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# An Online Collaboration Platform Enhances the Design Process for Creativity in Cultural and Creative Product Design Projects

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**Abstract**

**Background and Aim:** The growing demand for spiritual and cultural enrichment in today's digital economy presents new opportunities and challenges for cultural and creative product design. This study investigates whether integrating the online collaboration platform Fabrie into the design thinking process can enhance creativity in cultural and creative product design, addressing a critical gap in technology-driven pedagogy.

**Materials and Methods:** A quasi-experimental study was conducted with 85 sophomore product design students (treatment group: *n*=43; control group: *n*=42). Participants, preselected for comparable proficiency in computer-aided design and overall performance, underwent no pretest to baseline equivalence. After a 5-week intervention, outcomes were assessed using the Creative Product Semantic Scale (CPSS), which evaluated novelty, resolution, style, visualization, and collaboration, and a supplementary engagement questionnaire.

**Results:** Mann-Whitney U test revealed that the treatment group exhibited higher mean ranks than the control group across all six dimensions. Significant improvements were observed in resolution ($p = 0.016$), style ($p = 0.042$), and visualization ($p = 0.040$). These results suggest that the integration of design thinking with an online collaborative platform positively enhances students' design capabilities.

**Conclusion:** The findings demonstrate that Fabrie significantly enhances practical problem-solving, aesthetic expression, and visual communication in design education, providing actionable insights for integrating technology into creativity-driven pedagogy. While promising, generalizability is limited by sample size and homogeneity. Future work should diversify participant demographics and benchmark Fabrie against emerging platforms to strengthen applicability.

**Keywords**: Online Collaboration Platform; Cultural and Creative Products; Design Process; Creativity

## Introduction

With the development of society and economy, people's pursuit of spiritual life continues to improve, ushering in new opportunities and challenges for cultural and creative products (Feng et al., 2022). The cultural and creative industry, which relies on personal creativity, skills, and talent to develop and promote cultural resources, has emerged as a vital sector in the context of global economic integration (Huang & Jia, 2022). Its core lies in culture and creativity, shaping the identity, economy, and quality of life in global cities (Henriques & Elias, 2022). Chinese cultural and creative products, for instance, carry profound cultural and social significance, fulfilling not only aesthetic but also spiritual needs (Feng et al., 2022).

Design creativity and technical fluency are central to this industry, particularly in the area of Industry 4.0 (Vo, 2022). Creativity in design involves generating novel solutions through iterative processes—asking, imagining, planning, creating, and improving. However, its subjective nature makes it challenging to measure or teach through standardized methods (Open Colleges). Studies show that design aesthetics influence consumer purchase intentions via perceived value, with cultural traditionality moderating this effect (Li & Li, 2022).

In education, design thinking has become a key methodology for nurturing creativity and innovation (Kessner et al., 2021). It equips students with problem-solving frameworks and reinforces creative confidence (Clark et al., 2020). Collaborative learning further enhances this process; students integrate



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theory, skills, and artistic expression using platforms that support idea-sharing through visualizations, diagrams, and multimedia tools.

Despite these advances, gaps persist in understanding how digital collaboration tools optimize creative workflows in education, as well as how cultural specificity interacts with design creativity. This study aims to address these gaps by investigating how an online collaboration platform (Fabrie) is incorporated into the design thinking process to enhance creativity in cultural and creative product design projects.

**Research Objectives**

RO1. To compare the design creativity scores-comprising novelty, resolution, and style-between students using the online collaboration platform and those using traditional methods.

RO2. To examine differences in the design process outcomes-specifically visualization and collaboration-between the treatment group and the control group.

RO3. To assess and compare student engagement levels in a cultural and creative product design project across the two groups.

**Literature review**

The integration of technology in education has become pivotal for fostering innovation and creativity, particularly in design disciplines. Research indicates that digital tools enhance teaching outcomes by facilitating interactive and visualized learning processes (Singh et al., 2021). Among these tools, AI-powered platforms have gained prominence for their ability to streamline collaborative workflows and support creative problem-solving (Fitria, 2021). Online whiteboard platforms, for instance, address the limitations of physical collaboration by enabling remote teams to brainstorm, organize ideas, and co-create in real time (Ozturk et al., 2021). Such tools are especially valuable in design education, where visual thinking and iterative feedback are central to the learning process.

While multiple platforms support digital collaboration, their functionalities cater to distinct user needs. Miro: A widely adopted whiteboard tool optimized for large-scale team collaboration and project management. Figma: Primarily a UI/UX designer and prototyping tool, favored for its vector-based editing and developer handoff capabilities. Fabrie: Positioned as a hybrid tool for creative teams, Fabrie combines whiteboard flexibility with design-oriented features, such as mood boards, design research templates, and AI-assisted ideation. Unlike Miro or Figma, it emphasizes visual storytelling and non-linear design processes, making it particularly suited for cultural product design projects where contextual exploration and style development are critical.



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**Table 1** Comparative Analysis of Collaborative Platforms

| Application | Key Features | Suitable Industries | Target Audience | User Expericence | Pricing Model |
|---|---|---|---|---|---|
| **Miro** | Real-time collaboration, infinite canvas, rich template library, integrations | Education, project management, marketing, design | Teams, educators, project managers | User-friendly, intuitive interface | Free version, user-based subscription |
| **Figma** | Design-focused, powerful prototyping tools, real-time collaboration, cloud-based design | UX/UI design, product development, design agencies | Designers, product managers, developers | Smooth design experience, precise control | Free version, professional subscription |
| **Fabrie** | Creative brainstorming, simple UI, seamless integration with design tools | Creative industries, design, advertising | Creative teams, artists, designers | Clear and easy-to-use, focused on creative processes | Free trial, premium subscription |

**Fabrie**

The technology utilized in this study is Fabrie, an Artificial Intelligence (AI)-augmented online collaboration whiteboard developed by Shanghai Corbusi Technology Co., LTD. (launched in 2022), accessible via web browsers, desktop application, and WeChat Mini program. Positioned as a tool for design features for design research, design exploration, brainstorming, mind-mapping, and visual presentation, distinguishing itself from generic whiteboards (e.g., Miro) through its focus on nonlinear design workflows and style exploration templates.

