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Carrying Out Training Courses in Creative Graphic Design based on Design Thinking and Problem-based Learning to Increase Students' Creative Thinking Abilities

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Abstract

Background and aim: This study focuses on the influence of creative graphic design training courses based on design thinking and problem-based learning on the cultivation of the creative thinking ability of Chinese art students, expands the breadth and depth of research on students' core literacy, and contributes to the development of students' all-round ability. The purpose of this study was to compare the students' creative thinking ability before and after learning through the creative graphic training course based on design thinking and problem-based learning.

Materials and methods: In this experimental study, 30 students of art majors from Xi'an University were investigated. This study used a scoring rubric of creative thinking ability given to students before and after learning through a creative graphic design training course based on design thinking and problem-based learning. Data were collected and analyzed by means, standard deviation, and t-test for the dependent sample.

Results: From the study, it was found that: The mean scores of pretests of students' creative thinking ability were 35.13, SD was 2.76, and the mean scores of post-tests were 41.53, SD was 2.83. The finding after implementing a creative graphic design training course based on design thinking and problem-based learning, post-test scores of students' creative thinking ability were greater than pretest scores at 0.01 level of statistical significance (t=20.21, p=0.001). The average scores of this study developed increasingly higher than the pretest. The effect size of Cohen's in this study was 3.70 it was considered to be a large effect of implementing creative graphic design training courses based on design thinking and problem-based learning on students' creative thinking ability.

Conclusion: The developed creative graphic design training course based on design thinking and problem-based learning has a significant effect on enhancing the creative thinking ability of art major students in college.

Keywords: Creative Graphic Design Training Course; Design Thinking; Problem-based Learning; Creative Thinking Ability

Introduction

We must maintain that science and technology are the primary productive forces, talent is the primary resource, and innovation is the primary driving force, said the report to the Party's 20th National Congress (2022). We must fully implement the strategies of rejuvenating the country through science and education, strengthening the country through talent, and innovation-driven development, opening up new areas and new tracks for development, and constantly creating new drivers and advantages for development. Framework for 21st Century Skills formulated by the United States in 2002, pointed out that creativity and innovation oriented to problem solving are the core skills that students must possess in the 21st century. This framework is organized and constructed based on the characteristics of the 21st century. It points out the importance of innovation and creativity, the spirit of questioning and reflection, and the ability of practice and application for students to adapt to the future world development and change. Training students' creative thinking ability not only conforms to the trend of world education reform and development but also plays an important positive role in the sustainable development of students. Training students' creative thinking ability can encourage students to open their minds, expand their imagination, and think more deeply and broadly. It can promote the development of students, master the necessary skills to adapt to the future development of society, and students can learn to study and learn to survive.

The potential meaning of higher education should be to discover, excavate, and strengthen students' creative potential, to tap and stimulate students' innovative and creative thinking, to cultivate students' innovation spirit, and to create a large number of innovative talents. Innovative education

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requires continuous innovation in teaching management, educational systems, and educational content, and comprehensive innovation in teaching methods and teaching processes. Therefore, the cultivation of college students' creative thinking and the cultivation of innovative talents are carried out together in the innovation of higher education and the cultivation of college students' creativity. Creation is the materialization and thinking results obtained by the operation of creative thinking, that is to say, only with creative thinking can there be creativity. Research shows that the best age to create is 20 to 45 years old (Department of Human Resources, 2002), and college students are in the preparation stage of this period. While the conventional thinking of college students continues to develop, creative thinking has also developed significantly, which requires colleges and universities to seize the opportunity to timely train the creative thinking of college students, improve their creativity, and create conditions for their future development.

