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Research on the Application of Flipped Classroom in University Furniture Design Course- Taking Leshan Normal University as an Example

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Abstract

Background and Aim: Flipped classroom as a modern teaching method has attracted much attention in improving students' learning performance. This study employed a flipped-classroom teaching strategy and modern technology applications to conduct teaching experiments on students. Through the test of the furniture design drawings and questionnaires, this study aims to examine the impact of the flipped classroom teaching method on academic achievement between the experimental class and the control class.

Materials and Methods: This study is quasi-experimental research, using a quantitative research method. The subjects were third-year undergraduates majoring in environmental design at Leshan Normal University in Sichuan, China. Students were in two groups, an experimental group and a control group. The flipped classroom teaching strategy was used in the experimental group class A, 55 students. The traditional teaching method was used in the control group Class B, 55 students. Through the furniture design drawing test, it attempted to understand students' ability in innovation, visual rendering, practicality, and typography, as well as the applicability and ease of use of the learning platform Superstar APP in the flipped teaching course. Data were collected through tests and questionnaires, and analyzed by using the statistical software Jamovi. The hypotheses were tested by paired samples T-test and independent sample T-test.

Results: The results showed that the teaching method of flipped classrooms has a very positive impact on students' academic performance. Students' furniture design innovation ability and layout design ability have been improved significantly. Students showed a high level of effectiveness and convenience in using the Superstar platform APP for flipped classroom teaching.

Conclusion: Based on the research results, this paper makes some suggestions on the application of flipped classrooms in furniture design courses.

Keywords: Flipped Classroom; Superstar Teaching Platform

Introduction

As a cutting-edge educational approach designed to improve the effectiveness and experience of student learning, flipped classroom teaching strategies have attracted much attention in recent years (Felder, 2012). This approach involves flipping the order of standard learning activities so that students are exposed to course materials before class and use class time for more interaction and application-focused activities (Merlin, C.,2016). Flipped classroom teaching strategies have been widely used in various teaching contexts. Zhou (2021) found that the flipped classroom is the innovation and reform of the traditional classroom teaching mode. Based on modern educational technology, students can construct knowledge through independent learning. Supported by the teaching courseware, students can start self-study before class, transfer the knowledge after class, make knowledge internalization occur, and resolve the difficulties in the classroom. The key and difficult points could be solved, and online and offline cooperative education systems could be established. Many scholars have proved that flipped classroom teaching could enhance students' learning performance and effectiveness of teaching. Guo, Zhu, Shi, Zhou, Zhang & Wang (2021) found that by combining online teaching with flipped classrooms, students can have a good feedback effect, which can mobilize students' autonomy and enthusiasm for learning. Tao, Tao & Xie (2019) emphasized the mixed learning model based on a flipped classroom provides new ideas for the teaching reform of college curriculum and has a positive role in improving the teaching effect. Wei (2015) found the positive effect of the teaching concept of "flipped classroom" on the reform of art design in the course of art design in Chinese colleges and universities.

In the context of furniture design courses for college students, there are many problems with

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traditional teaching methods. Traditional course duration may not provide enough to cover all theoretical concepts and ample practical practice for furniture design courses (Xia, Zhou & Du, 2022). Time constraints limit the opportunities for students to be deeply involved in thematic content and develop a deep understanding of design principles, materials, and manufacturing processes (Feng, 2018; Sun & Chen, 2017). Traditional teaching methods commonly used in furniture course design courses often revolve around lectures and imitation exercises (Liu, Ye & Zhou, 2019). This monotonous teaching method may not fail to fully exploit the students' creative potential and critical thinking skills, resulting in little improvement in learning ability in the learning process.

Furniture design courses are broad and interdisciplinary and require a solid foundation of theoretical knowledge and practical ability (Zhang, 2017). However, due to the restrictive nature of their prior curriculum, many college students may not have the necessary preconditions. Their ability to understand and apply ideas and methods to furniture design may be hampered by a lack of such expertise. Insufficient prior knowledge base may hinder students' understanding and application ability of furniture design, as it is a comprehensive course that builds upon previously learned concepts and skills. Qin (2019) found that it's important to have a strong foundation in furniture design before moving on to more advanced concepts. Without sufficient prior knowledge, students may struggle to understand and apply the principles that make up this comprehensive course. By building upon previously learned concepts and skills, students can develop a deeper understanding of furniture design and improve their ability to create functional and aesthetically pleasing works (Wu & Xu, 2020).

What's more, furniture design courses typically necessitate a substantial time commitment to fully grasp the theory and engage in practical operations. However, due to the constraints imposed by limited course duration, it becomes challenging to adequately address both comprehensive theoretical instruction and hands-on coursework. Taking a furniture design course can be quite demanding. It's a delicate balance between theoretical instruction and hands-on coursework that can be hard to achieve in such a short time (Zheng, J. 2018).

The current furniture design course at Leshan Normal University usually adopts traditional teaching methods, mainly emphasizing instruction and imitation, but lacking different teaching methods and learning activities. This may limit the students' learning experiences and hinder their development. Therefore, it is urgent to find more diversified teaching methods and learning activities to help students really make the most of their education.

Objectives of the Research

This study aims to explore the influence of the flipped classroom teaching method on the teaching effects of student furniture design courses and get insight into the ease of use and usefulness that students use with the Superstar learning app.

