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Application of Double Diamond Model in Design Courses from the Perspective of Industry-Education Integration

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Abstract: *With the increasing emphasis on interdisciplinary capabilities, practice orientation and user experience in design education, the existing traditional teaching model based on "results orientation" has obvious deficiencies in terms of logical systematization, service awareness cultivation and thinking transfer ability. To this end, this paper introduces the "Double Diamond Model" design thinking method, combines the teaching needs under the background of industry-education integration, and constructs a "user-centered" four-stage teaching path (discovery-definition-development-delivery) to strengthen students' perception of real problems and the construction of logical structures, and design solution capabilities from a service perspective. In the actual teaching implementation, through group research tasks, stage prototype conception, service path map construction, reflection log writing and other methods, students' problem identification ability, solution construction ability and expression feedback ability are comprehensively improved. The qualitative research results show that through open coding and theme induction of students' reflection logs, it can be clearly observed that in the design learning process supported by the Double Diamond Model, the cognitive focus of students gradually shifts from "completing tasks" to "understanding processes" and "optimizing logic". Among the four core reflection themes, "user-centered" ranks first with 38 occurrences, and the keywords are concentrated on "needs, behavior, and experience", reflecting that students have widely realized that the starting point of design should be rooted in user reality rather than subjective assumptions.*

Keywords: *Industry-Education Integration Design Education; Double Diamond Model; Qualitative Research; User-Centered; Reconstruction of Teaching Process*

1. Introduction

As higher education reform continues to deepen, "industry-education integration" has become an important path to promote the connection between professional courses and industry needs and realize the cultivation of compound talents. In design majors, how to effectively introduce real scenes, service awareness and multidisciplinary perspectives into the classroom has become the core issue of current teaching reform. Traditional design courses are mostly result-oriented, focusing on form and neglecting process. Students often directly enter the conception of solutions without user understanding and problem insight, resulting in weak design logic and insufficient service value, which makes it difficult to adapt to the current society's urgent need for "people-oriented, problem-solving" design talents.

In this context, the Double Diamond model, as a design thinking method that emphasizes the dynamic cycle of "divergence-focus", provides a clear path for course structure optimization and teaching content reconstruction. Through the four-stage logic of "discovery, definition, development, and delivery", the model guides learners to be user-centered from problem exploration to solution implementation, emphasizing the cultivation of process cognition and reflection ability, which is highly consistent with the essence of "serving people" in design education.

In response to the current problems of fragmentation, weak logic, and target deviation in design teaching, this paper takes the double diamond model as the core teaching framework to explore its systematic application mechanism from the perspective of industry-education integration. Through teaching design practice and qualitative research methods, the role transformation and cognitive evolution of teachers and students in the teaching process are analyzed, aiming to build a teaching model with operability and transferability, and provide theoretical support and practical reference for

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promoting design education reform with user orientation, service value and thinking ability as the core.

2. Related Works

In recent years, educational concepts such as artificial intelligence, gamification learning, design thinking and industry-education integration have been continuously deepened around the world. Many scholars have explored the application practice and development trend of emerging technologies and teaching models in basic education, higher education and vocational education from different dimensions. The following is a review of related research.