Compared to Western countries, creative design education is relatively new in China. In recent years, design education in China has undergone a great deal of change and is in step with global development in design education (Siu, 2010). Especially since the late 1990s, under the guidance of the national policy of “popularization of higher education”, China's higher art education has expanded rapidly. And today, after entering the 21st century, China has become the largest higher art design education country in the world (Qing, 2009; Qingming, 2007). With the implementation of Opinions on Strengthening Aesthetic Education in Colleges and Universities in the New Era (2019) by the Ministry of Education of China, the traditional student-oriented learning mode has also undergone significant changes. In the current teaching system, some problems need to be solved, such as the lack of diversified interaction under the single learning mode, the insufficient status of the main body of learning, and the poor ability of students to learn independently. Therefore, how to mobilize the enthusiasm of students to acquire knowledge in the learning process, emphasizing the principal position of students, improving the single teaching mode of teachers, and promoting the diversification of students' learning mode are the main directions of teaching mode reform. However, design thinking means that people analyze, conceive, and reflect on problems in the process of thinking and solving problems, and acquire knowledge and generate necessary abilities in this process. Visibility, demand, and cooperation are important indicators of design thinking (Lin Shusheng and Yi, 2019). Design thinking focuses on real-time visual expression of one's thinking, advocates taking individual needs as the starting point, promotes students' learning drive, and is good at discussing and communicating with others. Therefore, problem-based and context-based teaching is the cornerstone of cultivating design thinking. By defining the problem, analyzing the problem, and improving the solution to the problem, the optimal solution is finally achieved. The cultivation of students' creative thinking ability takes teaching activities as the carrier and forms the process of teaching activities. In the course design process, the Problem-based Learning (PBL) teaching mode is selected as the basis, and the leading role of teachers is weakened and the guiding role of teachers is emphasized through continuous innovation of teaching mode, which can enhance the subjectivity of students' learning and the diversity of learning styles, help the free development of students' personality, and finally achieve the purpose of improving learning efficiency and learning performance. Therefore, this study focuses on the influence of creative graphic design training courses based on design thinking and problem-based learning on the cultivation of the creative thinking ability of Chinese art students, expands the breadth and depth of research on students' core literacy, and contributes to the development of students' all-round ability.

Research Question

The research question addressed by this research was how does the effectiveness of creative graphic design training courses based on design thinking and problem-based learning improve students' creative thinking ability?

Research Objective

The objective of this research was to determine the effectiveness of implementing the creative graphic design training course based on design thinking and problem-based learning by comparing the

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creative thinking ability of students before and after learning through the creative graphic design training course based on design thinking and problem-based learning.

Literature Review

Creative Graphic Design Training Course

Training Course is the basic basis of school education and teaching, as well as the basic guarantee for achieving educational goals and talent training goals (Mou, 2014). The theory of "creative graphic design" comes from the field of art design. This is one of the most important fields in the art discipline of modern society. The creative design of graphics is to increase the connotation of graphics, to disseminate the information designers want to express more effectively and accurately, and to further carry out cultural exchanges. When designing graphics, designers should form new design ideas according to the theme requirements through the visualization and reality of ideas and ideas, which is to express the emotional information designers want to convey through the increase of graphic connotation and achieve cultural exchange.

Creative graphic design is based on the theme content to be expressed, the graphic with explanatory function as the basic element, and the designer's personal imagination and unique organizational form for creation and expression. Profound works are easier to attract the attention of the public, and the works can be recognized by people in culture, but also can fully allow people to communicate their emotions in it. Visual elements are the basis of graphic creative design, these elements will make people have different ideas, which contain different meanings and philosophies. Secondly, the role of graphic creative design is that each designer's graphic creativity will have different cultures and connotations presented. So, it needs to be full of inspiration and content, before this, all designers must have a deeper understanding of the theme. The essence of design is the creation of something novel and unique (Hargrove, 2012).

The main mode of the creative graphic design training course is that students learn the basic knowledge of graphic creativity, and constantly practice and apply innovative thinking to complete the creation of graphic creativity. In the course teaching, theory teaching generally only accounts for about 30%, while the rest of the time is for students to train themselves and display their work. The purpose of a creative graphic design training course is to train students to develop their thinking ability and conceive their ideas through graphic creativity. Thus, design is often viewed as the process associated with creativity that is involved with the production and realization of new ideas and problem-solving (Dorst, 2003). In the long run, students can break away from the fixed mode and have more imagination and innovative thinking. But in the long run, it is also to train students to solve problems from different angles and starting points when they encounter problems. Therefore, the creative graphic design training course is different from the color and sketch courses of students. The creative graphic design training course is a developmental course worthy of promotion at all stages of students. As a link between art courses, the creative graphic design training course will play a certain role in promoting art teaching, guiding students to better possess art ability, apply innovative thinking to artworks, and lay a solid foundation for students' future professional design or study.

