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Philosophical Perspectives Promoting Design Innovation

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ABSTRACT

This paper aims to explore the ways in which philosophical perspectives facilitate educational outcomes in opportunity identification in the context of design innovation. It first integrates existing literature from entrepreneurship studies and education to propose a theoretical framework for understanding opportunity and innovation in the field of design. Then, drawing on this framework, this paper employs an experimental method that investigates the impacts of pedagogical strategies of three philosophical perspectives (behaviorism, cognitivism, and social constructivism) on three measurements of educational outcome (knowledge acquisition, opportunity identification ability, and innovation ability). The findings indicate that different teaching methods yield varying effects on the cultivation of each ability. Specifically, behaviorism is conducive to knowledge acquisition, cognitivism is beneficial for opportunity identification, and social constructivism stands out regarding innovation and teamwork. These findings validate the viability of the theoretical framework and empirical data for enhancing design innovation education.

KEYWORDS: Design Innovation Education, Opportunity Identification, Philosophy of Education

1 | INTRODUCTION

1.1 | Background and Significance

In the current era of rapid development, design innovation has become the core driving force for progress in various fields. Design innovation education is dedicated to cultivating innovative talents who can adapt to and lead the demands of the times, endowing them with acute opportunity identification abilities to create design outcomes of high value. However, currently, the selection of teaching methods in design innovation education lacks solid theoretical guidance, making it difficult to effectively meet the diverse learning needs of students. Philosophical perspectives, as an important way of thinking for understanding the world and guiding practice, hold tremendous value for design innovation education. An exploration of the relationship between philosophical perspectives and educational outcomes is, therefore, of significant theoretical and practical importance for optimizing design innovation education.

1.2 | Research Objectives and Questions

This research aims to construct a framework that integrates philosophical perspectives, learning theories, and teaching methods to promote opportunity identification in design innovation education. Specifically, the research will address the following questions: How do different philosophical perspectives influence opportunity identification in design innovation education? What are the corresponding learning theories and teaching methods? What impacts will these teaching methods have on students' knowledge acquisition, opportunity identification ability, and innovation ability? How can appropriate teaching methods be selected according to students' characteristics to achieve the optimal teaching effect?

1.3 | Research Methods and Innovation Points

This research adopts a combination of theoretical research and experimental research methods. Through in-depth review and analysis of relevant literature, a theoretical framework is constructed to clarify the relationships among philosophical perspectives, learning theories, and teaching methods. On this basis, experimental research is carried out, taking design major students as samples to compare the effects of teaching methods based on different philosophical perspectives. The innovation points of this research lie in systematically introducing philosophical perspectives into the research of design innovation education, deeply dissecting their functional mechanisms at the theoretical level, and verifying them through rigorous experimental design, thus providing new research ideas and empirical support for design innovation education.

2 | LITERATURE REVIEW

2.1 | Theories of Opportunity Identification

2.1.1 | The Opportunity Discovery Perspective

From the discovery perspective, opportunities are regarded as potential possibilities arising from imperfect competition in the product or factor markets. These imperfections stem from changes in external environmental factors, and opportunities are considered as objectively existing entities, independent of individual cognition. Under this perspective, individuals mainly explore opportunities through rational decision-making or subjective interpretation based on past experiential knowledge. Specifically, it can be divided into three strategies: active search, accidental discovery, and passive search (Costa et al., 2018).

The neoclassical economics viewpoint in the active search strategy emphasizes that entrepreneurs should match known products with existing demands. Based on the assumption of perfect information, individuals systematically search for opportunities in the market to achieve their goals. The corresponding learning theory is behaviorism. Behaviorism focuses on the relationship between external stimuli and individual behavioral responses. Teaching methods emphasize external observation and mechanical training processes, such as imparting theoretical knowledge of design innovation through lectures and guiding students to write business plans, etc., to help students master the knowledge and skills required for opportunity identification (Yarbrough, 2018).

The information economics viewpoint focuses on the asymmetric distribution of information in the market. Individuals need to conduct systematic searches in familiar fields, and the related learning theory is cognitivism. Cognitivism emphasizes the individual's cognitive process. Teaching methods focus on guiding students to organize knowledge and providing real learning experiences to solve cognitive imbalances. For example, through case analysis, students are trained to select information channels and update their knowledge structures, thereby enhancing their ability to actively explore and discover opportunities (Lorenz et al., 2018).

The strategy of accidentally discovering opportunities is characterized by low systematicness and non-deliberateness. This strategy holds that although opportunities objectively exist, they are difficult to obtain through systematic searches. The individual's vigilance plays a crucial role in discovering opportunities. Due to its dependence on the individual's unique characteristics, it is difficult to propose universal teaching methods. However, existing research has attempted to cultivate the individual's vigilance through collecting relevant cases or reading articles to assist in opportunity discovery (Rashid, 2019).

