# Art Design Major Students' Performance and Perceptions towards Online Collaborative Project at a Chinese University

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## Abstract

Technology has a transformative impact on collaboration in the design industry. However, the impact of new technologies on collaborative learning in art design education remains limited. Art and design educators lack empirical evidence to guide students in effective online collaborative learning. This study investigated the impact of online collaborative technologies on art design students' learning performance and perceptions of collaborative learning. A quasi-experiment, coupled with a questionnaire survey, was conducted with 90 third-year art design students enrolled in a "Restaurant Design" course at a public university in China. The students were divided into an experimental group using Miro for online collaboration and a control group participating in face-to-face collaboration.

According to the data analysis results, the experimental group performed significantly better in the design process and design product than the control group, with no significant difference in design presentation performance. In addition, the results showed significant differences in perceptions between the experimental and control groups regarding peer interaction, student-instructor interaction, emotional engagement, and social presence in collaborative learning, while no differences were found in their perceptions of learning performance. The study demonstrated that online collaborative technology in art design education positively impacted student learning performance and collaborative experiences.

**Keywords:** Online Collaboration, Online Collaboration Whiteboard, Art Design Education, Student Performance, Collaborative Learning Perceptions

## Introduction

The design industry relies on teamwork throughout the design process, from creative development to multi-step procedures and the eventual implementation and delivery (Idi & Khaidzir, 2018). The development of online collaboration technologies has opened up a new

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path to collaboration within design teams, transforming the collaborative process and facilitating global communication and interaction among designers (Cho et al., 2016). It has significantly improved the design process's speed, accuracy, flexibility, and team efficiency (Gu et al., 2024) and enhanced the quality and productivity of designs (Marion & Fixson, 2021).

In parallel with industry trends, collaboration is increasingly recognized as an essential skill in art design education. Experts across multiple industries emphasize the importance of integrating collaborative practices into design curricula (Gale et al., 2014). Digital technology offers educators opportunities to transform collaborative design pedagogy through tools such as virtual design studios, real-time co-creation platforms, and project management software (Dreamson, 2017).

Studies have shown that well-planned and effectively implemented online collaborative learning can have many positive impacts. It can enhance learning performance (Wang et al., 2020), strengthen problem-solving skills (Al-Samarraie & Saeed, 2018), promote the development of critical thinking (Yadegaridehkordi et al., 2019), and improve student engagement and the quality of interactions (Janssen et al., 2007). However, despite technology's transformative impact on collaboration in the design industry, its influence on collaborative learning in art design education remains limited (Hettithanthri & Hansen, 2022). Online collaboration in art design education often fails to achieve desired outcomes, primarily due to students lacking the knowledge and skills necessary for effective online teamwork (Yazici, 2009). The invisibility of communication records and team members can reduce the quality and frequency of mutual feedback (Dreamson, 2017). Moreover, design courses have lagged in adopting collaborative technologies, possibly due to the limitations of early collaboration tools and the challenge of replicating complex visual communication and real-time operations in online environments. Concurrently, instructors and learners lack sufficient understanding of the tools, experience, and methods required for effective online collaboration (Fleischmann, 2018).

In response to these challenges, researchers have actively explored the application of online collaborative technologies in art design education to enhance the effectiveness of collaborative learning. Cho and Cho (2014) used Blackboard as an online collaboration tool in design courses, finding that text-based online collaboration was less effective for visual content feedback, with students perceiving offline collaboration as more effective. Güler (2015) integrated social media into collaborative design to facilitate peer interaction. Fleischmann (2018) employed a visual online collaboration tool to support student teams' online iterative creative design process. Kim et al. (2020) further corroborated that social media

tools can facilitate student design communication and promote idea generation and problem exploration. More recently, Lee et al. (2021) evaluated the effectiveness of the online collaboration tool Slack and its relationship with a broader media ecology, providing insights into the integration of multiple digital platforms in art design education.

Although existing studies provide valuable insights, empirical research and teaching practices on online collaboration in art design major remain rare. There is insufficient evidence to support the effectiveness of online collaborative technologies in art design education, especially in the relationship between collaborative media and collaboration quality (Cho et al., 2016; Dreamson, 2017). The classroom is where students are prepared for the actual design world and practice. Educators are expected to provide diverse online collaboration opportunities to help students prepare for their careers and translate their acquired knowledge into future practical applications (Strauß & Rummel, 2020). Scholars unanimously agree that considering technology carefully is essential for successful collaboration among art design students (Sharma, 2022). The teaching approaches for design programs at higher education institutions are expected to evolve with the times to ensure that students graduate with skills aligned with professional practice.