Literature Review

Constructive theory of learning

The evolution of educational practices and instructional methodologies has been significantly influenced by the constructivist approach. It promotes learner-centered instructional strategies like problem-solving exercises, opportunities for experiential learning, group projects, and active involvement in the learning process (Zhang, 2015). The theory of cognitive development during the early 20th century was first presented by Swiss psychologist Piaget, J. (1973) who went on to become a trailblazer in the field of constructivist learning theory. According to this view, kids actively participate in creating their own knowledge and understanding through varied interactions with their surroundings. Lev Vygotsky, a Soviet psychologist, developed the sociocultural theory, which emphasizes the crucial connection between social interaction, learning, and cultural setting (Vygotsky & Cole, 1978). American psychologist Bruner, J. (1961) emphasized that education should encourage active student participation in learning, transforming the learning process into a building and discovery of information. This idea is at the heart of the educational constructivism theory. The modern constructivist school has progressively emerged with the advancement of science and technology and the deeper examination of learning processes. Active learning, cooperative learning, and reflection in real-world contexts are constantly being studied by a large number of educators, psychologists, and cognitive scientists.

Technology integration

Technology integration refers to the seamless integration and use of technological tools,

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resources, and digital content across various aspects of teaching, learning, and educational practices. Instead of using technology for its own sake, it includes the deliberate and intentional application of technology to improve and enrich the experiences associated with teaching and learning (Davies & West, 2014).

Academics have developed various theoretical models to assess and facilitate the learning of student teachers in utilizing digital tools and applications for teaching purposes. Christopher (1995) developed a conceptual framework, known as the LoTi model, to assess levels of technology implementation. This model can aid school districts in adapting their teachers' curricula to incorporate concept and process-based teaching, while also facilitating the integration of authentic technology use and qualitative assessment. The Technology Acceptance Model (TAM) was initially proposed by Davis (1989) to elucidate individuals' acceptance and utilization behavior toward novel technologies (Bringhurst, 2004). The unified Theory of Acceptance and Use of Technology (UTAUT) model is a further extension and integration of the TAM model. UTAUT integrates several previous technology acceptance models, Including TAM, TPB (Theory of Planned Behavior), MAM (Motivational Model), IDT (Innovation Diffusion Theory), and so on (Venkatesh & Davis,2003). Puentedura (2003) created the Substitution, Augmentation, Modification, and Redefinition (SAMR) model to present educators with a framework for evaluating and improving their use of technology in their practice. The RAT (Replacement, Amplification, and Transformation) model proposed by Hughes, Thomas & Scharber (2006) is primarily utilized in the training of both pre-service and in-service teachers to enhance their critical decision-making skills regarding the integration of technology into K-12 classrooms. Koehler, Mishra, Kereluik, Shin & Graham (2014) proposed technological pedagogical content knowledge (or TPACK for short).

Mobile Learning Resource

Mobile learning resources, in a larger sense, refer to a system made up of a database of these resources, mobile learning support systems, and the setting where this occurs (Nie, 2019). Mobile learning resources, in a strict sense, relate to brief, in-depth digital materials that are generated with technologies appropriate for mobile devices and designed by the curriculum and learning objectives. Du (2019) finds the platform to be user-friendly and straightforward to operate, which has contributed to its effectiveness in improving academic performance. Superstar mobile platform application is easy to use, easy to operate, and has significant effects. Chi, Jiang, Li, Jiang & Wang (2020) believed that by using the App in the database system principle and application of online and offline blended teaching, students' learning autonomy and learning interest have been greatly improved, making the classroom "alive". Also, the teaching effect has been improved, and the teaching quality has been greatly enhanced.

These tools can successfully support students' participation in mobile learning. Superstar teaching platform is a new generation of network teaching platform developed by Beijing Superstar Erya Education Technology Co., Ltd., which is divided into PC end and mobile end, which are called "pan-elegant" and "learning Tong" respectively. The curriculum resources developed by the institute are mainly based on the platform. The teachers can establish classes through the PC platform, edit courses, analyze learning data, and perform other operations. The learners can choose either the PC platform or mobile devices to access their learning materials, complete various assignments and tests, as well as engage in communication and interactive activities (Zhang & Li, 2020).

Flipped classroom teaching strategy

A teaching strategy known as the "flipped classroom" places collaborative and inquiry-based learning outside of class time while low-level knowledge acquisition—often in the form of a video podcast—occurs inside of it (Bergmann & Sams, 2012; Herreid & Schiller, 2013). An instructional strategy called the "flipped classroom" seeks to turn around the conventional order of learning. While engaging in interactive and applied learning activities including discussions, problem-solving, group work, and practical projects during class, students use self-directed learning to review material before class (Bergmann & Sams, 2012). The concept of classroom mode and the transformation of teacher and student identity in the flipped classroom was first developed by J. Wesley Bake and proposed at the 2000 International Conference on University Teaching in 2000, namely "Information communicators teaching on the platform" turned into the process of students' practice "experience sharer" and "direction leader" are the original flipped classroom understanding. Through research, Dina found that the “Business Translation” flipping classroom teaching mode can integrate MOOC teaching methods and traditional business translation teaching content to realize personalized learning and independent learning, and effectively improve teaching effects (Zhai, 2017). Yang (2017) mainly discussed the advantages, importance, and feasibility of “flip classroom” in the context of big data, and analyzed the

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model applied to the teaching of college literature. The constructivist learning approach in that technology has been integrated took advantage of the flipped classroom learning environment and showed good learning achievements (Koohang, Riley, Smith & Schreurs, 2009). A flipped classroom was defined as a combined, constructivist learning environment (Felder, 2012; Strayer, 2012). This instructional strategy aimed to maximize teaching effectiveness by increasing students' involvement, active participation, and thorough comprehension.