The passive search strategy is similar to the accidental discovery viewpoint. It holds that individuals do not need to actively search for opportunities. The objectively existing opportunities in the market will be discovered when individuals possess a certain level of vigilance, and the individual's vigilance can be improved through teaching. The related learning theory is cognitivism. Teaching methods such as role-playing and perspective-taking aim to enhance the individual's cognitive ability and sensitivity to the environment, thereby discovering more potential opportunities (Kim et al., 2018).

2.1.2 | The Opportunity Creation Perspective

The opportunity creation perspective originates from the radical subjectivist Austrian economics viewpoint, emphasizing the individual's subjective initiative. It holds that opportunities are endogenously created by individuals through their own efforts and actions, and are a subjective phenomenon closely linked to the social environment (Goss & Sadler-Smith, 2018). The ontology of this perspective is relativism, the epistemology is constructivism, and the corresponding learning theory is social constructivism (Bratianu et al., 2020).

Under this perspective, scholars believe that entrepreneurs should not only discover opportunities but also create opportunities through social interaction processes (Kakouris & Liargovas, 2021). Since the information before opportunity creation is incomplete and full of uncertainties, individuals need to develop their subjective ideas through sharing and discussing with their trust networks (Leal-Rodriguez & Albort-Morant, 2019). The social constructivism learning theory emphasizes that learning is a process of constructing meaning in social interaction. Learners actively construct knowledge in interaction with others, and teachers mainly play a facilitating and guiding role in the learning process (Lynch et al., 2021).

Related teaching methods include self-directed learning, team cooperation, participation in communities of practice, and design thinking, etc. These methods promote communication and cooperation among individuals, helping individuals to be exposed to different viewpoints in actual entrepreneurial activities, thereby creating more potential opportunities (Pande & Bharathi, 2020). For example, through the effectuation method, individuals are trained to integrate their own resources to form business opportunities, or through the design thinking process, individuals are helped to create feasible business ideas (Bell & Bell, 2020).

2.2 | Learning Theories and Teaching Methods

The behaviorist learning theory is closely connected with the opportunity discovery viewpoint of neoclassical economics. Its teaching methods focus on knowledge transmission and procedure application, which are suitable for providing students with basic theoretical knowledge and skill training, helping students establish a solid knowledge system and laying the foundation for subsequent innovative practices (Fayolle, 2018). The cognitivist learning theory is in line with the opportunity discovery viewpoint of information economics and the passive search strategy, emphasizing the individual's active exploration and knowledge integration. By enhancing the individual's cognitive ability, it strengthens the opportunity identification ability and cultivates students' independent thinking and problem-solving abilities (Debarliev et al., 2022). The social constructivism learning theory is highly consistent with the opportunity creation perspective, focusing on the meaning construction of individuals in social interaction. Through experiential learning and cooperative learning, etc., it cultivates students' innovative thinking and opportunity creation ability, encourages students to break through traditional thinking patterns and actively cooperate with others to create new design opportunities (Hägg & Gabrielsson, 2020).

Integrating these learning theories and teaching methods into design innovation education helps to construct a comprehensive and systematic educational system. For example, in the initial stage of curriculum design, behaviorist teaching methods can be used to impart basic design knowledge and skills to students, enabling students to have a preliminary understanding and recognition of the design field.

As the curriculum progresses, cognitivist teaching methods are introduced to stimulate students' active exploration spirit, guide students to analyze design problems in depth, and cultivate students' critical thinking and innovative abilities.

In the later stage of the curriculum, social constructivist teaching methods are adopted to organize students to carry out team projects and practical activities, allowing students to exercise their innovative abilities and team cooperation abilities in real design situations and cultivate students' comprehensive design literacy.

Meanwhile, according to different teaching contents and goals, appropriate teaching methods are flexibly selected. For example, when cultivating students' market analysis ability, cognitivist teaching methods can be used. Through case analysis and simulation experiments, etc., students are enabled to have a deep understanding of market demands and competition situations.

When enhancing students' team cooperation and innovative abilities, social constructivist teaching methods can be used. By organizing students to participate in design workshops and team competitions, etc., the communication and cooperation among students are promoted (Jones et al., 2019).

3 | THEORETICAL FRAMEWORK

3.1 | Relating Philosophical Perspectives to Opportunity Identification

In the field of design innovation, opportunity identification is a complex process that involves acute insights into design problems, exploration of potential solutions, and accurate grasping of market demands and trends (Newman et al., 2019). From a philosophical perspective, the opportunity discovery perspective and the opportunity creation perspective offer different dimensions for understanding this process.