Williams et al. introduced three AI (Artificial Intelligence) literacy courses for junior high school students, emphasizing active learning, embedded ethics, and low-threshold design. The courses combine online workshops with hands-on practice and programming activities to enable students to understand AI technology and social impact, and summarize the experience and suggestions of AI teaching in the K-12 stage [1]. Dahalan et al. analyzed the research trends of gamification and game-based learning in the field of Vocational Education and Training (VET) through a systematic literature review. The results showed that since 2020, the research enthusiasm in Asia has increased, especially in the fields of engineering and medicine [2]. Hwang and Chang explored the trend of chatbot research in the field of education by analyzing SSCI (Social Sciences Citation Index) journal articles. The United States, Taiwan, China and Hong Kong, China are the main research areas. Most of them use quantitative methods, and statistical analyses such as ANCOVA (Analysis of Covariance) are commonly used [3]. Guaman-Quintanilla et al., based on constructivist learning theory, examined the effect of design thinking on improving college students' problem solving and creativity. 910 students participated in the course, and the three stages were scored by self-evaluation, peers, and teachers. The results showed that design thinking significantly improved students' abilities, especially in the early stages, which supported its promotion and application in higher education [4]. Syarnubi et al. explored the curriculum design of Islamic religious education based on cultural concepts. Character education was implemented through classroom teaching to promote the development of students' moral cognition, emotions and behaviors, and to achieve the comprehensive shaping of graduates' character [5]. Boud and Dawson proposed a teacher feedback literacy framework through interviews and analysis of 62 Australian university teachers, clarifying the key abilities of teachers with different responsibilities in designing and implementing effective feedback, and emphasizing the importance of improving teachers' feedback ability for professional development [6]. Kim et al. explored the application of ChatGPT as a second language learning tool, and designed and taught business English writing courses based on task-based language teaching. The study showed that ChatGPT had the potential to assist language learning, but it still needed to be improved, and its effectiveness in diversified teaching should be further verified in the future [7]. Johnson et al. systematically reviewed the current status of online teaching in K-12 in the United States, emphasizing that the key conditions to support student learning include teacher preparation, technical support, student development needs and self-regulation ability [8]. Särmäkari explored the phenomenon of digital fashion and, through case studies of two pioneering companies, revealed how digital 3D design reshapes fashion design culture and designer identity. As an emerging subfield, digital fashion, relying on technology and professional pride, promotes the transformation of designers into digital craftsmen, blurring the professional and material boundaries of traditional designers [9]. Rakhimovna analyzed the degree of curriculum integration in dual-education programs and proposed five types, from parallel to comprehensive integration, revealing the diversity of existing integration methods and problems in policy implementation [10]. Wen et al. analyzed the opinions of students, teachers, managers and corporate executives on the sustainable development of industry-education integration in higher vocational colleges in Guangdong Province and found that there are deficiencies in policy support, talent training, capital investment and practical ability [11]. Although existing research has achieved certain results in the innovation of educational technology and teaching models, there are still problems such as fragmented application scenarios, inconsistent evaluation systems and difficulty in cross-cultural promotion.

3. Methods

3.1 Structure of the Double Diamond Model and Its Teaching Value

The Double Diamond model clearly divides the design process into four stages: "Discover - Define - Develop - Deliver", reflecting two continuous cycle structures of divergence and convergence. This

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model not only emphasizes exploring opportunities from problems, identifying needs, proposing solutions, and feedback verification, but also emphasizes the value orientation of "user-centered". This concept is highly consistent with the fundamental purpose of "serving people" in majors such as space design and art design.

Introducing the Double Diamond model in teaching helps to break the tendency of over-emphasizing results and ignoring processes in traditional design teaching, guide students to think about problems systematically from the user's perspective, and improve overall logic and creativity.

3.2 Reconstruction of Teaching Logic: Course Organization Oriented Towards "Space + Service"

Based on the trend of industry-education integration, design education is shifting from "work-oriented" to "user demand-oriented". Under this framework, the Double Diamond model is not only a teaching method, but also a reconstruction mechanism of teaching logic. Teaching design can focus on the integrated perspective of "space + service" to transform students' design tasks from satisfying formal beauty to solving real service needs.

At the beginning of the course, teachers should clearly convey the people-oriented design goals through task setting, guide students to pay attention to the user's behavior patterns, psychological needs, cultural background, etc., so as to achieve a close connection between the course content and the actual service scene.

3.3 Stage 1: Discovery Phase - Building Multidimensional Research and Analysis Capabilities

The core of the "discovery" phase is problem exploration. Students need to identify the essence of the problem from the real situation under the guidance of teachers. In terms of teaching organization, rich research resources should be provided, such as online videos, image cases, database documents, etc., and students should be guided to use questionnaires, user interviews, site observations and other methods to establish systematic problem cognition.

Teaching activities can be combined with group discussions, problem mapping diagrams, and visualization of research results to help students form a wide range of observation dimensions, and strengthen their induction and analysis capabilities through data collation, avoiding the formalistic tendency of "design for design".

3.4 Stage 2: Definition Stage - Focusing on Core Issues and Clarifying Design Direction

In the "definition" stage, the focus of teaching shifts to problem focus and path clarification. Through the sorting and analysis of research materials, students are guided to find the real pain points of users and the most representative problem groups.

Brainstorming, SWOT analysis, problem statement writing and other methods can be used in teaching to help students gradually transition from vague perceptual cognition to clear design propositions. At the same time, students are encouraged to form preliminary design goals, service content ideas and basic logical frameworks, and build a rational and targeted design starting point.