Design Thinking

Design thinking can be understood as "thinking like a designer". One of the important differences between artificial science and natural science is that artificial science cannot be separated from human design, and the integration of artificial science and natural science cannot be separated from human thinking. The core task of the school is to guide students to learn how to think about design, and then create more artifacts that integrate with nature (Lin et al, 2016). In 1987, Peter Rowe, majoring in architecture and urban design at Harvard School of Design, formally proposed the concept of "design thinking" in his book "Design Thinking", which has since been used in business, art, engineering, architecture, and other fields. In 1991, David Kelly founded IDEO with design thinking as its core idea and successfully commercialized it. In 1992, Richard Buchanan further developed the connotation of design thinking as an innovative way to solve complex problems in the design process, which attracted a lot of attention. In 2005, David Kelly founded The Hasso Plattner Institute of Design at Stanford University (D. school). The institute aims to cultivate interdisciplinary, human-centered, and innovative

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designers, funded by the world's largest management software provider - the famous German company SAP (Lu, 2015). In 2007, Dr. Hasso Plattner, co-founder of SAP, founded the School of Design Thinking at the University of Potsdam in Germany. The two schools share a similar educational philosophy and innovation experience, each offering two semesters of innovation-driven graduate courses, in addition to on-campus courses, the two schools also offer various forms of innovation training for enterprises. In 2011, the Communication University of China introduced the design thinking curriculum system from the University of Potsdam, Germany, and set up two sets of innovative courses for postgraduates. In 2014, the Communication University of China officially established the Design Thinking Innovation Center (Wang, 2017). Nowadays, design thinking has become a hot topic in the field of education and organizations, and its theoretical and practical exploration are booming.

The process model of design thinking preserves enough space between the problem and the solution, so the process of design thinking is also an exploration process without a standard answer. In this study, we mainly discuss the design thinking process model proposed by Stanford University (Hasso, Christoph, Larry, 2020).

Empathize refers to understanding the needs of the user. The core value of this stage is people-oriented, and the starting point of all needs is "people". Through observation, listening, interviews, and other methods, empathy is generated with users, and then the core demands of users are analyzed.

Define refers to reorganizing and defining the problem in a human-centered way. In the definition phase, the problem can often be described in one sentence: Who? (User), What does need? (Need), What did I find? (Insight). The core value of the definition phase is convergence, and prioritization, where we identify what is important to the user and what we should spend more time on.

Ideate refers to the creation of many ideas or ideas in the creative stage. At this stage, we can use various methods to enhance creativity, brainstorming and sketching are the most commonly used, the goal is to produce as many different concepts as possible, and then visualize them.

Prototype refers to the design of a product prototype or a solution to a problem. After the ideation phase, many ideas and ideas were generated, some of which were selected to form a basic conceptual model and to design a relatively detailed solution. The core value of prototyping is the spirit of MVP, which is to produce the least viable product.

The test refers to verifying the design prototype and improving the solution. Test phase, you can find colleagues to carry out, of course, the best way is to test users, more inspiring, and then the test results feedback to the next iteration of the product, so the core value of the test phase is the spirit of iteration.

Problem-based Learning

Problem-based Learning originated from McMaster University in Canada in the 1960s. It is a "set of teaching models designed by medical educator Howard Barrows, whose initial purpose was to" teach medical students to learn basic scientific knowledge and to better retain and retrieve it for later use in clinical situations" (Delisle, 1997); Later, after continuous research and improvement, he defined this new teaching as "learning through the process of trying to understand and solve problems, resulting in results", that is, we call PBL teaching method.

The PBL teaching method has been recognized by Western education scholars. In 1990, almost 40% of medical schools in the United States adopted PBL, while in 2000, about 50% of the courses in the American engineering School adopted PBL (Rong Zhao, 2001). Currently, there are three medical schools in the UK (Glasgow, Liverpool, and Manchester) that adopt PBL as their main teaching strategy (Morrison, 2004). In addition to medical school, the PBL teaching method has also been applied to the field of computer science. The University of Sydney in Australia believes that students' skills and attitudes towards computer science at the beginning will affect their later studies (Barg et al.,2000). The Center for Problem-Based Learning (PBL) was established in the state of Illinois in the United States to try to implement PBL teaching methods into primary and secondary education. In recent years, China has vigorously promoted educational reform, and the curriculum of colleges and universities has gradually attached importance to students' creative ability and problem-solving abilities, so many

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teaching methods are different from the traditional ones. The main features of the PBL teaching method are as follows:

1) Ask questions as the starting point of learning;
2) The question must be an ill-structured question that can be encountered by the learner in his or her upcoming professional field;
3) The learner's learning content is structured with questions as the main axis;
4) More emphasis is placed on group learning and less on teaching by narration;
5) The learner must bear the responsibility of learning and the teacher's role is to guide learning, not to pass on knowledge.