Conceptual Framework and Research Hypothesis

Conceptual Framework

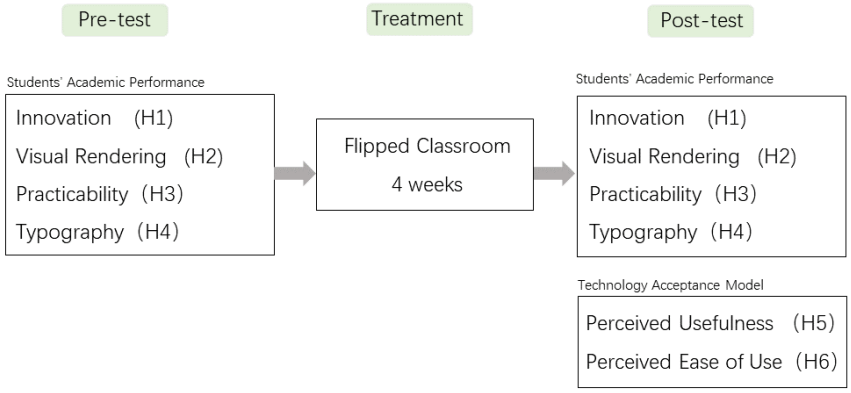

Figure 1 Conceptual Framework

Research hypothesis

This study tested students' ability in furniture design from four aspects, namely innovation, visual rendering, practicability, and typography. Innovation can be distinguished from invention, which Schumpeter defined as the initial discovery of new products or processes, it may also be used interchangeably with technological change to describe the necessary steps for introducing a new product into the market (Greenacre & Alpek, 2012). The term visual rendering refers to the utilization of computer software, hand-drawing techniques, and other technologies to convert design drawings or models into visually realistic images. These images are employed to showcase the appearance and impact of the design scheme (Gill & Lange, 2018). Practicability is employed to characterize the functionality and pragmatic viability of a program, project, or action. Typography, similar to exhibition board typesetting, refers to the process of adjusting the position and size of visual information elements such as text, pictures, and graphics in the layout to organize the layout (Bringhurst, 2004). Therefore, this paper puts forward the following assumptions:

$H_0$1: There is no difference in the level of students' innovation after receiving instruction in a flipped classroom.

H_a1: There is a difference in the level of students' innovation after receiving instruction in a flipped classroom.

$H_0$2: There is no difference in the performance of students' visual rendering after receiving instruction in a flipped classroom.

H_a2: There is a difference in the performance of students' visual rendering after receiving instruction in a flipped classroom.

$H_0$3: There is no difference in students' practicability design scores after receiving instruction in a flipped classroom.

H_a3: There is a difference in students' practicability design scores after receiving instruction in a flipped classroom.

$H_0$4: There is no difference in students' typography design scores after receiving instruction in a flipped classroom.

H_a4: There is a difference in students' typography design scores after receiving instruction in a flipped classroom.

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Research Methodology

The purpose of this study was to investigate the impact of flipped classroom teaching on students' academic achievement in furniture design courses and to investigate students' perception of the use of the software Superstar, so it is quasi-experimental research, using a quantitative research method. This is done by focusing on two groups of students, the experimental group and the control group, to collect and analyze data. The teacher used different teaching strategies in these two groups. A flipped classroom teaching strategy was used in the experimental group Class A, and traditional teaching was used in the control group Class B.

Population and Sample Size

The population is the juniors in the universities in China. The samples came from third-year undergraduates who were studying at Leshan Normal University, aged around 19-21 years old. Lesan Normal University is a public undergraduate college in Southwest China. Students were admitted through the Chinese College Entrance Examination. These juniors have also adapted to the university learning style and have a certain understanding of their major. Students of the same major have the same curriculum and teaching syllabus in the same year. In addition, the school management will assign the same teacher to teach the same course.

G*Power software was used to determine the required sample size. G*Power, which was created specifically for behavioral research, offers precise power analyses for the majority of statistical experiments (Erdfelder, Faul & Buchner, 1996). The result indicated that each group required a minimum of 51 samples, with a total of 102 samples needed.

Sampling Method

Purposive sampling is a technique for choosing samples based on predetermined goals and standards, allowing researchers to thoroughly examine a certain phenomenon or group (Miles & Huberman, 1994). The samples were third-year furniture design undergraduates from a normal university in Sichuan, China, who took a furniture design course in the first semester of the third year of college. They came from two classes, 55 participants each, with a total of 110 participating in the teaching experiment.

Research Instrument

The researcher used Leshan Normal University's scoring standards for teaching furniture design courses as the source of evaluating students' furniture design ability and conducted a questionnaire survey on the perceived usefulness and perceived ease of use. The questionnaire was modified to make it suitable for the content of this study. The researcher also tested the validity and reliability of the measurement tool through a pilot test.

In this study, the PU (Perceived usefulness) questionnaire and the PEOU (Perceived ease of use) questionnaire were used to understand how the students felt about using the Superstar learning platform APP. Perceived usefulness is the degree to which a person believes that using a particular system would enhance their performance, and perceived ease of use is the degree to which a person believes that using a particular system would be free from effort (Kitchakarn, 2016).

Reliability of Research Instruments

The questionnaire was designed for a smaller sample to test the ability of respondents to understand and track the questions in the instrument. The purpose of the pilot test is to evaluate the questionnaire with smaller samples before entering the more important samples so that the efforts taken in collecting the data should achieve the exact purpose. It also helps to test for any errors in the questionnaire. The questionnaire was distributed among junior students at Leshan Normal University who were not involved in the teaching experiment. Incomplete questionnaires were not considered for further processing. Respondents were asked their opinions on the process, wording, and difficulty of answering the questions and instructions. It helps to effectively reveal some of the deficiencies in the predictive questionnaires.