3.5 Stage 3: Development Stage - From Creative Conception to Path Generation

The "development" stage is a key stage for solution generation and path construction. At this stage, teaching should focus on the balance between students' divergent thinking and system capabilities. On the one hand, creative thinking training (such as SCAMPER method, design analogy, service blueprint, etc.) should be used to stimulate students' exploration of diverse solutions; on the other hand, it is also necessary to strengthen the consideration of technical logic and actual constraints to improve the feasibility of the solution.

Course activities may include design sketching, functional flow chart design, group prototype collage, toolkit simulation, etc., focusing on the visual expression of the solution and team collaboration practice. Through continuous modification and reconstruction, students are encouraged to build a closed-loop logic from "user problem-design goal-functional path".

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3.6 Stage 4: Delivery Stage - Design Output and Reflective Application

The "delivery" stage is not only a process of presenting results, but also a critical period for students to internalize knowledge into capabilities. Teachers should encourage students to fully express their design plans through drawings, models, videos or interactive experiences, and conduct comprehensive self-evaluation and mutual evaluation of the functionality, aesthetics, and user adaptability of the plans.

A "design reflection" session can be set up in the classroom to guide students to conduct multi-dimensional review and summary around core issues such as "whether the design responds to the initial question", "whether it reflects the user center", and "whether it is feasible". The teaching at this stage not only solidifies the results, but also accumulates experience for future design practice and forms a transferable design thinking framework.

3.7 Four-stage Cycle Teaching: From Linear Process to Spiral Improvement

In the context of industry-education integration, design education needs to be more systematic and practical. Based on the four-stage division of the double diamond model, a "four-stage double-cycle" teaching structure can be further constructed, that is, after completing a round of "discovery-definition-development-delivery", a new round of design cycle can be entered again through problem reflection, theoretical reorganization, and user feedback, forming a spiral progression of teaching content.

In actual teaching, each stage should not be handled in isolation, but should be task-driven, problem-oriented, and case-introduced to form a complete "cognition-practice-reflection-application" chain in the teaching process, so as to achieve the continuous improvement of design capabilities and the migration and development of thinking patterns.

4. Results and Discussion

4.1 Objects and Fields

The research objects are second- and third-year students in a design college, totaling 3 teaching classes. The research embeds the teaching logic of the double diamond model in its professional core courses, covering a full semester teaching cycle. The course teaching adopts the "hybrid teaching + task-oriented" method. The researcher acts as a participatory observer to conduct on-site recording and process intervention throughout the research process, and cross-validates with student self-evaluation materials and teacher feedback materials.

4.2 Data Collection Methods

To ensure the openness and depth of the research, data collection is conducted in parallel using the following qualitative methods:

Classroom observation notes: students' behavioral performance, discussion content, and changes in participation at each stage (discovery, definition, development, and delivery) are recorded;

Student learning logs and weekly reflection notes: students' cognitive paths and emotional attitudes from their self-statements are analyzed;

In-depth interviews: 12 typical students are selected to conduct semi-structured interviews around their changes in design thinking, teamwork, and user understanding;

Teacher lesson plans and course reflection records: teachers' strategic choices and adjustment logic in the process of designing teaching content and implementation are analyzed.

Through triangulation, cross-comparison of content from different data sources is conducted to enhance the credibility and depth of the research.

4.3 Data Analysis

From the overall emotional tendency in Figure 1, the "delivery" stage has the highest proportion of positive emotions (90%), and the keywords are concentrated on "expression, summary, reflection", indicating that students have gained a high sense of satisfaction and accomplishment in the process of

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design results display and self-expression. The task output and peer evaluation mechanism in this stage enhance students' recognition and sense of belonging to learning results, and it is the stage with the most positive emotional feedback in the entire teaching process.

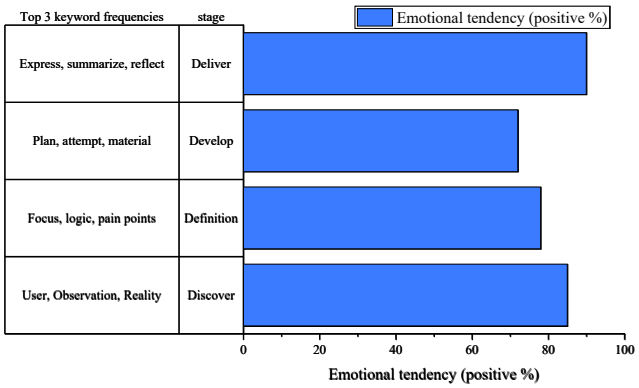

Figure 1 Key words for stage feelings

The second is the "discovery" stage (85%), with the keywords "user, observation, reality", reflecting that students first came into contact with the core concept of "people-oriented" in research and scene perception, and gained a strong sense of substitution and exploration interest. This stage is an important starting point for establishing a sense of real problems, and students' understanding of design begins to change from perceptual experience to structural observation.

