. At the end of the teaching experiment from March 2023 to July 2023, students in the two classes were tested after the teaching experiment. This way, the effectiveness of this paper's interdisciplinary integration teaching model is verified in interior design and environmental design courses.

3.1.2   Questionnaire design

The questionnaire was initially designed by reading a large amount of literature and analyzing it in the context of what was being studied. The questionnaire was improved through the preliminary review by the instructors, and suggestions for improvement were made. Finally, the questionnaire was tested for reliability and validity. The indicators in the questionnaire were analyzed in

combination with the opinions of the expert teachers. The questionnaire was modified according to the opinions of the expert teachers until the questionnaire was perfected. Then the students in the two classes were visited and recorded according to the survey needs of this paper.

The content of the questionnaire designed in this paper mainly focuses on the core literacy of students' interior design and environmental design courses, which mainly includes the dimensions of vocational ethics, vocational mind and body, vocational skills, and vocational behavior, and the five-point scoring method is used to quantify the data. 80 questionnaires were distributed, 80 were successfully recovered, and the questionnaire data was primarily processed by SPSS software using mathematical statistics.

3.2   Evaluation of the teaching of interior environmental design

3.2.1   Teaching quality evaluation system

Interior design and environmental design courses are comprehensive and strong professions involving multiple subject areas such as architectural construction, engineering drawing, design aesthetics, ergonomics, environmental psychology, etc. Its design courses include home space design, commercial space design, program fast-track design, public space design, thematic design, etc., and mastering good design ability is an internalization process. Therefore, by sorting out several aspects such as evaluation concept, evaluation means, and evaluation objectives, constructing a scientific, reasonable and effective evaluation system is necessary to promote the high-level and high-quality development of vocational education in interior design and environmental design courses.

In the interdisciplinary integration teaching mode of interior environmental design based on the support of STEAM teaching theory, this paper establishes the teaching quality evaluation index system of this teaching mode as shown in Table 1, whose main contents include students' professional ethics, professional body and mind, professional skills and professional behavior.

Table 1. Environmental design teaching evaluation system

Dimension	Observation point	Code
Vocational ethics	Cross-cultural thinking	O1
	Political literacy	O2
	Moral quality	O3
	Career ideal	O4
Vocational and physical mind	Physical quality	P1
	Adaptive ability	P2
	Will power	P3
	Gumption	P4
Vocational skill	Professional knowledge	Q1
	Professional skill	Q2
	Vocational qualification	Q3
	Ability to express innovation	Q4
Vocational behavior	Professional image	R1
	Team spirit	R2
	Communication skills	R3
	Organizational ability	R4

The evaluation system can be reasonably scientific and practical, and it can provide all-around evaluations of students' learning effectiveness and promote the development of students' vocational literacy. Utilizing information technology, combining quantitative evaluation, descriptive evaluation, qualitative analysis evaluation and other evaluation methods, the evaluation system is carried out throughout the whole process of teaching before, during, and after class, forming a teaching evaluation system of "evaluation-diagnosis-adjustment-guidance-re-evaluation-diagnosis-adjustment-guidance." At the same time, with the teaching evaluation system of students' comprehensive development and interdisciplinary integration and development, we have established a learner-centered "balance-imbalance-new balance" learning mobility mode, formed a benign and feasible cyclic learning method and lifelong learning mindset, and realized the comprehensive development of student's physical and mental qualities.

3.2.2 Comprehensive evaluation model for teaching and learning

1) Determination of teaching quality evaluation index weights

The rough set method is an objective assignment method that derives the intrinsic connection between attribute indicators through the analysis of objective data without any a priori knowledge, and the classification idea and attribute approximation are its two main elements. The method is mainly based on defining indicator importance from different perspectives, and the attribute weights are derived based on the importance.

The basic idea of determining weights based on the importance of positive domains is that each condition attribute plays a different role in the comprehensive judgment, i.e., their importance is different [24]. Then, rough set theory is used to categorize the object by considering all the attributes comprehensively to calculate the attribute weights. Then, after removing one attribute, the object is categorized again. The degree of change in the categorization after removing each attribute is compared to the categorization without removing the attribute. The attribute weights are determined according to the importance of the attribute and are proportional to the degree of change.