The platform's shared virtual spaces facilitate design thinking by transforming abstract concepts into tangible visual representations. This visualization enhances both team communication and self-reflective learning, a critical element of creative development. Furthermore, Fabrie's real-time co-editing and version history features enable students to iteratively refine ideas through the externalization of thought processes, aligning with established practices in design education.

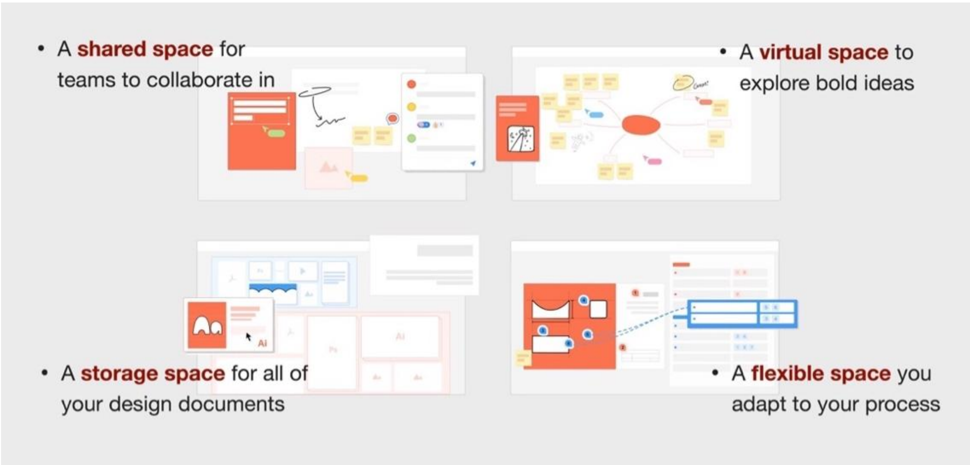


**Figure 1** Features of Fabrie (Adapted from Fabrie.cn)

## Conceptual Framework

### Theoretical Framework

This research is grounded in constructivist learning theory and incorporates elements of collaborative learning, project-based learning (PBL), design thinking (DT), and product semantics. These theoretical frameworks are extended and adapted to align with the research purpose and instructional design.



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*Constructivism Learning Theory*

Proposed by Jean Piaget, constructivism posits that learning is an active process where learners construct knowledge based on prior experiences (Rob & Rob, 2018). Constructivism Theory posits that learners actively construct knowledge through interactions with their environment (Schunk, 2012). Collaborative environments enhance this process, enabling learners to create meaningful products through interaction, shared tools, and mutual understanding (Rob & Rob, 2018).

*Collaborative Learning*

Collaborative is fundamentally defined as "the process of two or more people or organizations working together to complete a task or achieve a goal" through shared knowledge, consensus building, and mutual learning (Dillenbourg, 1999). In creative disciplines like media arts and design, this manifests through social contexts where participation enables both creation and knowledge sharing, forming peer-to-peer and mentor-peer collaborative relationships (Tsortanidou et al., 2019; Meyer et al., 2018).

*Project-based Learning (PBL)*

PBL as a constructivist practice (Wu & Tu, 2023) is a student-centered approach that uses real-world problems to foster inquiry-based learning. It cultivates critical thinking, problem-solving, and teamwork while aligning with constructivist principles- students deepen understanding by applying knowledge. In design education, PBL enhances comprehensive skills (Baldissera & Delprete, 2020).

*Design Thinking (DT)*

Design and design thinking may be critical to creativity and innovation (Kessner et al., 2021). DT is a human-centered, iterative process rooted in design cognition. Tim Brown defines it as integrating user needs, technology, and business requirements (https://designthinking.ideo.com/). By reframing problems as opportunities, DT encourages exploratory problem-solving (Nielsen & Stovang, 2015).

*Product Semantics*

Emerging in the 1980s, this discipline studies symbolic meanings of objects in use contexts (Krippendorff & Butter, 1984). It addresses not only physical functions but also psychological, social, and cultural dimensions, shaping industrial design practices.

**Theories Related to the Variables**

The relationship between variables and the theoretical framework in this study can be understood as follows: utilizing a collaborative learning environment through a Project-Based Learning (PBL) project approach grounded in constructivism theory, and creating meaningful products through the design process. Accordingly, the variables identified for this study include novelty, resolution, style, visualization, collaboration, and engagement.

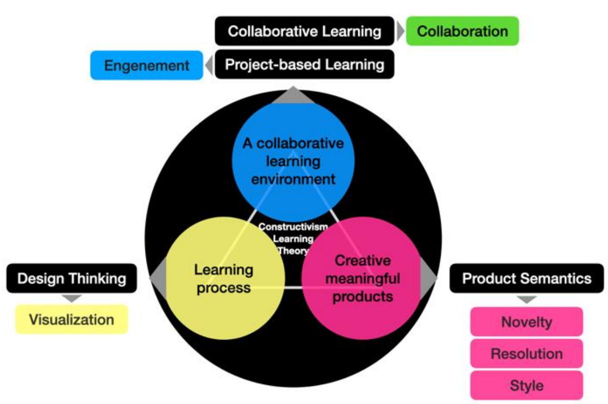


**Figure 2** Diagram of the Relationship of Theoretical Variables



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*Novelty*

Novelty refers to the originality and unexpectedness (i.e., rarity and surprise) of an idea or product (Vo, 2022). Key dimensions include newness, infrequency, and subjective perception of unusualness (Azadegan et al., 2008). In creativity research, it specifically denotes the uniqueness and distinctiveness of generated ideas (Runco & Jaeger, 2012).