The PBL teaching method helps learners lay the knowledge foundation of spiritual life and develop critical thinking and creative thinking ability to solve practical questions. Develop the combined acting capacity and the self-learning capacity. The problem-based teaching model is based on the development of cognitive psychology, which is closely related to the research results of Piaget, Vygotsky (Bruner), etc. It is the embodiment of the theory of the construction of the main meaning theory, the theory of the knowledge of the situation, the theory of the transfer theory, and so on.

Creative Thinking Ability

Creative thinking is a high-level thinking process, which is based on the existence of a unique, new, and valuable product. It includes the forms of the generative thought dimension, the convergent thought dimension, the enlightenment, the imagination, and the creative analogical reasoning, among which the generative thought dimension and the convergent thought dimension are the two main forms of the creative thought dimension (Runco, 2003). Creative thinking is the core of creativity, and the level of individual creative thinking ability is an important reflection of his creativity, (Jiannong, 2005; Qing-Lin, and Sternberg, 2002). The meaning of creative thinking is that people's cognition of objective things is the result of originality under the guidance of creative thinking. Innovation means constant renewal and change. In the development of our society, different new things are constantly produced, and nothing can completely replace the previous things. The history of human development is also a history of innovation, and we can see the rich achievements made by our predecessors in various fields such as art, philosophy, science, and technology. They used their innovative consciousness to create more works, put forward the importance of more sophisticated products, and lead the social thought and the trend of the Times.

In 1950, Guilfold placed creativity into a large framework of structure based on the intellect. Guilford's classic structure of intellect model identifies five operations of the structure of intellect: **cognition, memory, convergent thinking, divergent thinking,** and **evaluation**, (Guilford, 1950). Guilford believed that divergent thinking is most important for creative thinking among five operations, and emphasized four divergent abilities: **Fluency, Flexibility, Originality,** and **Elaboration**. Based on Guilford's model, this study chose these four components to assess creativity: Fluency (the number of ideas), Flexibility (the number of categories of ideas), Originality (the unusualness of ideas), and Elaboration (the extension of ideas).

Fluency: Writer and educator Dan Kirby states, "Fluency is the first consideration. It is the basis for all that follows" (Dan,1991) It comes from a Latin term meaning "flowing". This is why fluency is "the first consideration" for creative thinking. Until students can paint freely and let their ideas flow freely, they will have a hard time unleashing their most creative ideas. Individuals can quickly come up with rich creative results in a short period, which reflects the patency of an individual's association with things. In the face of unexpected problems, to quickly come up with suitable solutions in a short time, we need to associate people with good thinking fluency.

Flexibility: The word flexibility comes from a Latin root meaning "pliant, easily bent". When students have to adapt or bend their thinking about something familiar and ordinary, they can discover creative ideas that are unfamiliar and extraordinary. Effectively overcoming the original frame requirements can make the unique and novel way of thinking in the human brain as an exploration tool, diverging thinking along different modes, and the results have strong rich characteristics. Flexibility refers specifically to the ability of thinking to adapt to changes, holding a negative attitude to the

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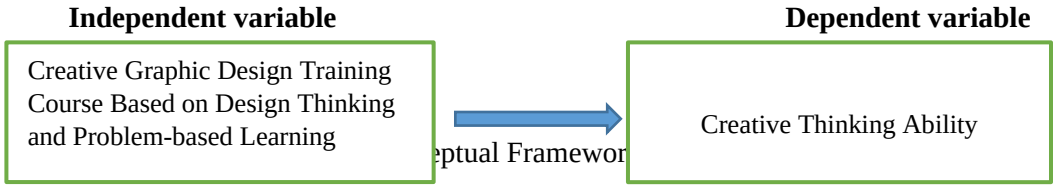
thinking set, and creating new thinking results at any time, which is the characteristic of the intermediate level of divergent thinking (Sternberg, 2006).