Definition 1 A quaternion $S = (U, A, V, f)$ is said to be a knowledge representation system. Where U is a non-empty finite set of objects, called an argument domain. A is a non-empty finite set of attributes, $A = C \cup D$, $C \cap D = \varnothing$, $D \neq \varnothing$, C is called the set of conditional attributes, and D is called the set of decision attributes. $V = \bigcup_{a \in A} V_a$, V_a is the value domain of attribute a, $f : U \times A \to V$ is an information function that assigns an information value to each attribute of each object, i.e., $\forall a \in A$, $x \in U$, $f(x, a) \in V_a$. A knowledge expression system is also known as an information system, and is often replaced by $S = (U, A)$. $S = (U, A, V, f)$ Given a knowledge expression system $S = (U, A)$, for each subset there are:

$$\underline{R}X = \bigcup \{Y_i \in U/A | Y_i \subseteq X\} \tag{1}$$

$$\overline{R}X = \bigcup \{Y_i \in U/A | Y_i \cap X \neq \varnothing\} \tag{2}$$

Call them lower and upper approximations of X, respectively.

Definition 2 In a knowledge representation system $S = (U, R, V, f)$, the indistinguishable relation for each subset of attributes $B \subseteq R, B$ is defined as:

$$ind(B) = \{(x, y) \in U^2 : \forall a \in A, f(x, a) = f(y, a)\} \tag{3}$$

And $[x]_{ind(B)} = \underset{R \in B}{\cap}[x]_R \cdot U/ind(B)$ denotes all equivalence classes classified by equivalence relation $ind(B)$.

Definition 3 For any subset $P \subseteq R$ of attributes, if there exist Q independently, $Q \subseteq P$, and $ind(Q) = ind(P)$, then Q is said to be a simplicialization of P, denoted by $red(P)$.

Definition 4 In a knowledge system S, let P and Q be equivalence relations in U, and the P-positive domain of Q is denoted by $pos_P(Q)$, i.e:

$$pos_P(Q) = \underset{X \in V/Q}{\cup} PX \tag{4}$$

Where $\underline{pX}$ is the P lower approximation of X, and the P positive domain of Q is the set of all objects in U which can be accurately classified into the equivalence class of the relation Q based on the information of the classification U/P.

Definition 5 Given a knowledge base system $S = (U, R)$ and P, $Q \subseteq R$, when $ind(P) \subseteq ind(Q)$, knowledge P is said to be dependent on knowledge Q and the dependence of knowledge Q on P is defined as:

$$r_p(Q) = card(pos_p(Q))/card(U) \tag{5}$$

Where $card$ denotes the base of the set and $pos_p(Q)$ denotes the positive region of set P in $U/ind(Q)$.

Definition 6 When C and D are conditional and decision attribute sets, respectively, the importance of attribute subset $C' \subseteq C$ with respect to D is defined as:

$$\sigma_{CD}(C') = r_C(D) - r_{C-C'}(D) \tag{6}$$

In particular, when $C' = \{a\}$, the importance of property $a \in C$ with respect to D is:

$$\sigma_{CD}(a) = r_C(D) - r_{C-\{a\}}(D) \tag{7}$$

The objective weight of attribute $a \in C$ with respect to D is defined as:

$$w_a = \frac{\sigma_{CD}(a)}{\sum\limits_{x \in C} \sigma_{CD}(x)} \tag{8}$$

2)   Comprehensive evaluation model of teaching quality

Fuzzy comprehensive evaluation (FCE) method is a comprehensive evaluation method based on the principles of fuzzy mathematics, which is one of the most basic mathematical methods in fuzzy mathematics [25]. It is based on the affiliation theory of fuzzy mathematics, and considers and analyzes each index factor, and transforms the qualitative evaluation into the process of quantitative evaluation. The general steps for implementing the fuzzy comprehensive evaluation method are as follows:

Step1 Determine the factor set of the evaluation object. Let $U = \{u_1, u_2, ..., u_s\}$ be the s evaluation factors (evaluation indicators) that characterize the evaluated object. Where s denotes the first evaluation factor.

Step2 Determine the weight vector of evaluation factors. The methods for determining the weight vector of evaluation factors include judgment matrix analysis, frequency statistics method, and expert estimation method, which is adopted in this paper. The fuzzy weight vector can be expressed as:

$$W_i = (w_{i1}, w_{i2}, \cdots, w_{in})(i = 1, 2 \cdots, n) \tag{9}$$

Step3 Determine the set of rubrics for the subject of evaluation. Let $V = \{v_1, v_2, \cdots, v_j\}$ be the set of evaluation ratings consisting of various total evaluation results that the evaluator may make on the subject of evaluation. Where v_j represents the j rd evaluation result, and $j = 1, 2, \cdots, j$, j are the total number of evaluation results.