*Resolution*

Resolution refers to the logical coherence, practical utility, and clarity of a creative outcome (Vo, 2022). It emphasizes that a solution must be well-developed ("just right"), complete, and sufficient to address the intended problem (Azadegan et al., 2008). Additionally, resolution encompasses the feasibility and implementability of ideas, ensuring they are viable in real-world contexts (Amabile, 1996).

*Style*

Style encompasses the aesthetic refinement, expressive quality, and technical execution of a creative work. It reflects organicity (cohesive integration), craft (skillful execution), and elegance (polished optimization) in the final output (Vo, 2022). Additionally, style captures the distinctive aesthetic character and expressive uniqueness that define a creative product's visual or conceptual identity (Kirton, 2003).

*Visualization*

Visualization is the process of transforming abstract creative thinking into concrete representations (Abd et al., 2022), enabling designers to externalize and refine ideas through diagrams, logical frameworks, and textual annotations (Clark et al., 2020). It serves as a bridge between conceptualization and execution, making intangible ideas tangible, communicable, and actionable (Cross, 2006).

*Collaboration*

Collaboration is a socially embedded process where individuals or groups work collectively to achieve shared creative goals (Dillenbourg, 1999). It integrates knowledge exchange, peer-to-peer learning, and consensus-building within design projects (Meyer et al., 2018), while also fostering mentor-guided and participatory dynamics that enhance media arts practices (Tsortanidou et al., 2019).

*Engagement*

Engagement refers to the degree of active involvement, commitment, and sustained effort demonstrated by individuals in a learning or creative process (Schlechty, 2011; Fredricks et al., 2004). In educational contexts, it specifically captures students' dedication to achieving their goals and their consistent participation in both classroom and extracurricular activities (Dubey et al., 2023). This concept underscores cognitive, emotional, and behavioral investment, whether in academic pursuits or creative endeavors.

**Table 2** Theories and Supported Variables

| Theory | Supported Variables |
|---|---|
| Constructivism | Engagement, Visualization, Collaboration |
| Collaborative Learning | Engagement, Collaboration |
| Project-based Learning | Engagement, Novelty, Resolution |
| Design Thinking | Visualization, Collaboration |
| Product Semantics | Novelty, Resolution, Style |

**Research Framework**

The pre-test is not utilized in this research. The premise is that all the students have completed prerequisite courses, including *Design Process and Methods*, and successfully passed the corresponding exams, and the rank distribution of students is similar. They are familiar with the design process, as well as proficient in computer-aided design and overall design performance.

Then the students were divided into two groups, the treatment group and the control group. Both groups were assigned the same design task: to create a cultural and creative product that expresses traditional Chinese culture through teamwork. The difference lies in the approach- while the treatment



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group implemented the design process using Fabrie, the control group followed a traditional teaching method.

After five weeks of instruction, the final works of both groups will be evaluated separately based on the criteria of novelty, resolution, style, and visualization. Additionally, both groups will complete a questionnaire to assess their engagement levels after the evaluation.

The instruction plans for the treatment group spanned five weeks, with a total teaching time of 60 hours, comprising four half-day classes per week. In the first class, both groups were introduced to the design task. The treatment group then followed the five steps of the design process using Fabrie to complete their project, while the control group adhered to the traditional teaching approach.

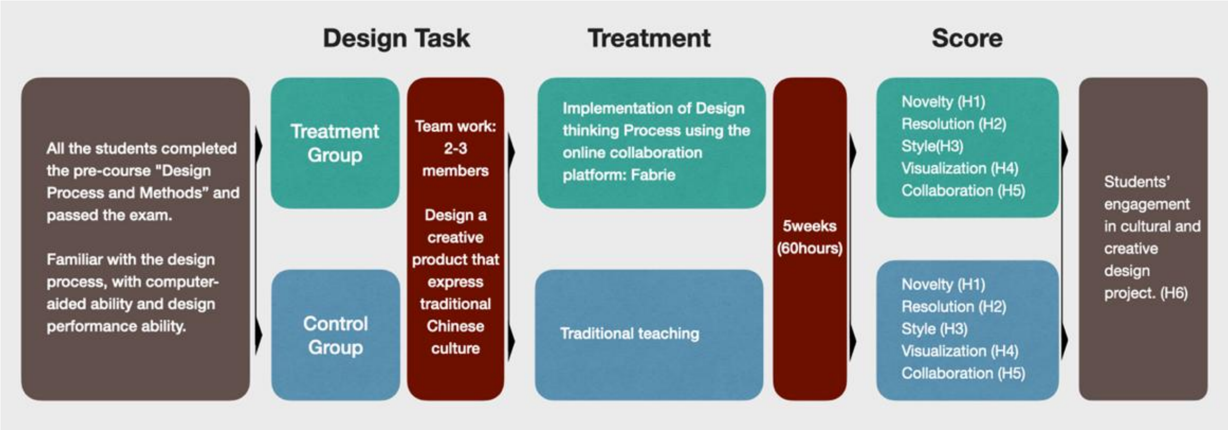


**Figure 3** Research Framework

**Hypotheses**

$H_0$1 There is no difference in the novelty score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_a$1 There is a difference in the novelty score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_0$2 There is no difference in the resolution score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_a$2 There is a difference in the resolution score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_0$3 There is no difference in the style score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_a$3 There is a difference in the style score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_0$4 There is no difference in the visualization score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_a$4 There is a difference in the visualization score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_0$5 There is no difference in the collaboration score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_a$5 There is a difference in the collaboration score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

$H_0$6 There is no difference in the engagement between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.


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$H_a6$ There is a difference in the engagement between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design process.