Originality: Originality is the ability to think creatively in an appealing way. The word originality comes from a Latin root meaning "source". When students think creatively, they come up with fresh, original ideas. They take risks and discover new territory. Some of their original ideas may work, and others may not. Helping students understand that taking risks and making mistakes is part of the creative process and can help them learn. Originality can make a unique reflection of the stimulation of objective things, and provide a different way of expressing things than ordinary people. It can be said that the essence of divergent thinking is in this unique innovation ability, which is an important expression of the highest level of divergent thinking (Runco, 2004).

Elaboration: Elaboration means "to explain something in greater detail". It comes from a Latin word meaning "to work out". Elaboration is the ability to enhance ideas by providing information and detail. Elaboration can make basic ideas, answers, or pictures interesting and exciting.

Conceptual Framework

The research title "Creative Graphic Design Training Course Based on design thinking and Problem-based Learning to enhance students' Creative Thinking Ability" was designed as the conceptual framework as follows:



Methodology

Population and samples: The population of this study was 100 first-year students in art majors at Xi'an University and the sample of this study was 30 students from the population, which were randomly selected by cluster random sampling method.

Research Instrument: Research instruments were the tools for collecting data. The research instruments used in this study were:

1. Experimental instruments

1.1 Creative graphic design training course based on design thinking and problem-based learning: The instructional strategy of the training course based on design thinking and problem-based learning included five steps:

1) Material preparation and raise a question
2) Discussion and reflection and problem identification
3) Problem situation and hypothesize
4) Deductive reasoning and feasibility judgment
5) Achievement exhibition and iteration.

Five experts evaluated the draft course in the 10 items of the training course evaluation form. It was found that the mean score was 4.93 (SD=0.13) revealing that creative graphic design training courses based on design thinking and problem-based learning were at a very high level.

1.2 Lesson plans: Five experts evaluated the six lesson plans. According to the expert evaluation form, it was found the mean score was 4.89 (SD=0.19) revealing that the lesson plan was at a very high level.

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2. Instruments for data collection

The research instrument for assessing students' creative thinking ability was a scoring rubric of creative thinking ability. The instrument in this study was compiled by Torrance based on Guilford's theory of intelligent structure and the theory of divergent thinking test. Creative thinking ability in this study included four dimensions fluency, originality, flexibility, and elaboration. Teachers then evaluated students' creative thinking ability through the scoring rubric. The reliability of the scoring rubric was computed and should be more than 0.7. It was found that reliability was at 0.89, indicating that the scoring rubric was qualified and could be used to collect data.

Data Collection

The procedures of data collection during the training course implementation process were as follows:

1) The samples were given the pre-assessment of creative thinking ability through a scoring rubric.

2) The samples that were assigned as experimental groups were taught creative graphic design training courses based on design thinking and problem-based learning to enhance the creative thinking ability of art majors at Xi'an university.

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

3) After implementation was over, the samples were given the post-assessment by using the same instrument as the pre-assessment.

Data Analysis

In this study, quantitative data were analyzed by using the statistical program in line with the research objectives as follows

Statistics were used to determine the different significance at the .01 level of scores on students' creative thinking ability before and after learning through creative graphic design training courses based on design thinking and problem-based learning to enhance the creative thinking ability of art majors in Xi'an University by using a t-test for dependent sample.

Results

According to the research objectives, the results were as follows:

Results of comparing the creative thinking ability of the students before and after receiving creative graphic design training courses based on design thinking and problem-based learning by using a t-test for dependent samples.

Table 1 Result of comparing the different scores of creative thinking ability before and after learning through creative graphic design training course based on design thinking and problem-based learning

Group	n	Pretest scores		Posttest scores		t	p	Effect size
		M	SD	M	SD			
Experimental group	30	35.13	2.76	41.53	2.83	20.21**	0.001	3.70

** p<0.01

As presented in Table 1, the mean scores of pretests of students' creative thinking ability were 35.13 (SD = 2.76) and the post-test of students' creative thinking ability was 41.53, (SD = 2.83).

Moreover, this study aimed to examine the different scores before and after the implementation of creative graphic design training courses based on design thinking and problem-based learning to enhance creative thinking ability. The finding of this table revealed that after the implementation of the creative graphic design training course, post-test scores of students' creative thinking ability were greater than pretest scores at a .01 level of statistical significance ($t29$= 20.21, p=0.001). The effect size of Cohen's d in this study was 3.70, it was considered to be a large effect

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of implementing creative graphic design training courses based on design thinking and problem-based learning on students' creative thinking ability.