To test the reliability of the questionnaire, 35 samples completed the pilot test of the questionnaire. The internal consistency reliability of the scale was measured with Cronbach alpha.

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According to Cronbach (1951) and Hair (2014), it was found a Cronbach alpha greater than 0.7 was considered "good". The Alpha values for Cronbach are shown in Table 1.

Table 1: Cronbach's Alpha of the Constructs Measured

Construct	Cronbach's Alpha	No of items
Perceived Usefulness	0.917	10
Perceived Ease of Use	0.923	5

Perceived usefulness had an alpha value of 0.917. Perceived ease of use had an alpha value of 0.923. Reliability statistics for the constructs were excellent as the reliability score is seen to be above 0.7. As a result, the questionnaire for the research is considered reliable and can be employed to collect data for the research.

Validity of Research Instruments

To test the content validity of the questionnaire items, the item objective consistency (IOC) method was used to measure the consistency of the questionnaire items to measure the constructs. Three experts were invited to provide ratings for each item. These experts were selected based on the following criteria, having a master's degree or a doctor's degree, experts and experience in education and/or fields, and being a lecturer teaching in a university. All of the items measuring the constructs had an IOC rating larger than 0.67, indicating they were valid to use (Turner & Carlson, 2003).

Data Collection and Analysis

The university software technicians have developed a user manual for the Superstar learning platform APP for all the teachers. The researcher chose teachers who were qualified to implement teaching technology programs and who were willing to participate in teaching reform experiments. Before the experiment, the students of the two classes, the experimental group, and the control group, were pretested, then the teaching experiment began. After four weeks, 64 classes of the experiment, the students had the post-test on their furniture design ability, and then a questionnaire survey was conducted on the ease and usefulness of the Superstar learning platform APP. The data from the test and questionnaire survey were collected. The questionnaire was a five-level Likert scale questionnaire, from 1 (disagree) to 5 (agree). The questionnaire was distributed to the students who were in the experimental group.

To analyze the data and test the hypotheses in this study, the researcher used the paired-sample t-test and the independent sample t-test. Jamovi statistical software was used for all statistical analysis. The research utilized descriptive statistics, including measures of central tendency and variability. Specifically, the mean, median, and standard deviation were employed to characterize data from both experimental and control groups. The questionnaire employs a 5-point Likert scale to gather data from respondents, and an arbitrary level is applied for data interpretation. An independent t-test was conducted to analyze the scores and determine whether significant differences existed between the experimental and control groups. The paired-sample t-test is a statistical hypothesis test used to compare the means of two related groups of data. It is applicable when there is a correlation between the paired observations, such as measurements taken from the same participants at different time points or under different conditions (Abdullah & Ward, 2016).

Results

Research results were obtained through data analysis. To start things off, demographic information of the samples was presented, which is followed by a detailed description of the statistical results for the tests and questionnaires. Paired-samples t-test and independent sample t-test were used for hypothesis testing.

Demographic Information

The table below provides a clear and concise overview of the sample's demographics, including age, gender, and other relevant factors. It can be seen that there were 110 students participated in the experiment, split into two groups with 55 people each. The students in the experimental group Class A

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consisted of 10 boys (18%) and 45 girls (82%). The age range for Group A was between 21 and 23, with 10 students, or 18.18% aged 21, 37 students, or 67.27% aged 22, and 8 students, or 14.55% aged 23. In the control group, Class B had a total of 55 students, including 9 boys (16.36%) and 46 girls (83.64%). The age range for Class B was also between 21 and 23, with 9 students, or 16.36% aged 21, 36 students, or 65.45% aged 22, and 10 students, or 18.18% (see Table 2 and Table 3 for more details).

Table 2: Demographic Information for Students in Class A

Student demographic information		Number	Percentage
Gender			
	Male	10	18.0%
	Female	45	82.0%
Age			
	19 years of age	10	18.18%
	20 years of age	37	67.27%
	21 years of age	8	14.55%

Table 3: Demographic Information for Students in Class B

Student demographic information		Number	Percentage
Gender			
	Male	9	16.36%
	Female	46	83.64%
Age			
	19 years of age	9	16.36%
	20 years of age	36	65.45%
	21 years of age	10	18.18%

Descriptive Statistics for Variables

The results of the furniture design test were analyzed by using the statistical software Jamove, comparing pre- and post-experiment data between Class A and Class B. The results are presented in Table 4.

Table 4: Descriptives statistics for furniture Design A and B Class pre and post-test

	N	Mean	Median	SD	Minimum	Maximum
Pre-test of Class A （Total）	55	77.9	79	5.82	56	86
Pre-test of Class B （Total）	55	77.0	78	5.84	57	88
Post-test of Class A （Total）	55	85.7	87	5.75	65	94
Post-test of Class B （Total）	55	81.4	82	6.08	61	91

The average score of Class A students before the experiment was 77.9 points, and the standard deviation was 5.82. The average score of Class B students was 77 points. The standard deviation was 5.84. The average score difference between the two classes was only 0.9 points. The experimental group

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was only 0.9 points higher than the control group. Standard deviations were almost the same. The highest and lowest scores in Class A were 86 and 56, respectively. The highest and lowest scores in Class B were 88 and 57, respectively. This shows that the difference in the academic performance of the two classes before the experiment was very small. The furniture design ability of the students in these two classes was basically the same.