In the "definition" stage (78%), keywords such as "focus, logic, pain points" indicate that students have a preliminary logical integration ability in the process of summarizing research content and refining core propositions, but due to the increase in task complexity, it is also accompanied by a certain cognitive load, and emotional fluctuations have increased slightly. This stage relies heavily on teachers' guidance and support for logical construction, and is a key link in students' transition from sensibility to rationality.

The "development" stage has the lowest emotional tendency (72%), with the keywords "plan, attempt, material", reflecting the uncertainty brought by the various choices and repeated adjustments faced by students when conducting creative design and path generation. Although it is the stage for cultivating core design capabilities, it is also the most prone to anxiety and bottlenecks in thinking, indicating that teachers' process feedback and program demonstration support should be strengthened at this stage to enhance students' tolerance for "trial and error" and self-efficacy.

From the perspective of teachers' role positioning and intervention frequency in the four stages of the double diamond model, this study reveals the teaching trend of teachers gradually transforming from "knowledge transmitters" to "process guides". In Figure 2, overall, the frequency of teachers' interventions shows a distribution characteristic of "dense at the beginning and sparse at the end" in the entire teaching process, reflecting the shift of the teaching focus from input orientation to student subjectivity development.

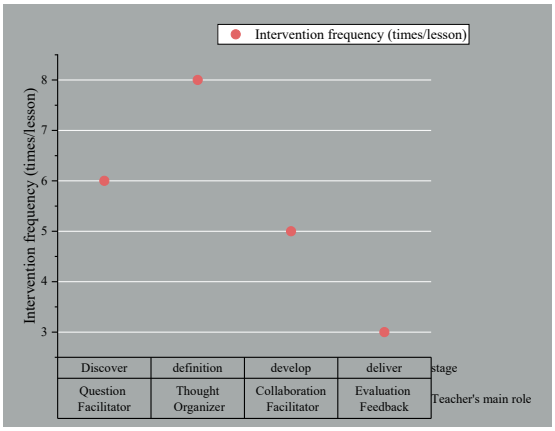

Figure 2 Teacher role transformation

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In the early "discovery" and "definition" stages, teachers play the roles of "problem guide" and "thinking organizer" respectively, with intervention frequencies of 6 and 8 times per class, which are the two most intensive intervention stages. This setting reflects the students' high dependence on teachers' directional guidance and thinking framework support in the process of initial problem recognition and logical structure construction. At this time, teachers not only need to guide students to establish user awareness and clarify design propositions, but also assist them in integrating fragmented information and forming a systematic thinking path.

After entering the later "development" and "delivery" stages, the frequency of teachers' interventions decreases significantly, only 5 times and 3 times, and the roles change to "collaboration facilitator" and "evaluation feedback". This shows that as students' design capabilities are gradually established, teachers leave more space for students to explore independently and try and error solutions, while they themselves focus on creating a discussion atmosphere, coordinating teamwork and giving periodic feedback. Especially in the delivery stage, teachers are more responsible for the evaluation of results and reflection guidance tasks, supporting students to learn in reverse from the results.

Table 1 Summary of student interviews

Interview topic	Representative student's original words
Design motivation changes	"At first I was only focused on the visual aspect, but now I think about how people use the space."
Design Thinking Shift	"I used to think design was based on feelings, but now I think about logic and paths."
Collaborative Experience	"This is the first time we've really done user research together."
Course Satisfaction	"The course is challenging but realistic and more rewarding."

In the analysis of the interview data, students generally express a high sense of participation and transformation in the course experience, reflecting that the teaching design supported by the double diamond model has indeed triggered the multi-dimensional growth of their design motivation, thinking mode and cooperative cognition. From the perspective of perception, most students gradually shift from their initial reliance on formal aesthetics to a focus on user behavior and the logic of space use. As one student says, "At first I only focused on vision, but now I think about how people use this space." This change shows that the concept of "people-centered" has begun to be internalized as the starting point of its design.