## Methodology

### Research Design

This study of the online collaboration platform, Fabrie, assists in the design thinking to enhance creativity in the cultural and creative product design projects is a research and development, which is conducted in two phases according to the research objectives.

In the first phase of the research, a quasi-experimental method was adopted. The samples were divided into two groups: one is the treatment group, and the other is the control group. After a period of teaching with identical content and duration, the final design works, comprising design sketches, digital renderings, design prototypes, and the design process (design thinking), produced by the treatment and control groups, were independently assessed through a performance test. Descriptive statistical analysis was then applied to conclude.

In the second phase, a questionnaire was used to determine students' engagement for both the treatment and control groups was used to further explore students' perspectives and to compare the differences.

### Population and Sample

This curriculum study was developed for sophomore design majors at the School of Art and Design, Zhejiang Business College, China. The purpose is to explore whether the use of an online collaborative platform can enhance students' design creativity. It is hypothesized that the online collaboration platform is used in the creative process to visualize design thinking, which can more intuitively support the imagination and creative process of students, and finally produce the design outcomes of cultural and creative products with creative value through team collaboration.

The sample size consists of a total of 85 students. They are all sophomores majoring in product design. They possess a certain level of art foundation, aesthetic sense, design skills, innovation awareness, and familiarity with the design process. None of them has prior experience using Fabrie.

All of the samples are assigned to classes based on the university assignment. Thus, the researcher utilized the natural class that already existed. In order to identify the class as a treatment or the control class, the researcher utilizes a simple random sampling method of using a coin flip to assign the class to the treatment and control classes.

### Research Treatment

### First phase: Performance Test

Research follows the design thinking (DT) process model. The teaching strategy of this study is centered on the implementation process of design thinking. The collaborative methods and tools of design thinking help teams utilize their differences positively. Design thinking is a non-linear process. In combination with the five steps of design thinking proposed by Stanford innovation methodology, students are encouraged to work together in a team, visualize the process of design thinking through Fabrie, and more intuitively apply the creative process to the creation of cultural and creative product design projects.



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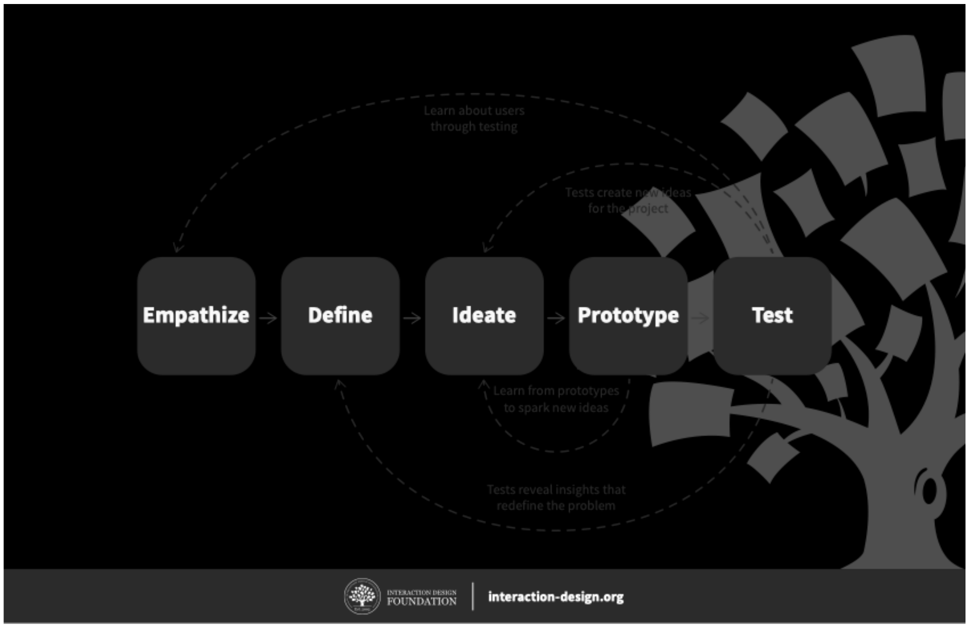

**Figure 4** The five-stage process of design thinking
(Adapted from Interaction Design Foundation - IxDF. What is Design Thinking (DT)? (2016)

In the cultural and creative product design project, the teaching process will last for 5 weeks, with classes held on Mondays, Tuesdays, Thursdays, and Fridays for half a day each. This schedule provides a total of 60 hours of teaching time. At the beginning of the course, the teacher introduced key considerations in cultural and creative design. Following the introduction, students are assigned the design task of designing a creative product that expresses traditional Chinese culture. The project is completed in groups of 2-3 students within a specified timeframe.

| Cultural and Creative Design Project | | |
|---|---|---|
| Week | Treatment Group | Control Group |
| 1st week (12h: Mon, Tue, Thu, Fri morning) | Design task: Design a creative product that express traditional Chinese culture (3-4 students) | |
| | **Design thinking process (Empathize) using Fabrie** After group discussion, each team member can share and record information at any time using Fabrie | Case analysis: Group discussion |
| 2nd week | **Design thinking process (Define) using Fabrie** After group discussion, define/determine the challenge, complete the Persona using Fabrie | Team work: Group discussion |
| 3rd week | **Design thinking process (Ideate) using Fabrie** Collaborate to complete brainstorming, mind mapping using Fabrie, and converging toward one idea | Team work |
| 4th week | Sketches, Digital drawing (Rhino, C4D, Keyshot), Modeling / 3D Print | |
| | **Design thinking process (Prototype) using Fabrie** Update and refine the design plan according to the product model using fabrie | Division of tasks |
| 5th week | **Design thinking process (Test) using Fabrie** Visualization design thinking by Fabrie, and collaborates complete project proposal and presentation | Presentation: Use the traditional method to show the results |
| Performance test | Date Collection: Performance test to the project (Novelty, Resolution, Style, Visualization, Collaboration ) | |
| Questionnaire | Date Collection: Students' engagement in cultural and creative design project | |

**Figure 5** Research Treatment

Designers tend to share their ideas through various channels, such as notes, drawings, and models. It is essential to portray ideas on paper for the design process (Ozturk et al., 2021).