The mean score of class A students after the experiment was 85.7, with a standard deviation of 5.75. But the average score of Class B students was only 81.4 and the standard deviation was 6.08. The mean score of the experimental group was 4.3 points higher than that of the control group. In terms of standard deviation, the standard deviation of Class A in the experimental group was 5.75, 0.33 less than that of Class B (6.08). The highest score of Class A in the experimental group was 94 points, 3 points higher than that of Class B. The lowest score in experimental group A was 65, 4 points higher than that of the control group Class B. This shows that the difference between the two classes is larger after the experiment, and the learning results of the students in the experimental group class A are better than that of the control group class B.

Table 5 represents the learning performance before and after the experiment in Class A and Class B of the control group. As can be seen from Table 5, the average score of class A increased from 77.9 points to 87.7 points, by 7.8 points. The standard deviation decreased from 0.07, from 5.82 to 5.75. The highest score increased from 86 points to 94 points, and the lowest score increased from 56 points to 65 points. After the experiment, the average score of control group Class B increased only by 4.4 points, from 77 points to 81.4 points, while the standard deviation increased from 5.84 to 6.08. The highest score increased from 88 points to 91 points, and the lowest score increased from 57 points to 61 points. Before the experiment, the highest score of class A in the control group was 2 points lower than that of class B, but the highest score of class A was 3 points higher than that of the control group.

Table 5: Descriptive statistics for the pre and post-test scores of furniture design

	N	Mean	Median	SD	Minimum	Maximum
Pre-test of Class A （Total）	55	77.9	79	5.82	56	86
Post-test of Class A （Total）	55	85.7	87	5.75	65	94
Pre-test of Class B （Total）	55	77.0	78	5.84	57	88
Post-test of Class B （Total）	55	81.4	82	6.08	61	91

It can be seen from the above analysis that although the total score of the two groups of furniture design courses has been improved, the total score of the students in the experimental group Class A is even higher than that of the control group Class B. What's more, the furniture Design course evaluates students' works from four aspects. The following is the analysis of the four aspects, innovation, visual rendering, practicability, and typography.

Descriptive statistics for innovation

The comparison of the furniture design works of the students from the aspect of innovation is shown in Table 6. It can be seen that the average score of Class A, which adopts the flipped classroom teaching and superstar learning platform, increased by 2.1 points, from 19.1 points to 21.2 points, the standard deviation increased from 2.02 to 2.28, the highest score increased from 23 points to 25 points, and the lowest score increased from 12 points to 14 points. The average score of the control group Class B increased only by 1.1 points, from 18.9 points to 20 points, the standard deviation increased from 2.09 to 2.19, the highest score rose from 22 points to 24 points, and the lowest score rose from 13 points to 14 points. Before the experiment, the highest and lowest scores of class A were higher than those of the control group. In general, students in the experimental group Class A had a better improvement in innovation than those of the control group Class B.

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Table 6: Descriptive statistics for innovation

	N	Mean	Median	SD	Minimum	Maximum
Class A Pre-test	55	19.1	20	2.02	12	23
Class A Post-test	55	21.2	22	2.28	14	25
Class B Pre-test	55	18.9	19	2.09	13	22
Class B Post-test	55	20.0	20	2.19	14	24

Descriptive Statistics for Visual rendering

Table 7 shows the comparison of the furniture design works of class A and class B students from the aspect of visual rendering. It can be seen that the average score of Class A increased by 1.9 points, from 19.4 points to 21.3 points and the standard deviation rose from 1.94 to 2.0. The highest score rose from 23 points to 25 points, and the lowest score rose from 13 points to 15 points. After traditional teaching in the control group, the average score of Class B increased only by 1.4 points from 19.1 to 20.5, and the standard deviation increased from 2.15 to 2.16. The highest score was from 23 to 24, and the lowest score was from 13 to 14. Before the experiment. The highest and lowest scores of class A were higher than those of the control group. In general, the performance of experimental group A was similar to that of control group B in terms of rendering effect, but some students in class A performed better than those in control group B.

Table 7: Descriptive statistics for visual rendering

	N	Mean	Median	SD	Minimum	Maximum
Class A Pre-test	55	19.4	19	1.94	13	23
Class A Post-test	55	21.3	22	2.00	15	25
Class B Pre-test	55	19.1	19	2.15	13	23
Class B Post-test	55	20.5	20	2.16	14	24

Descriptive Statistics for Practicability

Then we made a data analysis on the practicality of students' furniture works. Table 8 shows the comparison between the furniture design works of Class A and Class B in terms of practicality. As can be seen from Table 8, the average score of class A, which adopts the flipped classroom teaching and superstar learning platform, increased by 1.8 points from 19.8 points to 21.6 points after the experiment, the standard deviation decreased from 2.16 to 1.9, the highest score rose from 23 points to 25 points, and the lowest score rose from 13 points to 16 points. After traditional teaching in the control group, the average score of class B increased from 19.3 to 20.4, only with an increase of 1.1 points. The standard deviation rose from 1.99 to 2.01, the highest score rose from 23 to 24, and the lowest score rose from 13 to 15. This indicates that the two classes were based on the same level, but the experimental group Class A improved significantly after the experiment.