Step4 Conduct single-factor fuzzy evaluation and establish the fuzzy relationship matrix. Determine the degree of affiliation of a single factor to the fuzzy subset of each rating of the evaluated object, and then form a fuzzy relationship matrix as:

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} & \cdots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & r_{m3} & \cdots & r_{mn} \end{pmatrix} \tag{10}$$

Step5 Multi-indicator comprehensive evaluation. Synthesize the fuzzy weight vector W with the fuzzy relationship matrix R to get the fuzzy comprehensive evaluation result vector B of each evaluated object, then the model of fuzzy comprehensive evaluation is:

$$B = W \cdot R$$
$$= (w_1, w_2, w_3 \ldots w_m) \cdot \begin{pmatrix} r_{11} & r_{12} & r_{13} & \cdots & r_{1n} \\ r_{21} & r_{22} & r_{23} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & r_{m3} & \cdots & r_{mn} \end{pmatrix} \tag{11}$$
$$= (b_1, b_2, b_3 \ldots b_m)$$

Where b_j indicates the degree of affiliation of the rated object to the fuzzy subset element v_j of the evaluation level at the overall level.

Step6 Analyze the fuzzy comprehensive evaluation results. The result of fuzzy comprehensive evaluation is the degree of affiliation of the rated object to the fuzzy subset of each grade, which is generally presented in the formation of a fuzzy vector, and the information contained in the fuzzy vector is richer and more three-dimensional than the point value, and the space that can be explored is more extensive.

The grades are considered to be a relative position that makes them continuous. To quantitatively deal with it, the grades are quantized by combining the set of rubrics and determining the rank of each grade. The rank of each grade is weighted and summed with the corresponding component in B to obtain the relative position of the evaluated object, which is expressed as follows:

$$P = B \times V^T = (b_1, b_2, b_3 \ldots b_m) \times (V_1, V_2, V_3, V_4, V_5)^T \tag{12}$$

4 Empirical analysis of interdisciplinary integration teaching of interior environmental design

Under the demand of the transformation and development of higher education, how to integrate the concept of multidisciplinary integration into the whole process of cultivating talents of interior design and environmental design majors in colleges and universities is the key issue facing the current professional transformation and development. Given the problems of talent cultivation in the design courses of interior design and environmental design majors in colleges and universities, the interdisciplinary fusion teaching mode is established based on STEAM teaching theory, which organically integrates the design course teaching and practice and then realizes the goal of cultivating high-quality design talents.

4.1 Effectiveness of interdisciplinary integration teaching model

4.1.1 Comparison of Student Achievement in Core Literacy

Class A and Class B students were given a pre-measurement survey before the teaching practice was conducted. Students from classes A and B conducted the survey. The questionnaire contained four different dimensions. The questionnaire contained four different dimensions with four questions under each dimension and was scored out of 40. The data from the questionnaire was collected and entered into SPSS software to analyze the difference between the data of students in class A and class B through an independent samples t-test. Table 2 shows the students' pre-test scores in classes A and B. The p-values in the table show the fixed class, the importance of Class A and Class B for the students' core literacy, quantitative and different dimensions, and Cohen's d-value shows the influence size.

The p-values for each item in the table are greater than 0.05, all of which show consistency, and Cohen's d-values are less than 0.15, indicating a small effect size. Before the beginning of the teaching practice, the pre-test mean values of the students' core literacy scores in Class A and Class B were 105.13±2.64 and 105.22±2.59, respectively, and there was not much difference between the mean values of the two classes. This indicates that the difference in overall competence between the two classes was not significant before the beginning of teaching practice. Comparing the performance of class A and class B on each dimension, it was found that the difference between the means of the two classes was not significant in terms of work ethic, work mind and body, work skills, and work behavioral literacy, which indicates that there was no significant difference between the students of

the two classes in these areas at the time of the pre-test. Then the conditions of the study for the beginning of the quasi-experiment were fulfilled.