The progress at the cognitive level is also particularly significant. The original intuitive design method has gradually been replaced by structured thinking. The feedback of "I used to think that design was based on feelings, but now I think about logic and paths" clearly depicts the improvement of students' control over design methods and reasoning processes under the guidance of teaching. Teaching is no longer a simple teaching of formal language, but provides a complete thinking framework so that students can learn "why to design like this" (see Table 1).

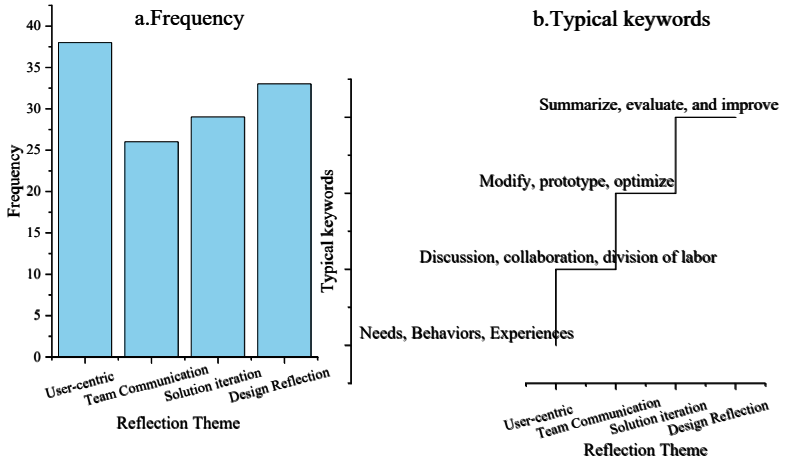

Figure 3 Journal theme coding

Through the open coding and theme induction of students' reflection journals in Figure 3, it can be clearly observed that in the design learning process supported by the double diamond model, the cognitive focus of students gradually shifts from "completing tasks" to "understanding processes" and "optimizing logic". Among the four core reflection themes, "user-centered" ranks first with a frequency

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of 38 times, and the keywords are concentrated on "needs, behaviors, experiences", reflecting that students have widely realized that the starting point of design should be rooted in user reality rather than subjective assumptions (see Figure 3b). This reflection trend also shows that the research practice and problem definition activities in the early stage of the course have successfully promoted a fundamental change in students' design perspectives.

Following closely are "design reflection" and "solution iteration", which appear 33 and 29 times respectively. Keywords such as "summarize, evaluate, improve" and "modify, prototype, optimize" show that students no longer regard design as a one-time creative process, but establish iterative cognition in continuous trial and error, feedback and improvement. Reflection is no longer limited to "what I did", but goes deep into the meta-cognitive level of "why do it this way" and "is there a better way" (see Figure 3a). This understanding and optimization of the process itself is an important manifestation of the deepening of design capabilities.

Although the theme of "team communication" appears less frequently (26 times), its typical keywords "discussion, collaboration, division of labor" reveal that students' cognition and experience of the cooperation mechanism are also gradually strengthening. Especially in the design development stage, the frequency of discussion and task coordination within the team become important variables that determine project efficiency and solution quality. Through practice, students gradually realize that communication itself is part of design, and this cognition breaks through the traditional thinking pattern of "individual work".

5. Conclusions

This paper focuses on the teaching transformation needs of design education under the background of "industry-education integration", takes the double diamond model as the teaching framework, and conducts a systematic structural reconstruction and teaching practice exploration of design courses. By introducing the four-stage thinking path of "discovery-definition-development-delivery", the "user-centered" service awareness is deeply integrated into the entire teaching process, and a full-process learning closed loop from problem identification to solution delivery is constructed. The study adopts a qualitative research method, combined with classroom observation, interview data, reflection logs and keyword coding, to analyze students' cognitive transformation, design behavior and teacher role changes. The results show that the teaching model significantly improves students' problem understanding ability, solution construction ability and process reflection awareness, and promotes the cultivation of design thinking oriented to service value. Although this study has achieved preliminary results in the construction of teaching framework and process effectiveness analysis, there are still certain limitations, such as the limited scope of research samples and the single course type. Subsequent research can further verify the applicability and extensibility of the model in multidisciplinary integration courses; at the same time, it can also combine quantitative methods to conduct a more systematic evaluation of students' ability growth, so as to achieve multi-dimensional verification and continuous optimization of teaching effects.

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