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Table 8: Descriptive Statistics for Practicability

	N	Mean	Median	SD	Minimum	Maximum
Class A Pre-test	55	19.8	20	2.16	13	23
Class A Post-test	55	21.6	22	1.91	16	25
Class B Pre-test	55	19.3	20	1.99	13	23
Class B Post-test	55	20.4	20	2.01	15	24

Descriptive Statistics for Typography

Finally, we conducted a data analysis on the typesetting integrity of the students' furniture works. Table 9 represents the comparison of the furniture design works of experimental group Class A and control group Class B in terms of typesetting integrity. As can be seen from Table 9, the average score of class A, which adopts the flipped classroom teaching and superstar learning platform, increased from 19.5 points to 21.6 points, up by 2.1 points. The standard deviation decreased from 2.22 to 1.82, the highest score increased from 23 points to 25 points, and the lowest score increased from 15 points to 17 points. After traditional teaching, the average score of control group Class B increased from 19.6 points to 20.6 points, up by 1 point. The standard deviation increased from 2.03 to 2.06, the highest score increased from 23 points to 24 points, and the lowest score increased from 13 points to 16 points. Most of the students in Class A which adopted the flipped classroom teaching and superstar learning platform performed better than Class B.

Table 9: Descriptive Statistics for Typography

	N	Mean	Median	SD	Minimum	Maximum
Class A Pre-test	55	19.5	20	2.22	15	24
Class A Post-test	55	21.6	22	1.82	17	25
Class B Pre-test	55	19.6	20	2.03	13	23
Class B Post-test	55	20.6	21	2.06	16	24

Descriptive Statistics for Questionnaire Perceived Usefulness and Perceived Ease of Use

For the questionnaire Perceived Usefulness and Perceived Ease of Use, Arbitrary Level was used for the interpretation. In the study, the 5 Level Likert Scale questionnaire (from disagreement to agreement) was employed to collect data from respondents. The arbitrary level for the interpretation of the data is presented in Table 10.

Table 10: Arbitrary Level for the Interpretation of the Questionnaire on Participant Engagement (Pimentel, 2010).

Scale	Interpretation
1.00-1.79	Disagree
1.80-2.59	Partly Disagree
2.60-3.39	Neutral
3.40-4.19	Partly Agree
4.20-5.00	Agree

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To understand the perceived usefulness of the educational technology Superstar Mobile Platform APP on students learning in the furniture design class, a questionnaire was conducted on students in the experimental group Class A. The following are the statistical results of the data.

Table 11: Descriptive statistics of perceived usefulness of superstar mobile platform APP

	N	Mean	SD	Minimum	Maximum
Average	55	4.39	0.506	3.00	5.00
PU-1	55	4.82	0.434	3	5
PU-2	55	4.80	0.447	3	5
PU-3	55	4.87	0.336	4	5
PU-4	55	4.76	0.470	3	5
PU-5	55	4.80	0.558	2	5
PU-6	55	3.93	1.184	1	5
PU-7	55	4.24	0.816	2	5
PU-8	55	4.04	1.053	1	5
PU-9	55	3.71	1.242	1	5
PU-10	55	3.87	1.090	1	5

It can be seen from above Table 11 that most students support the Perceived Usefulness of the Superstar Mobile Platform APP. Just as most of the questions in the questionnaire scored higher than 4.2 points, the overall score also reached 4.39 points, indicating that students were satisfied with the use of the superstar learning platform. However, it can be seen from the table that the score of some questions was higher than 3.4 but lower than 4.2, indicating that some students using the Superstar learning platform have not reached their expectations. All in all, the Superstar Mobile Platform APP can still support students' learning in the furniture design course to a greater extent.

To understand how students feel about the convenience of using the Superstar Mobile Platform APP, the Perceived Ease of Use questionnaire was applied in furniture design courses to collect data, and the following are the statistical results of the data (see Table 12).

Table 12: Descriptive statistics of perceived ease of use of superstar mobile platform APP

	N	Mean	SD	Minimum	Maximum
Average	55	4.31	1.113	3.80	5.00
PEOU-1	55	4.54	1.198	3	5
PEOU-2	55	4.15	1.026	3	5
PEOU-3	55	4.37	1.103	2	5
PEOU-4	55	4.25	1.061	3	5
PEOU-5	55	4.20	1.217	2	5

It can be seen that most of the questions in the questionnaire were scored higher than 4.2, the overall score reached 4.31, indicating that students felt convenient to use the Superstar Mobile Platform APP. The Perceived Ease of Use was evaluated high by the students. However, for the second question, the rated score was below 4.2, indicating that the Superstar Mobile Platform APP for video learning has not reached students' expectations. However, the superstar learning platform can also support students

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learning to a larger extent in furniture design courses, and students felt using the learning platform auxiliary learning is relatively easy.

Hypothesis Testing

For hypothesis testing, paired sample t-test and independent sample t-test were used to assess whether there was a significant difference in the scores between the pre-test and post-test.

Hypothesis 1

$H_0$1: There is no difference in the level of students' innovation after receiving instruction in a flipped classroom.

Ha1: There is a difference in the level of students' innovation after receiving instruction in a flipped classroom.

For Hypothesis 1, we tested the data collected from the innovative aspect of the students in the experimental group by using the statistical method of paired sample t-text. Then the innovative performance of the experimental group Class A students and the control group Class B students were tested by using independent sample t-text. The test results are shown in Figure Figure Table and Table.

Table 13: Paired Samples T-Test for Innovation

			statistic	df	p		Effect Size
Class A Pre-test	Class A Post-test	Student's t	-9.79	54.0	< .001	Cohen's d	-1.32

Table 14: Independent Samples T-Test for Innovation

		Statistic	df	p		Effect Size
Innovation	Student's t	3.66	108	< .001	Cohen's d	0.699

As can be seen from Table 13 the scores of students in Class A (Mean = 21.2, SD=2.28) were significantly higher than the scores before the experiment (Mean = 19.1, SD=2.02), as t (54) = -9.79, p <0.001. This indicates that the scores of students in Class A were significantly different before and after the experiment. From Table 14, it can be seen that the scores of students in Class A (Mean = 21.2, SD=2.28) were significantly higher than that of Class B in the control group (Mean = 20, SD=2.19), as t (108) =3.66, p< .001. Therefore, it can indicate that the innovation ability of furniture design was significantly improved after using the Super Star learning platform app in the flipped classroom. So, the null hypothesis $H_0$1 should be rejected.