The opportunity discovery perspective emphasizes the objective existence of opportunities in the market environment. Individuals discover these pre-existing opportunities through the collection, analysis, and rational judgment of market information. Under this perspective, designers are like explorers, seeking innovative entry points within the existing market structure and demand framework. For example, by conducting market research to analyze consumers' dissatisfaction with existing products, opportunities to improve product functions or appearances can be discovered (Haefner et al., 2021).

The opportunity creation perspective, on the other hand, highlights the subjective initiative and creativity of individuals, believing that opportunities do not pre-exist but are created by individuals in the process of interacting with the social environment. Designers under this perspective are more like creators, relying on their own imagination, experience, and understanding of social culture to actively shape new design opportunities (Urbinati et al., 2019). For example, by introducing new materials, technologies, or design concepts, entirely new product types or service models can be created to meet potential market demands (Wei et al., 2019).

These two philosophical perspectives are complementary in design innovation and jointly promote the development of design innovation. In the actual design process, designers need to possess the ability to discover existing opportunities as well as the courage and wisdom to create new ones.

3.2 | Selection of Learning Theories Based on Philosophical Perspectives

Based on the philosophical assumptions of the opportunity discovery perspective, behaviorism and cognitivism learning theories are inherently consistent with it. The behaviorist learning theory helps students establish stable behavioral patterns and knowledge systems through the observation and reinforcement of individual behaviors. In design innovation education, behaviorist teaching methods can be used to teach students basic knowledge and skills such as the use of design tools and compliance with design specifications. For example, through repeated practice and demonstration, students can master the operation skills of design software proficiently, ensuring that students have a solid foundation in design practice (Kim et al., 2018).

The cognitivist learning theory emphasizes the individual's cognitive structure and information processing process, focusing on guiding students to actively construct knowledge. In the opportunity discovery process, cognitivist teaching methods can cultivate students' ability to analyze market information, solve design problems, and predict innovative opportunities (Sahut et al., 2021). For example, through case analysis, group discussion, etc., students' thinking can be stimulated, helping them understand the principles and methods of design innovation and enhancing their ability to discover opportunities in a complex market environment.

Starting from the opportunity creation perspective, the social constructivism learning theory provides a solid theoretical support. Social constructivism believes that knowledge is jointly constructed in social interaction, and an individual's learning and development are inseparable from communication and co-operation with others (Ratten & Usmanij, 2021). In design innovation education, social constructivist teaching methods encourage students to participate in team projects, design workshops, etc., allowing students to share different viewpoints and experiences with classmates, teachers, and industry experts in the interaction, broaden their horizons, and stimulate innovative thinking. For example, in a team collaborative design project, students communicate with each other, exchange ideas, and jointly create novel and unique design proposals, cultivating students' innovative ability and team collaboration ability.

3.3 | Design and Application of Teaching Methods

Designing corresponding teaching methods for different learning theories is crucial for promoting opportunity identification in design innovation education.

Teaching methods based on the behaviorist learning theory include the use of standardized teaching manuals, repeated practice, and testing. The standardized teaching manuals provide students with a systematic knowledge framework and operation procedures, ensuring that students can comprehensively master the basic knowledge of design innovation. Repeated practice helps students consolidate the knowledge and skills they have learned and improve their proficiency. Testing can timely feedback students' learning results and help teachers adjust their teaching strategies. For example, in a design foundation course, teachers can introduce design elements, principles, and methods to students through detailed teaching manuals and assign a large number of targeted practice assignments, such as design composition exercises, color matching exercises, etc., and conduct regular tests to examine students' mastery of knowledge (Martin et al., 2019).

Teaching methods supported by the cognitivist learning theory include problem-based learning, project-based learning, and simulation experiments. Problem-based learning takes actual design problems as the starting point, guiding students to actively think, analyze problems, and propose solutions. Project-based learning enables students to comprehensively apply the knowledge and skills they have learned in the process of completing specific projects, cultivating their ability to solve actual problems (Leal-Rodriguez & Albort-Morant, 2019). Simulation experiments provide students with a design situation close to the real one, allowing them to exercise their opportunity identification and decision-making abilities in practice. For example, in a product design course, teachers can pose an actual product design problem, such as "Design a smart health monitoring device suitable for the elderly", and students complete the entire project through market research, user demand analysis, function design, prototype making, etc., continuously improving their design ability and opportunity identification ability in this process (Makri et al., 2021).