Discussion

The design thinking and problem-based learning creative graphic design training course was an educational program designed to teach students creative graphic design while guiding them to apply design thinking and problem-based learning methods to solve real-world design challenges. The teaching mode takes design thinking as an effective way to help students solve problems, and the process of design thinking is the process of solving problems. The repository of methods is the repository of wisdom and talent (Yin Dingbang,2003). In the collation of experimental data, it was found that with the use of design thinking and problem-based learning teaching methods, students' creative thinking ability was significantly higher than before its implementation. Thus, this teaching method greatly improved the learning effect of creative thinking ability.

The evaluation of the development of a creative graphic design training course based on design thinking and problem-based learning was unanimously agreed upon by the experts. There may be the following reasons: First, in the preparation stage, the researcher analyzes the advantages of design thinking and problem-based learning model applied to learning, and expounds the principles, goals, content, learning process, learning materials, and learning assessment. Barrows encourages students to think purposefully to promote students' mastery of book knowledge and improve their analytical and problem-solving skills (Barrows, 1975). According to the steps of design thinking and problem-based learning proposed by domestic and foreign experts and scholars, a new model of design thinking and problem-based learning is proposed. Secondly, combined with the "Empathize, define, Ideate, prototype and test" model and problem-based learning model proposed by Stanford University, the author designs five steps from the preliminary preparation stage, problem-solving stage, and evaluation and feedback stage.

Step 1: Material preparation and raise a question. In this step, teachers determine teaching objectives based on understanding students' existing abilities and provide students with relevant materials and problems to be solved, so that students can carry out independent learning.

Step 2: Discussion and reflection and problem identification. In this step, students critically reflect on the feedback received in class and identify the issues to be studied in group discussions.

Step 3: Problem situation and hypothesize. After step 2, students have internalized the problem to be solved. Next, students have to analyze the problem in depth in the context of the existing problem, collect and process the required information by using learning resources, propose the final hypothesis through group cooperation, and then judge the feasibility of the proposed hypothesis through deductive reasoning.

Step 4: Deductive reasoning and feasibility judgment. If the problem in the previous step is not well resolved, continue the problem resolution phase by revising the plan until the problem is resolved. In this process, teachers should pay attention to key guidance.

Step 5: Achievement exhibition and iteration. In this step, the team should present the results of the solution obtained, and finally conduct the self-evaluation within the group and the mutual evaluation between the groups. The teacher should also conduct the process evaluation and the final result evaluation according to the process of solving problems of students, and the evaluation process should be objective and true. The diversified evaluation method also allows students to reflect and summarize continuously, and iterate on existing solutions while further internalizing knowledge.

Design thinking and problem-based learning are at the core of the training course, where students learn relevant concepts and skills by solving practical design problems. These problems include user experience optimization, brand identity, information visualization, etc., requiring students to think and solve from multiple perspectives. A series of practical projects are designed to allow students to apply their knowledge and skills in practical situations. Introduce some successful creative graphic design case studies to inspire students' creative thinking and allow them to learn from best practices and techniques. Students are required to complete part of the project in a team to develop teamwork and

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communication skills. The feedback mechanism of the course allows students to receive feedback from classmates and teachers after completing the project, learn from it, and improve their design. Active learning helps students become more engaged, learn more deeply, have better problem-solving and critical thinking skills, and both students and teachers can have more fun in the process. Students are encouraged to demonstrate an innovative and experimental spirit, challenge traditional design concepts, and try new techniques and methods to develop creative thinking and independent problem-solving skills. Tao Xingzhi put forward the discussion of cultivating students' creative ability through practical education with insight (Tao,2011).

Recommendations

1)In the course of teaching implementation, we should not only pay attention to how to improve students' creative thinking ability but also consider how to improve teachers' creative thinking ability with the support of design thinking and problem-based learning mode.

2)The experimental design needs to be further optimized. This research should improve the design of the teaching experiment and extend the experiment period to fully verify the research hypothesis. Clarify and improve the measurement methods of variables. The design of the teaching experiment should conform to the overall educational environment. Future research will focus on strengthening the scientific and rational demonstration of teaching experiments and improving the quality of experimental design.

3)Expand the scope of the research, increase the number of research objects, and explore the different influences of design thinking and problem-based learning teaching activity framework on learners at different ages, and the differences in learning effects for learners at different grades.

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