Hypothesis 2

$H_0$2: There is no difference in the performance of students' visual rendering after receiving instruction in a flipped classroom.

Ha2: There is a difference in the performance of students' visual rendering after receiving instruction in a flipped classroom.

For Hypothesis 2, we tested the data collected from the visual rendering aspect from the students in the experimental group by using the statistical method of paired sample t-text. The visual rendering performance of the experimental group Class A students and the control group Class B students were tested by using independent sample t-text. The test results are shown in Figure Table 15 and Table 16.

Table 15 Paired Samples t-test for Visual Rendering

			statistic	df	p		Effect Size
ClassA Pre-test	ClassA Post-test	Student's t	-10.1	54.0	< .001	Cohen's d	-1.36

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Table 16 Independent Samples t-test for Visual rendering

		Statistic	df	p		Effect Size
Visual rendering	Student's t	2.00	108	0.048	Cohen's d	0.381

As can be seen from Table 15, the scores of students in Class A in the experimental group (Mean = 21.3, SD=2.0) were significantly higher than the scores before the experiment (Mean = 19.4, SD=1.94), as t (54) = -10.1, p <0.001. This indicates that the scores of students in Class A were significantly different before and after the experiment. It can be seen from Table 16 that the performance of students of Class A after the experiment (Mean = 21.3, SD=2.0) was significantly higher than that of students of Class B in the control group (Mean = 20.5, SD=2.16), as t (108) =2.00, p=0.048. Therefore, the innovation ability of furniture design was significantly improved after using the Super Star learning platform app in the flipped classroom, so the null hypothesis $H_0$2 should be rejected.

Hypothesis 3

H03: There is no difference in students' practicability design scores after receiving instruction in a flipped classroom.

Ha3: There is a difference in students' practicability design scores after receiving instruction in a flipped classroom.

For Hypothesis 3, paired sample t-text was conducted on the data collected from the practicability aspect of the students in the experimental group. Then the practicability performance of the experimental group Class A students and the control group Class B students were tested by using independent sample t-text. The test results are shown in Figure Figure Table and Table 18.

Table 17 Paired Samples T-Test for Practicability

			Statistic	df	p		Effect Size
Class A Pre-test	Class A Post-test	Student's t	-9.04	54.0	< .001	Cohen's d	-1.22

Table 18 Independent Samples T-Test for Practicably

		Statistic		df	p		Effect Size
Practicability	Student's t	3.28	[a]	108	0.001	Cohen's d	0.625

[a] Levene's test is significant (p < .05), suggesting a violation of the assumption of equal variances

As can be seen from Table, the scores of students in Class A (Mean = 21.6, SD=1.91) were significantly higher than the scores before the experiment (Mean = 19.8, SD=2.16), as t (54) = -9.04, p <0.001. This indicates that the scores of students in Class A were significantly different before and after the experiment. From Table 18, it can be seen that the scores of students of Class A (Mean = 21.6, SD=1.91) were significantly higher than that of students of Class B in the control group (Mean = 20.4, SD=2.01), as t (108) =3.28, p=0.001. Therefore, this shows that the practicability of students' furniture design works was significantly improved in the use of Superstar Mobile Platform APP teaching in flipped classrooms. So, the null hypothesis $H_0$3 should be rejected.

Hypothesis 4

$H_0$4: There is no difference in students' typography design scores after receiving instruction in a flipped classroom.

Ha4: There is a difference in students' typography design scores after receiving instruction in a flipped classroom.

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For Hypothesis 4, paired sample t-text was conducted on the data collected from the typography aspect of the students in the experimental group. Then the typography performance of the experimental group Class A students and the control group Class B students were tested by using independent sample t-text. The test results are shown in Figure Table 19 and Table 20.

Table 19 Paired Samples T-Test for Typography

			statistic	df	p		Effect Size
Class A Pre-test	Class A Post-test	Student's t	-9.32	54.0	< .001	Cohen's d	-1.26

Table 20 Independent Samples T-Test Typography

			df	p		Effect Size
Typography	Student's t	3.82 [a]	108	< .001	Cohen's d	0.729

[a] Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

As can be seen from Table 19, the scores of students in Class A (Mean = 21.6, SD=1.82) were significantly higher than the scores before the experiment (Mean = 19.5, SD=2.22), as t (54) = -9.32, p <0.001. This indicates that the scores of students in Class A were significantly different before and after the experiment. From Table 20, the performance of students in Class A (Mean = 21.6, SD=1.82) was significantly higher than that of Class B in the control group (Mean = 20.6, SD=2.06), as t (108) =3.82, p< .001. Therefore, it shows that the typesetting quality of students' furniture design works has been significantly improved after the use of Superstar Mobile Platform APP teaching in the flipped classroom. So $H_0$4 should be rejected.