Teaching methods advocated by the social constructivism learning theory include team project cooperation, design thinking workshops, and participation in practice communities. Team project cooperation requires students to form teams to jointly complete complex design tasks, cultivating students' team collaboration ability, communication ability, and innovative ability (Pande & Bharathi, 2020). Design thinking workshops guide students to experience each stage of design thinking, from understanding user needs, defining problems, conceiving ideas to making prototypes and testing, cultivating students' innovative thinking and ability to solve complex design problems. Participation in practice communities provides students with a platform for communicating with industry experts and peers, allowing them to understand the latest industry trends and broaden their network resources. For example, schools can organize students to participate in international design competitions in team form. During the competition, students use design thinking methods, cooperate closely with team members, and communicate and interact with other competing teams and judges, obtaining valuable experience and feedback (Burgess et al., 2020).

4 | EXPERIMENTAL DESIGN

4.1 | Experimental Hypotheses

To thoroughly explore the role of philosophical perspectives in design innovation education, the following hypotheses are proposed in this study:

- Hypothesis 1 (H1): The behaviorist teaching method has a significant advantage in promoting students' mastery of basic knowledge. After receiving behaviorism teaching, students' test scores on knowledge mastery ability will be significantly higher than those of other teaching method groups.
- Hypothesis 2 (H2): The cognitivist teaching method can effectively enhance students' opportunity identification ability. Students who receive cognitivism teaching will score significantly higher in the opportunity identification ability test than those in other groups.
- Hypothesis 3 (H3): The social constructivist teaching method has the most significant promoting effect on students' innovation ability and teamwork ability. Students who receive this teaching method will score higher in the evaluations of innovation ability and teamwork ability than those in other teaching method groups.
- Hypothesis 4 (H4): The impact of different teaching methods on students varies depending on group characteristics (such as cognitive ability). Students with higher cognitive ability may show better learning effects when receiving cognitivism and social constructivist teaching methods.

4.2 | Experimental Subjects and Grouping

In this experiment, 180 design major students were selected as the research subjects. Using the stratified random sampling method, the students were divided into four groups: the behaviorism group, the cognitivism group, the social constructivism group, and the control group, with 45 students in each group. During the sampling process, factors such as students' grade, gender, and major direction were fully considered to ensure the similarity and comparability of each experimental group in the initial state.

4.3 | Manipulation and Measurement of Experimental Variables

4.3.1 | Manipulation of Independent Variables

The behaviorism group adopted a standardized teaching manual for teaching. The content of the manual covered systematic knowledge such as design principles, design processes, and market analysis methods. The teaching process emphasized the leading role of teachers. Through detailed explanations, demonstration operations, teachers guided students to conduct a large number of repetitive exercises and regularly conducted tests to reinforce students' mastery of knowledge and skills. For example, in the design foundation course, based on the teaching manual, the teacher explained in detail the functions and operation steps of the design software, and students followed the teacher to practice repeatedly until they mastered the software operation skills proficiently (Al-Shammari et al., 2019; Clark, 2018).

The cognitivism group took problem-based learning as the core teaching method. Teachers set a series of actual design problems according to the course content, such as "How to improve the user experience of existing public spaces". Students were guided to propose solutions by independently consulting materials, analyzing cases, and conducting group discussions, and then verified them in a simulated experimental environment. In the product design course, the teacher posed the problem of "Design an environmentally friendly office product". Students conducted market research to understand environmentally friendly materials and user needs, analyzed the advantages and disadvantages of existing office products, and then proposed innovative design solutions. They also evaluated the feasibility of the solutions through simulated production and user testing (Mynbayeva et al., 2018; Pande & Bharathi, 2020).

The social constructivism group focused on conducting team projects and design thinking workshops. In team projects, students were grouped to complete complex design tasks, such as "Design a sustainable community space". Group members cooperated with each other by dividing tasks, jointly conducting demand research, conceptual design, scheme refinement, and Results Presentation. The design thinking workshops guided students to follow the design thinking process, from understanding user needs, defining problems, brainstorming ideas, making prototypes to testing feedback, all in a teamwork manner. For example, in the service design workshop, student teams, for a specific service scene, used design thinking methods to conduct in-depth interviews with users to excavate potential needs, then jointly conceived innovative service modes, made service prototypes and conducted user testing, and continuously optimized the schemes according to the testing results (Farrokhnia et al., 2022; Suhendi, 2018).

The control group adopted the traditional lecture-based teaching method. Teachers mainly imparted design knowledge through classroom explanations, and students completed individual design assignments. No teaching intervention measures based on specific philosophical perspectives were introduced in the teaching process.

4.3.2 | Measurement of Dependent Variables

- Knowledge Mastery Ability: It was evaluated through the final theoretical test. The test content included knowledge of design theory, design methods, and market analysis, with a full score of 100 points. The types of test questions covered multiple-choice questions, fill-in-the-blank questions, short-answer questions, and essay questions, comprehensively examining students' understanding and memory of design innovation-related knowledge.