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In traditional teaching, after learning about design thinking, students use traditional methods such as paper to record the discussion results, a computer to collect design information, and finally complete the design.

Different from the traditional teaching (control group), the treatment group using Fabrie assists the design thinking process. Online solutions allow users to log in to a blank page designed to replicate a virtual whiteboard and digitally draw simultaneously by several people (Ozturk et al., 2021). The treatment group broke down the total teaching objective into several small teaching objectives according to the five-stage process of design thinking, and visualized the design thinking by using Fabrie to make mind maps and journey maps, etc., and all team members could collaborate online at the same time to edit and refine the design plan. Fabrie will document the entire process of the design proposal.

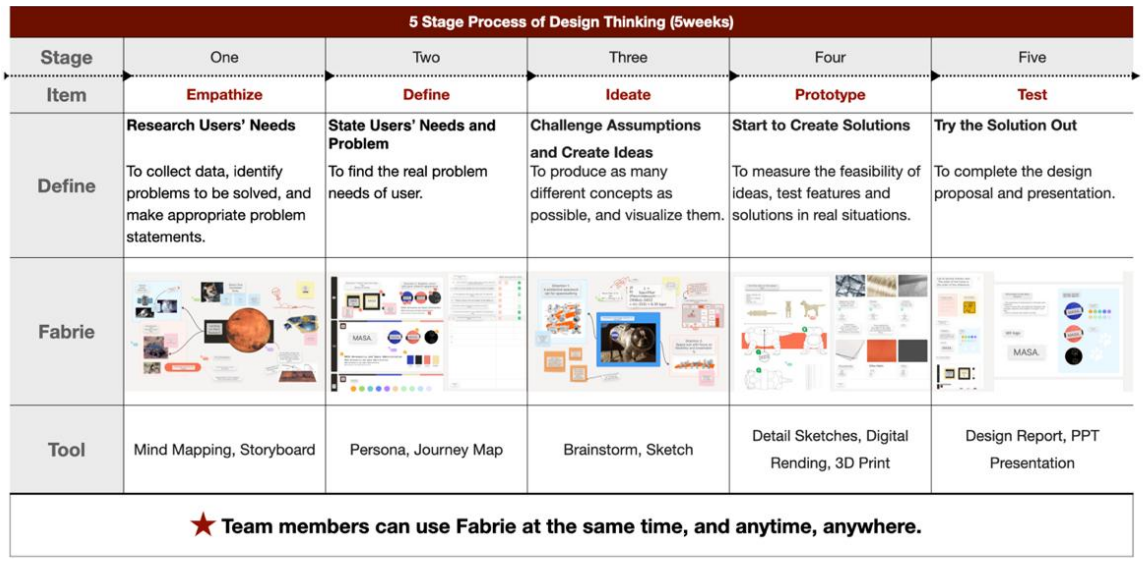


**Figure 6** Five-stage Process of Design Thinking Using Fabrie

*Stage one: Empathize - Research Users' Needs*

At this stage, the goal is to understand and observe. Through discussion and analysis of the task background, market dynamics, users' needs, available technology, constraints, regulations, and standards, students observe and analyze real behavior in authentic scenarios. This process connects specific tasks with user insights, enabling students to collect data, identify problems to be solved, and craft appropriate problem statements.

Student teams can utilize Fabrie for mind mapping, recording storyboards, and capturing emotional imagery. With Fabrie's open and flexible platform, students can record, share, and develop their ideas at any time, whether during or after class.

*Stage two: Define – State Users' Needs and Problem*

In this stage, the focus is on identifying the real problem and redefining it. By analyzing and categorizing the data collected in the previous step, various methods such as user persona, experience journey map, and problem trees can be employed. These tools help uncover patterns and similarities in users' needs and problems, enabling a more precise and actionable understanding.

To maintain a human-centered approach, the team may create personas that represent key user archetypes. These personas guide the team's efforts to stay aligned with user needs and priorities throughout the design process.

*Stage three: ideate – Challenge Assumptions and Create Ideas*

The purpose of this stage is to develop the solution to be tested. Students can use a variety of methods to expand their thinking and enhance their creativity. Techniques such as brainstorming, mind mapping, and sketching are employed to generate as many diverse concepts as possible and visualize them.

Team members use Fabrie to record and share ideas, identify innovative solutions for the problem, and select feasible solutions to advance to the next stage.

*Stage four: Prototype – Start to Create Solutions*



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This is an experimental stage aimed at identifying the best possible solution for each problem. Prototyping is a critical step in design thinking, encouraging students to evaluate the feasibility of their ideas in a real-world setting, testing both functionality and solutions. Abstract conceptual ideas can be transformed into tangible visualizations through detailed sketches, digital renderings, design documents, and 3D printing.

Teams explore these ideas by producing inexpensive, scaled-down versions of the product (or specific features of the product) for further investigation. Using Fabrie's important feature, the team can organize and store design concepts in real time, as well as update and iterate on design files seamlessly.

*Stage five: Prototype – Try the Solution Out*

In a cultural and creative product design project, the final steps involve prototype testing and presenting the design solution to evaluate whether it addresses the identified problems. Testing may reveal new insights, prompting teams to refine their prototypes or even revisit the Define stage to reassess the problem.

Through the process, team members can communicate online anytime and anywhere. By simply accessing Fabrie, they can modify design solutions, advance the design process, and visualize their design thinking. Additionally, teachers can provide real-time feedback and collaborate through Fabrie, ensuring continuous improvement and support.