Table 2. The student pre-test record between A and B class

Class	O1~O4	P1~P4	Q1~Q4	R1~R4	Total
A	25.14±2.77	26.37±3.15	24.95±2.81	28.67±2.96	105.13±2.64
B	25.18±2.65	26.41±2.98	24.91±2.87	28.72±2.84	105.22±2.59
T	0.571	0.148	0.279	0.357	0.262
P	0.689	0.873	0.852	0.838	0.864
S2pooled	15.134	15.627	15.379	15.461	90.515
Cohen's d	0.102	0.115	0.123	0.083	0.094

Class A and B students received a second measurement at the end of the teaching practice. The results of the independent sample t-test were analyzed. Class A and Class B data were analyzed for differences by independent samples t-test. The results of the independent samples t-test for the core literacy achievement of students in Class A and Class B are shown in Table 3. The p-values of the items in the table are less than $p<0.01$, all showing significant differences, and Cohen's d-values are all greater than 0.5, with a large effect size. Analyzing the posttest data of the core literacy scores of the students in Class A and Class B, it can be seen that the mean values of the posttests of Class A and Class B were 138.33±2.94 and 111.11±3.25 respectively, and the mean value of the posttest scores of the core literacy scores of the students in Class A in the Interior and Environmental Design course was higher than that of Class B by 27.22, which indicates that the overall posttest scores of Class A were significantly higher than those of Class B as a whole. This also shows that after utilizing the interdisciplinary integration teaching mode, compared with the core literacy scores of students in class B, students in class A had significant improvement in professional ethics, professional body and mind, professional skills, and professional behavioral literacy, which verifies the effectiveness of the interdisciplinary integration teaching mode in promoting the effectiveness of the teaching effect of interior design and environmental design.

Table 3. The student posttest record between A and B class

Class	O1~O4	P1~P4	Q1~Q4	R1~R4	Total
A	34.53±3.72	34.37±4.01	33.47±3.18	35.96±3.65	138.33±2.94
B	26.79±4.53	27.98±4.37	26.82±4.41	29.52±4.28	111.11±3.25
Difference	7.74	6.39	6.65	6.44	27.22
T	3.147	2.986	3.023	3.248	3.476
P	0.009***	0.001***	0.005***	0.003***	0.000***
S2pooled	25.128	22.343	21.935	23.572	66.419
Cohen's d	0.538	0.521	0.569	0.624	0.738

4.1.2 Interactive evaluation of environmental design works

The interdisciplinary integration teaching model based on STEAM education theory implements interactive evaluation for interior design and environmental design courses. At the end of the teaching experiment, an interactive subjective assessment was conducted for the students' interior and ecological design works.

This study takes the form of sampling evaluation; each randomly selected 30 students from A and B classes to evaluate each other on 30 interior design and environmental design works submitted by the class, and the scoring standards are set concerning the reference evaluation table of interior environmental design works in the textbook. The results are shown in Figure 3.

As can be seen from the figure, the scores of classes A and B are evaluated against each other. In the first rating of 80~100 points "excellent," there are 17 people in class A and five people in class B, and the number of people in class A in the first rating is significantly more than that of class B, accounting for 56.67% of the total number of people in class A. In the second rating of 60~80 points, "good," there are ten people in class A and 14 people in class B, and it is not difficult to see that the number of people in class A in the first and second ratings of "excellent" and "good" accounts for 90%, while the proportion of class B is only 63.33%. In the third rating of "fair" below 60, there are 3 in class A and 11 in class B. It can be seen that the evaluation scores of Class A students based on the interdisciplinary, integrated teaching mode of interior design and environmental design courses under STEAM education theory tend to be excellent and good.