- Opportunity Identification Ability: The simulated scenario testing method was adopted. Multiple simulated scenarios related to actual design projects were designed, such as "Design a cultural exhibition space with local characteristics for an international cultural festival in a certain city". Students analyzed the scenarios within the specified time, identified the design opportunities therein, and proposed preliminary design ideas and solutions. The scoring was a combination of evaluations by an expert panel (consisting of professional teachers and industry designers) and self-evaluation by students, with a full score of 50 points. The expert panel scored according to dimensions such as the accuracy, innovativeness, and feasibility of opportunity identification, while the student self-evaluation mainly examined students' ability to reflect on and evaluate their own opportunity identification process.

- Innovation Ability: It was evaluated based on students' works in actual design projects, with a full score of 50 points. The evaluation adopted a double-blind scoring mechanism, that is, the reviewers did not know the students to whom the works belonged and the teaching grouping situation, ensuring the fairness of the scoring. The evaluation indicators included novelty of creativity (such as the uniqueness of the design concept, application of innovative technologies or methods), practicality (such as the degree to which the design scheme meets user needs and actual application scenarios), and social value (such as contributions to social sustainable development, cultural inheritance, etc.).

- Teamwork Ability (Only for the Social Constructivism Group and the Control Group): It was evaluated by combining behavior observation and questionnaire survey. Behavior observation was carried out by teachers during the implementation of team projects. Teachers recorded students' behavioral performances such as communication, task division, and problem solving in team cooperation, and scored according to a pre-established behavior scale. The questionnaire survey was distributed to students after the project ended to understand students' satisfaction with the team cooperation process, evaluation of team members' contributions, etc. The comprehensive results of both were used to obtain the evaluation result of teamwork ability.

4.3.3 | Control Variables

To ensure the accuracy and reliability of the experimental results, the following variables that might affect the experimental results were controlled:

- Teaching Environment: All experimental groups were taught in the same classroom environment.

The classrooms were equipped with the same teaching equipment and tools, such as multimedia equipment, design software, and drawing tools, to ensure the consistency of teaching conditions.

- Teaching Time: The four experimental groups completed the teaching within the same teaching cycle. The weekly teaching duration was the same, totaling 32 hours, to avoid the impact of differences in teaching time on the experimental results (Saini & Abraham, 2019).

- Teacher Qualifications: Teachers with the same teaching experience and professional background were arranged to teach in the four experimental groups respectively to ensure that teachers' teaching level and teaching style would not interfere with the experimental results (Olokundun et al., 2018).

- Student Background: During the sampling process, background factors such as students' grade, gender, and professional foundation were balanced as much as possible to ensure that there were no significant differences in initial ability and knowledge reserve among students in each experimental group. This experiment lasted for 8 weeks, with 4 hours of teaching time arranged each week. Before the experiment, pre-tests were conducted on all students, including tests of knowledge mastery ability, opportunity identification ability (using simple simulated scenarios), and innovation ability evaluation (through analysis of students' previous design works) to understand students' initial levels (Leppink, 2019).

4.4 | Experimental Process

This experiment lasted for 8 weeks, with 4 hours of teaching time arranged each week. Before the experiment, pre-tests were conducted on all students, including tests of knowledge mastery ability, opportunity identification ability (using simple simulated scenarios), and innovation ability evaluation (through analysis of students' previous design works) to understand students' initial levels.

During the experiment, each experimental group conducted teaching according to the corresponding teaching method. The behaviorism group carried out teaching activities strictly in accordance with the standardized teaching manual, emphasizing knowledge imparting and skill training; the cognitivism group centered around problem-based learning to guide students to actively explore and solve actual design problems; the social constructivism group organized students to participate in team projects and design thinking workshops, emphasizing team cooperation and innovation thinking cultivation; the control group adopted the traditional lecture-based teaching method to complete the normal course teaching content (Zhao et al., 2021).

After the experiment, post-tests were conducted on students, including the final test of knowledge mastery ability, the simulated scenario test of opportunity identification ability, the evaluation of innovation ability based on actual works, and the assessment of teamwork ability (for the social constructivism group and the control group). At the same time, the learning behavior data of students during the learning process were collected, such as the data of students' participation in classroom discussions, online learning duration, and assignment submission recorded by the learning management system (LMS), which were used as supplementary analysis materials Winarti et al., 2019.

4.5 | Data Analysis Methodology

This experiment adopted multiple data analysis methods to conduct in-depth analysis of the experimental data. First, the descriptive statistical method was used to calculate statistical quantities such as the mean and standard deviation of students in each experimental group on each measurement indicator to visually present the distribution characteristics and central tendency of the data and preliminarily understand the performance of students under different teaching methods (Forson et al., 2021).