**Second phase: Questionnaire**

At the end of the course, students completed a questionnaire to assess their engagement in the cultural and creative product design project. The questionnaire was created using the SoJump application and distributed through WeChat to the 85 students who participated in the study.

**Table 3** Questionnaire Operation Table

| Item | | Operationalization |
|---|---|---|
| **Engagement** | **Behavior Engagement** | BE1. I pay attention in class. |
| | | BE2. I follow the rules of my institution. |
| | | BE3. I usually complete my assignments on time. |
| | | BE4. When I have doubts, I ask questions and participate in debates in the classroom. |
| | | BE5. I usually participate actively in group assignments. |
| | **Emotional Engagement** | EE1. I feel excited about the design project. |
| | | EE2. I like spending time on this design project. |
| | | EE3. I feel like a part of this design project. |
| | | EE4. I like to share my thinking/ideas for the design project. |
| | | EE5. My classroom is an interesting place to be. |
| | **Cognitive Engagement** | CE1. Finding ways to make the course interesting to me. |
| | | CE2. I talk to people outside my institution on matters that I learned in class. |
| | | CE3. If I do not understand some concepts taught, I try to solve the problem by consulting with others. |
| | | CE4. I try to integrate the acquired knowledge in solving new problems. |
| | | CE5. I try to integrate subjects from different disciplines into my general knowledge. |

After five weeks of instruction, both the treatment group and the control group submit their final works, which include an A3 design board, an A4 design report, a design prototype, and a 5-minute presentation. Experts evaluated the submissions based on five criteria: novelty, resolution, style, visualization, and collaboration. Subsequently, data on students' engagement in cultural and creative product design projects were collected through a questionnaire using a 5-point Likert scale.



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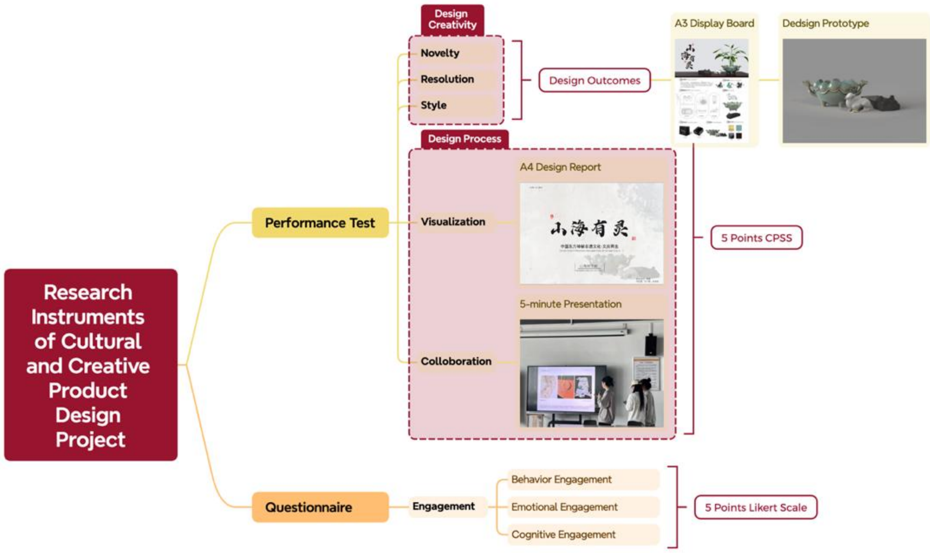


**Figure 7** Research Instruments

The evaluation criteria of the performance tests are derived from the Creative Product Semantic Scale (CPSS).

Creative Product Semantic Scale (CPSS) is based on a theoretical model (O'Quin & Besemer, 1989). Each attribute in the CPSS is assessed using semantic pairs on a seven-point scale. However, in this study, a five-point scale (1-5, low to high) was employed to facilitate score conversion.

Rating a total of 55 semantic pairs is time-consuming (Thang et al., 2008), and not all pairs have been tested in studies focusing on creativity in cultural and creative product design projects. Therefore, this study utilized a streamlined version of the CPSS, incorporating 10 semantic pairs. Examples include novelty (e.g., conventional – original), resolution (e.g., useless - useful), style (e.g., warmed-over - trendsetting), visualization (e.g., inadequate - adequate), and collaboration (e.g., inessential - essential). Additionally, performance test data were collected for further analysis.

## Results

The study adopts a quantitative research method, incorporating variables such as novelty, resolution, style, visualization, collaboration, and engagement. Two instruments were utilized in this study: a design work performance test and a questionnaire. The hypotheses were analyzed and tested using the Mann-Whitney test method.

### Demographic Information

The course of the Cultural and Creative Product Design course consisted of two classes with a total of 85 students. Among them, 31 are male (35.5%), and 54 are female (63.5%). All participants were sophomores, with 84 students (98.8%) having two years of design learning experience. One student (1.2%) had three years of design learning experience due to an extended study period caused by a previous suspension.

### Descriptive Statistics of Variables

This section presents the statistical analysis of the five performance test variables assessed in this study: Novelty, Resolution, Style, Visualization, and Collaboration. Normality tests were performed on the data to determine the appropriate statistical methods to be applied. The valid sample consisted of 85 participants. Group 1 (treatment group) comprises 43 participants, and Group 2 (control group) comprises 42 participants.

The questionnaire consisted of 15 questions with a total score of 75 points, divided into three themes: behavioral engagement, emotional engagement, and cognitive engagement, each accounting for 25 points.

According to Table 4, the results indicate that Group 1 outperformed Group 2 overall, particularly at higher percentiles. Furthermore, as shown in Table 5, the significance levels for both groups are below




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0.05, warranting the use of non-parametric statistical methods for subsequent analyses to ensure accuracy and reliability.