Discussion

First of all, it was found that through using the teaching strategy of the flipped classroom and Superstar mobile platform APP in a furniture design course, students' innovation in furniture design, rendering renderings, practicability, and typesetting were all improved. The main reason is that the flipped classroom teaching strategy is a relatively novel teaching method for students, which can fully mobilize students' learning enthusiasm and improve their participation. This result is in line with the (Gao, Zhu, Shi, Zou, Zhang, Wang & Yu, 2021) findings that flipped classroom teaching strategy and information technology could promote students' subjective initiative in learning, improve learning effects, and enhance students' comprehensive abilities. As a new and efficient teaching method， the teaching model of "superstar platform + flipped classroom" could improve the quality of teaching, promote students' independent learning, communication, cooperation, and other comprehensive qualities

Secondly, the use of scientific and technological methods to support teaching and learning is very in line with the characteristics of current students, who are growing with the development of technology and are willing to use technological means to assist their learning. Among the abilities required in the furniture design course, students' furniture design innovation ability and layout design abilities improved the most. It shows that teaching with technology can make students take the initiative, and actively use technology, and in return, technology can fully stimulate students' imagination and creation because modern technology can broaden students' horizons and improve their innovative ability. Wang, Bian, Li, Qu, Lv & Zhao (2019) found that the flipped learning students performed considerably better in painting and their creativity was significantly improved after the technology was applied in the

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classroom. Students appreciated the use of flipped instruction and agreed that technology was beneficial for the flipped instructional design.

Finally, in terms of the learning feeling, according to the questionnaire survey of using Superstar Mobile Platform APP in flipped classroom teaching, we found that students generally believe that using Superstar Mobile Platform APP in flipped classroom teaching can effectively improve students' learning effect, and believe that Superstar Mobile Platform APP is convenient to use, easy to operate and has remarkable effect This result is in line with the Zhang Jie (2019) findings that this is a learning platform suitable for furniture design course. It is also confirmed that the when "flipped classroom" teaching mode is applied to practical teaching, or combined with multimedia teaching, Superstar APP integrated in the flipped teaching mode can fully embody the "intuitive, vivid, image" teaching characteristics and demonstrate "student-oriented" teaching concept as the center. Using modern information technology to create an efficient classroom for students is an efficient means to stimulate students' interest in learning, improve their learning efficiency, and also an important way to improve the quality of education and teaching. As He's research result showed that based on analyzing big data and flipping classrooms, the network technology curriculum teaching model complements classrooms based on flipping technology characteristics of courses through three steps: the detailed design model, which can enhance students' ability to self-learning, practical ability, and innovative ability, and improve classroom teaching effect (He, 2016).

Conclusion

The research found that after using the Super Star mobile platform APP in flipped classroom teaching, students' learning performance in the furniture design course has been significantly improved in all aspects. A significant improvement was noticed in students' learning in the furniture design course, and a remarkable enhancement in the quality of the students' designs was observed. Not only did it improve the convenience and quality of their design drawings, but it also helped them a lot in the layout of the furniture design drawings. A considerable improvement was also observed in the students' furniture design innovation ability and layout design ability. Superstar mobile platform APP was a great tool that provided immense assistance to our students and helped them excel in their coursework.

According to the questionnaire survey of using the Superstar mobile platform APP in flipped classroom teaching, it is found that students generally believed that using the Superstar mobile platform APP in flipped classroom teaching can effectively improve their learning performance. Additionally, they found that the platform was user-friendly and straightforward to operate, which contributed to its effectiveness in improving their academic performance. Superstar mobile platform application is easy to use, easy to operate, and has significant effects on learning performance.

At the same time, the implementation of the flipped classroom requires a para. This study makes a compelling case for the benefits of a flipped classroom teaching strategy. By prioritizing extracurricular activities and classroom discussions, students were better engaged with the material and developed problem-solving skills. The positive impact on student learning performance and academic achievement is well-documented, making the flipped classroom an attractive option for educators seeking to optimize their teaching methods. However, implementing this approach requires a shift in teaching paradigms, as teachers must take on a more guiding and promoting role. Ultimately, the study of flipped classroom teaching is critical for improving the professional development and effectiveness of educators, and it provides a valuable resource for enhancing teaching methods and abilities. Shift in teachers' teaching methods requires them to take more guidance and promotion effects. The study of flipped classroom teaching is crucial to improving the professional development and teaching effects of educators, and it is also a valuable resource for improving teaching methods and teaching ability.

By studying the implementation and impact of the flipped classroom approach, this study provides valuable insights and inspiration for educational reform and promoting innovation and progress in education. This innovative approach has the potential to promote progress and enhance learning outcomes in education. By studying the flipped classroom model, we can optimize teaching

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methods and strengthen the overall learning experience for students. It is of great significance for optimizing teaching methods and strengthening learning.

Recommendation

Firstly, with the progress of information technology and technology, future research needs to explore the means of technical support education. In addition to the Superstar Mobile Platform APP, it also needs more technical support learning platforms, and means of research.

Secondly, this study is only applied to environmental design majors, and future research on flipped classrooms can be extended to other majors in art courses.

Thirdly, from the perspective of teachers engaged in art education, most teachers are more willing to use the traditional teaching mode for teaching, and they have not realized the reform that modern technology has brought to education. Therefore, it is urgent to strengthen the training in the use of modern educational technology for teachers.

Fourthly, the flipped classroom teaching model is difficult for curriculum development. In future research, teachers need to develop the flipped curriculum by using different means to solve the shortage of teachers' strengths.

Last but not least, the flipped classroom teaching mode is difficult for students learning management. In future research, to improve students' ability of independence, we should strengthen the construction of student management. For the teaching mode of the flipped classroom, we need to build a suitable teaching evaluation system for ourselves. More attention should be paid to the assessment of participation in the learning process and the student's ability to learn independently. As students study together for a long time and have a deeper understanding of each other, teachers can invite students to participate in the evaluation and organize students to democratically evaluate and score each other, to form a fair and reasonable evaluation system. In addition, teachers can establish adequate incentives to reward students who perform well to encourage other students to maintain positive enthusiasm.

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