Secondly, the one-way analysis of variance (ANOVA) was used to test whether the main effects of teaching methods on dependent variables such as knowledge mastery ability, opportunity identification ability, and innovation ability were significant. By comparing the between-group variance and the within-group variance, it was judged whether there were significant differences in students' scores among different teaching method groups, thereby verifying the differences in the impact of different teaching methods on each ability in hypotheses H1, H2, and H3 (Keith, 2019).

To further control the impact of individual differences of students (such as cognitive ability, learning foundation, etc.) on the experimental results, the analysis of covariance (ANCOVA) was used. The student background variables that might affect the experimental results (such as pre-test scores, scores of cognitive ability tests, etc.) were taken as covariates and incorporated into the analysis. Under the condition of excluding the interference of these factors, the independent impact of teaching methods on students' abilities was more accurately evaluated to ensure the reliability of the experimental results (Ugwuanyi et al., 2020).

Finally, the multiple regression analysis method was used. Taking teaching methods and student individual characteristics (such as cognitive ability, gender, etc.) as independent variables and students' various ability indicators as dependent variables, a regression model was established to explore the specific relationship between philosophical perspectives (reflected through teaching methods) and students' abilities, quantify the contribution degree of different teaching methods to the improvement of students' abilities, and further verify the impact of the interaction between teaching methods and student group characteristics in hypothesis H4. At the same time, through stratified analysis, stratified by students' gender, cognitive ability level, etc., the differential effects of teaching methods in different student groups were respectively explored to conduct in-depth analysis of the applicability and effectiveness of teaching methods (Hamdan et al., 2021).

5 | EXPERIMENTAL RESULTS AND ANALYSIS

5.1 | Hypothesis Testing Results

The scores of different experimental groups on various ability indicators are shown in Table 1. The behaviorism group has the highest mean score on knowledge mastery ability (90.3 ± 5.1), while the social constructivism group shows the most prominent performance on innovation ability (43.8 ± 4.3).

Table 1: Scores of Different Experimental Groups on Various Indicators of Competence

Group	Knowledge (K)	Opportunity Recognition (OR)	Innovation Capability (IC)	Total Score
Behaviorism	90.3	32.8	28.5	151.6
Cognitivism	82.7	38.2	35.6	156.5
Social Constructivism	75.8	40.5	43.8	160.1
Control	68.4	27.3	25.7	121.4

5.1.1 | Knowledge Mastery Ability

The descriptive statistical results indicate that the mean score of students in the behaviorism group in the knowledge mastery ability test is 90.3 ± 5.1, which is significantly higher than that of the other three groups. The results of oneway analysis of variance show that teaching methods have a significant impact on knowledge mastery ability (F (3, 176) $= 25.34, \mathrm{p} < 0.001$). Further post hoc multiple comparisons (such as LSD test) reveal that there are significant differences between the behaviorism group and the cognitivism group (mean 82.7 ± 6.3), the social constructivism group (mean 75.8 ± 7.1), and the control group (mean 68.5 ± 8.2) (p < 0.05). This supports Hypothesis H1, that is, the behaviorism teaching method performs best in terms of basic knowledge mastery.

5.1.2 | Opportunity Identification Ability

The mean score of students in the cognitivism group in the opportunity identification ability test is 38.2 ± 5.7, which is higher than that of the behaviorism group (mean 32.8 ± 6.2), the social constructivism group (mean $40.5 \pm$ 5.2), and the control group (mean 25.6 ± 4.8). The results of one-way analysis of variance indicate that teaching methods have a significant impact on opportunity identification ability $(\mathrm{F}(3, 176) = 18.56, \mathrm{p} < 0.001)$. Post hoc multiple comparisons show that there are significant differences between the cognitivism group and the behaviorism group and the control group ($\mathrm{p} < 0.05$), but the difference with the social constructivism group is not significant. This partially supports Hypothesis H2, indicating that the cognitivist teaching method has certain advantages in enhancing opportunity identification ability, but the social constructivist teaching method also shows a relatively high level in cultivating opportunity identification ability.

5.1.3 | Innovation Ability

The mean score of students in the social constructivism group in the innovation ability evaluation is 43.8 ± 4.3, which is significantly higher than that of the behaviorism group (mean 28.5 ± 4.9), the cognitivism group (mean 35.6 ± 5.1), and the control group (mean 20.3 ± 3.5). The results of one-way analysis of variance show that teaching methods have a significant impact on innovation ability ($\mathrm{F}(3, 176) = 32.45, \mathrm{p} < 0.001$). Post hoc multiple comparisons reveal that there are significant differences between the social constructivism group and the other three groups ($\mathrm{p} < 0.05$). This strongly supports Hypothesis H3, that is, the social constructivist teaching method has the most significant promoting effect on innovation ability.