**Table 4** Percentiles for Variables

| Percentiles | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Group** | **Percentiles** | | | | | | |
| | | | **5** | **10** | **25** | **50** | **75** | **90** | **95** |
| Weighted Average (Definition 1) | Novelty | 1 | 5.670 | 7.000 | 8.000 | 9.33 | 10.00 | 10.00 | 10.00 |
| | | 2 | 7.000 | 7.000 | 8.000 | 8.16 | 9.000 | 10.00 | 10.00 |
| | Resolution | 1 | 6.330 | 8.000 | 8.000 | 8.33 | 9.000 | 9.670 | 10.00 |
| | | 2 | 6.049 | 6.330 | 8.000 | 8.00 | 8.660 | 9.000 | 9.280 |
| | Style | 1 | 6.000 | 6.000 | 8.000 | 8.00 | 8.330 | 9.000 | 9.330 |
| | | 2 | 6.000 | 6.000 | 7.000 | 8.00 | 8.000 | 8.330 | 8.610 |
| | Visualization | 1 | 6.000 | 6.000 | 8.000 | 8.67 | 9.000 | 10.00 | 10.00 |
| | | 2 | 5.670 | 6.000 | 8.000 | 8.00 | 8.330 | 9.410 | 9.916 |
| | Collaboration | 1 | 6.000 | 6.000 | 8.000 | 8.33 | 9.000 | 10.00 | 10.00 |
| | | 2 | 5.000 | 5.000 | 7.172 | 8.00 | 8.670 | 9.469 | 9.950 |
| | Engagement | 1 | 46.80 | 58.20 | 66.00 | 75.0 | 75.00 | 75.00 | 75.00 |
| | | 2 | 46.50 | 56.90 | 70.00 | 75.0 | 75.00 | 75.00 | 75.00 |
| Tukey's Hinges | Novelty | 1 | | | 8.000 | 9.33 | 10.00 | | |
| | | 2 | | | 8.000 | 8.16 | 9.000 | | |
| | Resolution | 1 | | | 8.000 | 8.33 | 9.000 | | |
| | | 2 | | | 8.000 | 8.00 | 8.660 | | |
| | Style | 1 | | | 8.000 | 8.00 | 8.330 | | |
| | | 2 | | | 7.000 | 8.00 | 8.000 | | |
| | Visualization | 1 | | | 8.000 | 8.67 | 9.000 | | |
| | | 2 | | | 8.000 | 8.00 | 8.330 | | |
| | Collaboration | 1 | | | 8.000 | 8.33 | 9.000 | | |
| | | 2 | | | 7.340 | 8.00 | 8.670 | | |
| | Engagement | 1 | | | 67.50 | 75.0 | 75.00 | | |
| | | 2 | | | 70.00 | 75.0 | 75.00 | | |

**Table 5** Normality Test Results for Variables

| Tests of Normality | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Group** | **Kolmogorov-Smirnova** | | | **Shapiro-Wilk** | | |
| | | **Statistic** | **df** | **Sig.** | **Statistic** | **df** | **Sig.** |
| Novelty | 1 | .205 | 43 | <.001 | .826 | 43 | <.001 |
| | 2 | .204 | 42 | <.001 | .889 | 42 | <.001 |
| Resolution | 1 | .221 | 43 | <.001 | .889 | 43 | <.001 |
| | 2 | .314 | 42 | <.001 | .866 | 42 | <.001 |
| Style | 1 | .314 | 43 | <.001 | .786 | 43 | <.001 |
| | 2 | .385 | 42 | <.001 | .744 | 42 | <.001 |
| Visualization | 1 | .243 | 43 | <.001 | .864 | 43 | <.001 |
| | 2 | .316 | 42 | <.001 | .866 | 42 | <.001 |
| Collaboratio | 1 | .246 | 43 | <.001 | .857 | 43 | <.001 |



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| Tests of Normality | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Group | Kolmogorov-Smirnova | | | Shapiro-Wilk | | |
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| n | 2 | .232 | 42 | <.001 | .897 | 42 | .001 |
| Engagement | 1 | .364 | 43 | <.001 | .633 | 43 | <.001 |
| | 2 | .365 | 42 | <.001 | .594 | 42 | <.001 |
| a. Lilliefors Significance Correction | | | | | | | |

**Descriptive Statistics of Engagement**

Descriptive statistics, including mean and standard deviation values, were used to report the agreement levels of the samples concerning the questionnaire items. The interpretation of the mean values follows the guidelines provided by Norman (2010) to evaluate the agreement levels of the samples.

The total mean of the students' engagement in the cultural and creative product design project was 4.71, compared to the arbitrary level represents "strongly agree". The mean behavioral engagement was 4.75, reflecting students' high recognition or continuous participation in class focus, compliance with rules, completion of tasks on time, active participation in discussions, and teamwork. The mean emotional engagement was 4.67, indicating a very high level of emotional engagement, reflecting a high level of students' sense of enjoyment, sense of belonging, and interest in sharing ideas and participating in the design project and classroom environment. The mean cognitive engagement was 4.70, which reflected the students' ability to actively participate in and out of class, actively seek solutions to learning challenges, and integrate academic knowledge. Overall, students had high participation in the cultural and creative product design project.

**Hypotheses Testing**

This study investigates whether the online collaboration platform (Fabrie) facilitates the visualization of design thinking and thereby enhances design creativity, testing six hypotheses. Due to the non-normal distribution of the data, the Mann-Whitney U test was employed, with a significance level set at 0.05.