Compared to Class B, the number of students in Class A with high scores above 80 is relatively more concentrated, and the distribution of the overall number of students is also more scientific and reasonable. On the one hand, this reflects the value of innovation and diversity of independent learning brought by the interdisciplinary integration teaching mode project for students. At the same time, students, as individualized learning subjects, have a positive role in enhancing individual cognitive ability, promoting knowledge innovation and learning initiative through the interdisciplinary integration teaching mode.
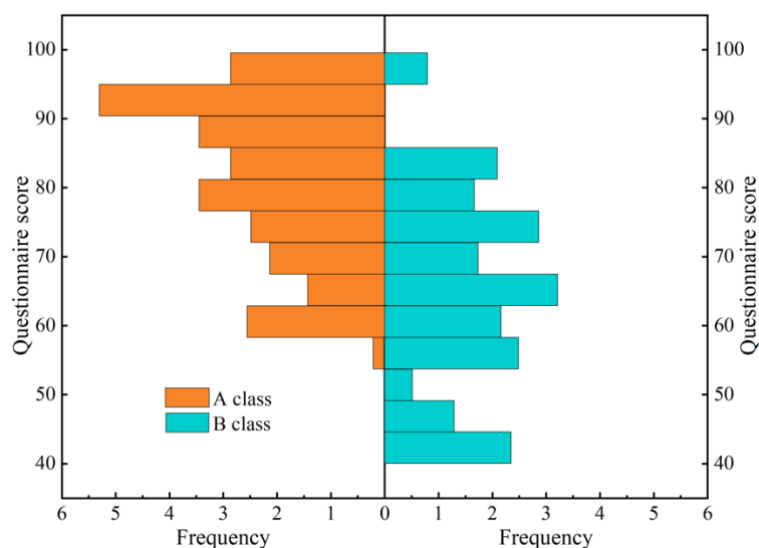

Figure 3. Statistics of mutual evaluation scores of works

4.2   Evaluation of the quality of interdisciplinary integration teaching

4.2.1   Determination of evaluation indicator weights

Using SPSS software to calculate the weights of the evaluation index system, combined with the previous method of determining the weights of the evaluation indexes based on the importance of the positive domain, the collected data will be defined as a subset of attributes, and the dependence of different indicators will be solved, to get the objective weights of other indicators on the

interdisciplinary fusion teaching model. Figure 4 shows the distribution of weights for evaluation indicators of the quality of multidisciplinary integration teaching, as shown in Figure 4.

The weights of the four dimensions of the teaching quality evaluation indicators of the interdisciplinary fusion teaching mode are 0.2422, 0.2395, 0.2781, and 0.2382, respectively, in which the students' vocational skills literacy has the largest proportion of weight in the teaching quality. In the evaluation of the interdisciplinary integration teaching quality of interior design and environmental design courses, special attention should be paid to the student's vocational skills and literacy in the teaching process. The quality of interdisciplinary integration teaching should not be determined by the final examination but evaluated using multi-dimensional, multi-stage, and diversified assessment methods. The multidisciplinary integration teaching mode can effectively enhance the students' professional ethics, professional body and mind, and professional behavior quality and help the high-quality development of interior design and environmental design courses. Among the indicators of observation points, the weights of intercultural thinking (O1), professional skills (Q2), and professional knowledge (Q1) ranked in the top three, with weights of 7.52%, 7.48%, and 7.25%, respectively. This reflects that the interdisciplinary integration teaching mode helps to enhance students' interdisciplinary cultural thinking, enable students to comprehensively apply the fundamental theories, basic knowledge, and basic skills learned in educational and teaching activities, exercise students' teaching and organizing skills, and test students' mastery of knowledge and skills.
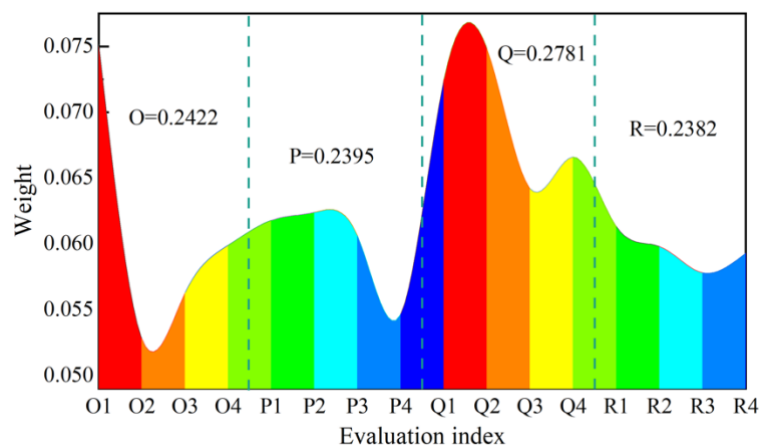

Figure 4. The evaluation index weight distribution of teaching quality

4.2.2 Comprehensive evaluation of teaching quality

In this paper, we obtain the data on the teaching quality of interdisciplinary integration of interior design and environmental design through the questionnaire designed based on the evaluation index system in the previous section and utilize the evaluation steps of the fuzzy comprehensive evaluation method for the construction of the evaluation factor set. The results of the evaluation subject's evaluation of the indicators are taken as a comment set, and the comment set is denoted by $V = \{V_1, V_2, V_3, V_4, V_5\}$, with $V_1 \sim V_5$ denoting complete non-conformity, less conformity, average, more conformity, and complete conformity. Starting from the individual factors among the factor sets at the indicator level, the evaluation is carried out, and the fuzzy comprehensive evaluation set of the cultivation objectives is processed by assigning a value of 9, 8, 7, 6 and 5 points, and the comprehensive evaluation value is calculated.