5.1.4 | Teamwork Ability

This is a comparison between the social constructivism group and the control group. Through the comprehensive evaluation of behavior observation and questionnaire survey, the social constructivism group scores significantly higher than the control group in teamwork ability. The results of the independent sample t-test show that there is a significant difference between the two groups ($t(88) = 8.56, p < 0.001$), further supporting the positive impact of the social constructivist teaching method on teamwork ability as stated in Hypothesis H3.

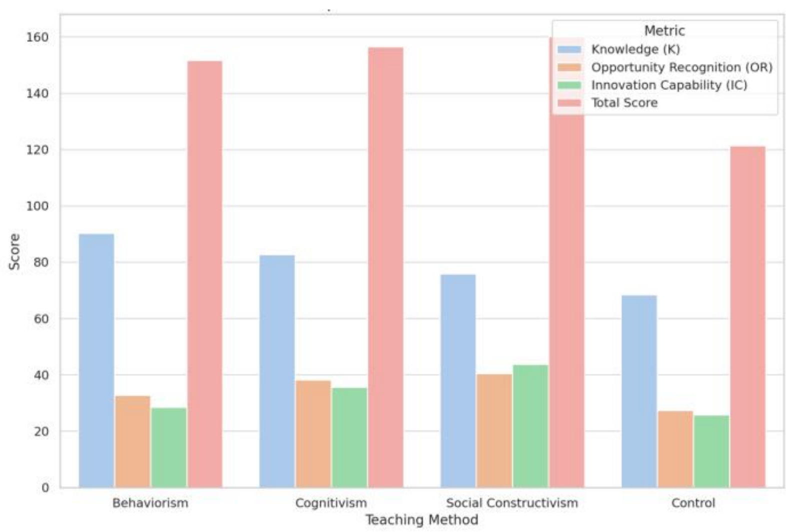

Figure 1: Group Enrichment Bar Chart

As shown in Figure 1, there are significant differences in the scores of different teaching methods on knowledge mastery ability, opportunity identification ability, and innovation ability. Among them, the behaviorist teaching method performs best in knowledge mastery, while the social constructivism method has an obvious advantage in innovation ability.

5.2 | Effectiveness Analysis of Different Teaching Methods

5.2.1 | Behaviorist Teaching Method

The behaviorist teaching method is highly effective in knowledge transmission. Its standardized teaching process and a large number of repetitive exercises help students systematically master the basic knowledge and skills of design innovation. Students perform excellently in memorizing theoretical knowledge and using basic design tools, laying a solid foundation for subsequent design practices. However, this teaching method is relatively insufficient in cultivating students' innovative thinking and opportunity creation ability. When facing complex and changeable actual design situations, students may lack the ability to respond flexibly and innovate actively.

5.2.2 | Cognitivist Teaching Method

The cognitivist teaching method has certain advantages in enhancing students' opportunity identification ability. Through problem-based learning and simulation experiments, it guides students to think actively, analyze problems, and cultivates students' acute insight into market demands and design trends. Students can use the learned knowledge and analysis methods to actively search for design opportunities and propose preliminary solutions. However, compared with the social constructivist teaching method, the cognitivist teaching method is slightly inferior in cultivating innovation ability. The novelty of students' ideas and the uniqueness of design schemes need to be further improved.

5.2.3 | Social Constructivist Teaching Method

The social constructivist teaching method shows excellent performance in cultivating innovation ability and teamwork ability. Team projects and design thinking workshops provide students with abundant opportunities for interaction and communication. In the process of cooperating with others, students can give full play to their respective advantages and jointly create novel and unique design works. Meanwhile, students' teamwork awareness and communication ability are significantly improved, enabling them to better meet the requirements of modern design innovation projects for teamwork. However, this teaching method may not be as good as the behaviorist teaching method in systematically transmitting knowledge. Students' mastery of some basic theoretical knowledge may be relatively weak.

5.3 | Interaction Between Teaching Methods and Group Characteristics

Through multiple regression analysis and stratified analysis, it is found that there is a certain interaction between teaching methods and student group characteristics (such as cognitive ability). For students with higher cognitive ability, the cognitivist and social constructivist teaching methods can better exert their advantages, and the improvement of students' opportunity identification ability and innovation ability is more obvious. For students with relatively low cognitive ability, the behaviorist teaching method plays an important role in helping them master basic knowledge, laying the foundation for subsequent learning and ability improvement. In terms of gender, no significant interaction between teaching methods and students of different genders is found. However, in terms of teamwork ability, female students may show stronger willingness to cooperate and communication ability in the social constructivism teaching environment.