The results revealed mixed findings across the measured variables. For Novelty, Group 1 had a higher mean rank (47.83 vs. 38.06), but the difference was not statistically significant ($p = 0.063$). Similarly, Collaboration showed no significant difference ($p = 0.069$), despite Group 1's higher mean rank (47.76 vs. 38.13). In contrast, Resolution ($p = 0.016$), Style ($p = 0.042$), and Visualization ($p = 0.040$) all demonstrated statistically significant differences, with Group 1 consistently outperforming Group 2 (mean ranks: 49.14 > 36.71, 47.92 > 37.96, and 48.23 > 37.64, respectively). For Engagement, no significant differences were found in total scores or their dimensions (Behavioral, Emotional, and Cognitive), though Group 1 had marginally higher ranks in Cognitive Engagement (45.78 vs. 40.15, $p > 0.05$). These results suggest that the intervention had a meaningful impact on Resolution, Style, and Visualization but not on Novelty, Collaboration, or Engagement.

**Table 6** Mann-Whitney Test Results for Variables

| Ranks | | | | |
|---|---|---|---|---|
| | Grou | N | Mean | Sum of |
| Novelty | 1 | 43 | 47.83 | 2056.50 |
| | 2 | 42 | 38.06 | 1598.50 |
| | Total | 85 | | |
| Resolution | 1 | 43 | 49.14 | 2113.00 |
| | 2 | 42 | 36.71 | 1542.00 |
| | Total | 85 | | |
| Style | 1 | 43 | 47.92 | 2060.50 |
| | 2 | 42 | 37.96 | 1594.50 |
| | Total | 85 | | |
| Visualization | 1 | 43 | 48.23 | 2074.00 |



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**Ranks**

| | **Grou** | **N** | **Mean** | **Sum of** |
|---|---|---|---|---|
| | 2 | 42 | 37.64 | 1581.00 |
| | Total | 85 | | |
| Collaboration | 1 | 43 | 47.76 | 2053.50 |
| | 2 | 42 | 38.13 | 1601.50 |
| | Total | 85 | | |
| Engagement | 1 | 43 | 42.55 | 1829.50 |
| | 2 | 42 | 43.46 | 1825.50 |
| | Total | 85 | | |

Test Statisticsa

| | Novelty | Resolution | Style | Visualization | Collaboratio | Engagement |
|---|---|---|---|---|---|---|
| Mann-Whitney U | 695.500 | 639.000 | 691.500 | 678.000 | 698.500 | 883.500 |
| Wilcoxon W | 1598.500 | 1542.000 | 1594.500 | 1581.000 | 1601.500 | 1829.500 |
| Z | -1.858 | -2.419 | -2.032 | -2.056 | -1.822 | -.203 |
| Asymp. Sig. (2- | **.063** | **.016** | **.042** | **.040** | **.069** | **.839** |

a. Grouping Variable: Group

**Table 7** Summary of Hypotheses Testing and Results

| **Hypothesis** | **Statement** | **Result after Analysis** |
|---|---|---|
| $H_01$ | There is no difference in the novelty score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.063, > 0.05$ Do not reject |
| $H_02$ | There is no difference in the resolution score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.016, < 0.05$ Rejected |
| $H_03$ | There is no difference in the style score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.042, < 0.05$ Rejected |
| $H_04$ | There is a difference in the visualization score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.040, < 0.05$ Rejected |
| $H_05$ | There is no difference in the collaboration score between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.069, > 0.05$ Do not reject |
| $H_06$ | There is no difference in the engagement between the students who have been taught traditionally and the group that has been taught with the Fabrie assist design thinking process. | $p = 0.839, > 0.05$ Do not reject |

**Discussion**

The statistical results showed that there were significant differences between the treatment group and the control group in the three dimensions: resolution, style, and visualization, suggesting that this teaching method notably improved students' abilities to solve practical problems, express unique design styles, and present designs visually. However, no significant differences were found between the two groups in



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novelty, collaboration, and engagement. These findings may stem from students' baseline creative abilities or prior experience with teamwork, requiring further investigation into potential influencing factors.

Two key limitations should be noted. Firstly, the sample size and participant diversity were limited, restricting the generalizability of the findings. Future studies should expand the sample to include participants from diverse educational institutions, cultural backgrounds, and academic levels, thereby improving the applicability of the results to a broader audience.

Secondly, the study focused on a single online collaborative platform deemed most suitable at the current stage. However, with the continuous evolution of digital tools, future research should explore and compare the effectiveness of different platforms in enhancing design creativity and collaboration. Identifying the most appropriate tools for specific educational contexts will further refine the model and its practical applications.

## Conclusion

This study, grounded in constructivism theory and driven by cultural and creative product design projects, established a collaborative learning environment to explore the potential of integrating the design thinking process with online collaborative platforms to enhance design creativity. By conducting Mann-Whitney U tests across six dimensions (novelty, resolution, style, visualization, collaboration, and engagement), the differences between the treatment and control groups were analyzed.

The findings are summarized as follows: The treatment group had higher mean ranks across all six dimensions compared to the control group, indicating that the combined teaching approach of design thinking and online collaborative platforms positively impacts students' design capabilities. Significant differences were observed in three dimensions: resolution, style, and visualization, suggesting that this teaching method notably improved students' abilities to solve practical problems, express unique design styles, and present designs visually. However, no significant differences were found between the two groups in novelty and collaboration, and the survey results on engagement also showed no significant differences. This may be attributed to the basic creative abilities or previous teamwork experience, resulting in a smaller score difference among group members.

For future research, in addition to observing team collaboration, it will be beneficial to evaluate individual performance and scores within groups or to increase the sample size to enhance the sensitivity of the statistical analyses.

## Recommendation

Amid rapid digital transformation, this study introduces an innovative teaching model merging online collaboration, design thinking, and creativity. Though preliminary, the model offers a framework for optimizing learning outcomes.

To advance this work, research should test the model’s adaptability across diverse settings (e.g., hybrid/remote classrooms). Develop educator training programs to bridge technological and pedagogical competencies. Investigate platform-specific effects and individual learning trajectories within teams. These steps will refine the model’s scalability and practical impact in design education.

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