Based on the four fuzzy evaluation relationship matrices of professional ethics, professional body and mind, professional skills, and professional behavior in the interdisciplinary fusion teaching quality

evaluation index system, combined with the weight vectors derived in the previous section, the weighted average type multiplicative-bounded operator is selected to calculate the comprehensive evaluation value. That is:

$$
\begin{aligned}
B &= W \times R \\
&= [0.2422 \quad 0.2395 \quad 0.2781 \quad 0.2382] \\
&\times \begin{bmatrix} 0.3668 & 0.4314 & 0.2396 & 0.0951 & 0 \\ 0.4251 & 0.6596 & 0.2274 & 0.1482 & 0 \\ 0.2449 & 0.2662 & 0.1953 & 0.0818 & 0 \\ 0.2724 & 0.3085 & 0.1462 & 0.0563 & 0 \end{bmatrix} \\
&= [0.3236 \quad 0.4108 \quad 0.2021 \quad 0.0949 \quad 0]
\end{aligned}
\tag{13}
$$

The fuzzy comprehensive evaluation vector is normalized to obtain the teaching quality evaluation result set for the interdisciplinary integration teaching mode. According to the principle of maximum affiliation, it can be seen that the teaching quality evaluation results for "more in line with" results accounted for the largest proportion of 0.4108, so the final result is "more in line with". Combined with the quantitative grading of the set of comments on teaching quality in the previous section, combined with formula $P = B \times V^T$, can be obtained:

$$
\begin{aligned}
P &= B \times V^T \\
&= [0.3236, 0.4108, 0.2021, 0.0949, 0] * \begin{bmatrix} 9 \\ 8 \\ 7 \\ 6 \\ 5 \end{bmatrix} \\
&= \{0.3236*9 + 0.4108*8 + 0.2021*7 + 0.0949*6\} \\
&\approx 8.183
\end{aligned}
\tag{14}
$$

Combined with the results of the fuzzy comprehensive evaluation, it can be seen that the comprehensive evaluation score of the interdisciplinary integration teaching quality of the interior design and environmental design course in this university is 8.183, combined with the set of rubrics can be seen to be at a more consistent level, which is consistent with the results obtained by the principle of maximum affiliation.

In summary, it can be seen that the interdisciplinary fusion teaching mode can effectively enhance the student's grasp of the interior environmental design course, promote the improvement of students' vocational skills and literacy, and also provide a reference for the innovation of the teaching mode of the interior design and environmental design course in colleges and universities, and help the quality of the training of interior environmental design talents to meet the social needs more.

5   Conclusion

Based on STEAM teaching theory, the article establishes an interdisciplinary integration teaching model for interior design and environmental design courses. It takes interior design and ecological design majors of a university as the research object and analyzes the data through teaching comparison tests.

1) The posttest mean values of core literacy of students in class A and class B are 138.33±2.94 and 111.11±3.25 respectively, and the posttest mean value of core literacy of students in class A is 27.22 points higher than that in class B. The mean value of core literacy of students in class A is 27.22 points higher than in class B in the posttest. Overall, the core literacy scores of students in Class A were more concentrated and distributed more reasonably above 80 points after using the interdisciplinary integration teaching mode.

2) In the teaching quality evaluation index system of interdisciplinary integration teaching mode, the weight of students' vocational skills literacy is the largest at 27.81%, and the difference in the proportion of vocational physical, mental, and behavioral literacy is only 0.13%. The comprehensive evaluation score of interdisciplinary integration teaching quality is 8.183, and the evaluation result is "more in line." The multidisciplinary integration teaching mode can enhance students' vocational skills mastery ability and improve the teaching quality of college interior design and environmental design courses to meet better the social demand for interior design and ecological design talents.

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