As shown in Figure 2, the performance of different teaching methods on various ability indicators shows obvious distribution characteristics. The social constructivist teaching method shows higher consistency in innovation ability, while the cognitivist teaching method has a smaller score difference in opportunity identification ability.

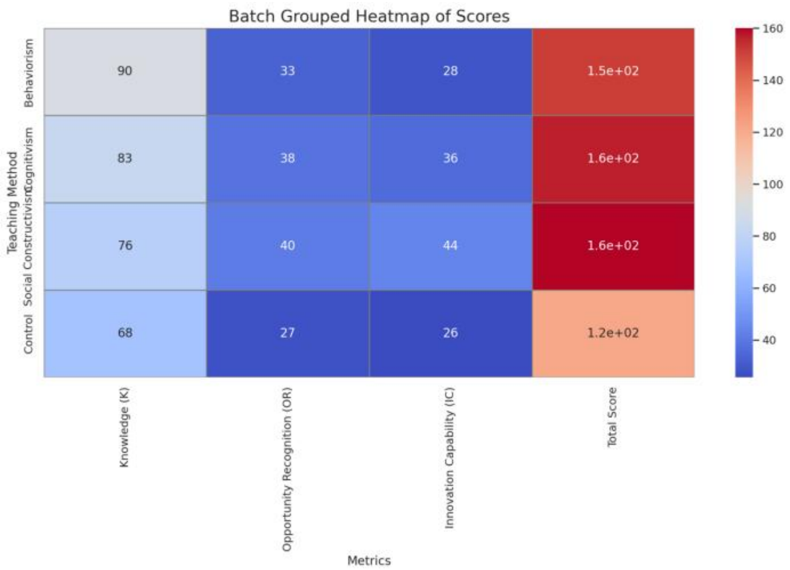

Figure 2: Batch Grouped Heatmap of Scores

6 | DISCUSSION AND CONCLUSIONS

6.1 | Summary of Research Findings

Through a rigorous experimental design, this study has verified the effectiveness and differential impacts of teaching methods under different philosophical perspectives in design innovation education. The behaviorist teaching method excels in knowledge mastery, the cognitivist teaching method helps enhance opportunity identification ability, and the social constructivist teaching method demonstrates remarkable effects in cultivating innovation ability and teamwork ability. Meanwhile, an interaction between teaching methods and student group characteristics has been identified, providing significant evidence for the selection and optimization of teaching methods in design innovation education.

From a global perspective, the performance of the three philosophical perspective-based teaching methods on different ability indicators is shown in Figure 2. The outstanding performance of the social constructivist teaching method in innovation ability is particularly notable, while the behaviorist teaching method maintains a leading position in knowledge mastery.

6.2 | Theoretical and Practical Significance

Theoretically, this study has further enriched the theoretical system of design innovation education, clarifying the relationships among philosophical perspectives, learning theories, and teaching methods, and providing an empirical basis and theoretical reference for subsequent research. Practically, it offers scientific grounds for educators to select appropriate teaching methods according to students' characteristics and teaching objectives, which is conducive to improving the quality and effectiveness of design innovation education. Educators can flexibly apply different teaching methods based on the course content and students' needs to achieve complementary advantages. For example, in teaching basic courses, the behaviorist teaching method can be appropriately adopted to ensure students' mastery of basic knowledge; when cultivating students' innovation ability and ability to solve practical problems, more use can be made of the social constructivist and cognitivist teaching methods.

6.3 | Research Limitations and Future Prospects

This study has certain limitations. Firstly, the experimental sample only consisted of some design major students, and the representativeness of the sample might be limited. Future research could expand the sample scope to cover students from different regions and different types of institutions to enhance the universality of the research findings. Secondly, the experimental period was relatively short, which might not fully reflect the long-term teaching effects. Subsequent research could extend the experiment time and track students' performance in actual work after graduation. Additionally, this study only explored the teaching methods under three major philosophical perspectives. Future research could further investigate the impacts of other philosophical viewpoints on design innovation education and the comprehensive application patterns of multiple teaching methods. During the implementation of teaching methods, the design of teaching activities could be further optimized to improve the pertinence and effectiveness of teaching. For example, in the social constructivist teaching method, team cooperation tasks and interaction links could be designed more meticulously to promote deeper communication and cooperation among students. Meanwhile, dynamic assessment of the teaching process could be strengthened to adjust teaching strategies in a timely manner to better meet students' learning needs. Future research could also conduct interdisciplinary studies, combining the theories of philosophy, psychology, sociology, etc. with design innovation education to provide more comprehensive theoretical support and practical guidance for cultivating design talents with innovation ability and comprehensive qualities.

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