In conclusion, this study aimed to investigate the impact of online collaborative technologies on the learning performance and perceptions of collaborative learning among art design students at a Chinese university. The study employed a quasi-experimental design and a questionnaire survey method and sought to offer new insights and practical guidance for art and design educators on integrating online collaboration tools in designing, developing, and implementing course activities. The findings were expected to provide empirical evidence for the effectiveness of digital collaboration in art design education and offer practical recommendations for educators to create more engaging and effective collaborative learning environments.

## Objectives

1. To compare students' performance in online collaboration and face-to-face collaboration in art design teaching.

2. To compare students' perceptions of collaborative learning in online collaboration and face-to-face collaboration in art design teaching.

## Research Framework

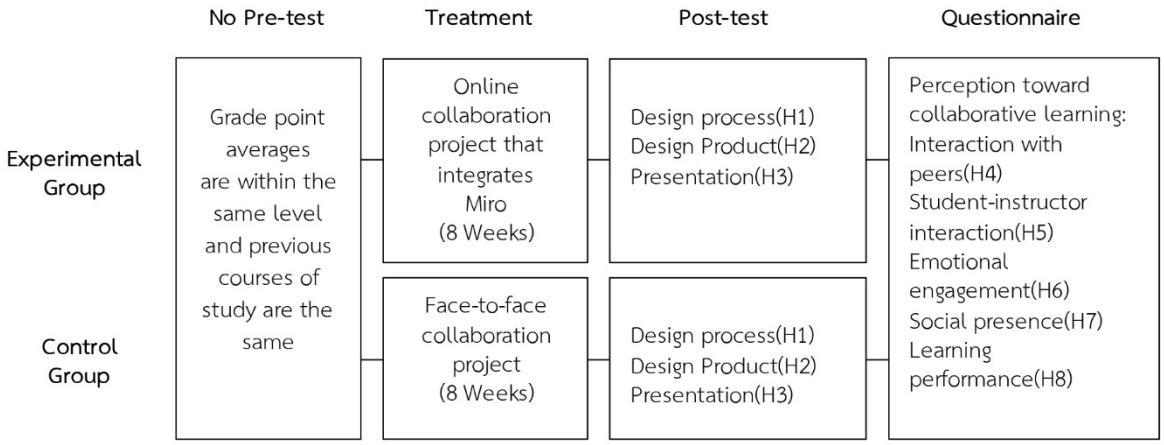


Figure 1. Research framework

## Research Methodology

### 1. Research Design

This study employed quasi-experimental research and questionnaire survey research design.

### 2. Population and Participants

The study population was approximately 1200 students majoring in art design at the School of Fine Arts and Design at a public university in Chengdu, China.

This study employed purposive sampling. The sample consisted of 90 third-year undergraduate students majoring in environmental design within the art and design program, aged 20-23. Based on G*Power analysis, a minimum sample size of 45 participants per group (90 total) was required. The sample size of 90 people in this study came from different semesters: 45 people in the first semester, as the control group used face-to-face collaboration; 45 people in the second semester, as the experimental group that used online collaboration. The two groups' entrance grades and average GPAs were within the same level, and their previous courses of study at the university were the same. It ensured similar academic backgrounds and achievements.

### 3. Research Treatment

The experimental course for this study was “Restaurant Design”. It lasted eight weeks, and the same instructor taught the experimental and control groups. The study procedure comprised four steps:

The first step was providing training on online collaborative tool for the participating instructor before the course;

The second step was pre-course training on online collaborative tool for the experimental group participants. The experimental group used the online collaboration platform "Miro," a visual online collaborative whiteboard platform that supports synchronous or asynchronous remote collaboration within an infinite digital whiteboard (Freitag et al., 2022). in contrast, the control group used face-to-face collaboration. Collaboration occurred throughout every stage of the design task.

The third step was project collaboration. At the beginning of the first week of the course, students were allowed to form their groups freely. The instructor divided the experimental group into 15 groups of three members each and similarly divided the control group into 15 groups of three members each. Students in both the experimental and control groups were first trained in collaborative skills before the project began. The design collaborative task included design research, concept generation, design decision, and design presentation. Students in the experimental group engaged with the online collaboration platform Miro, using it to record their design process and outcomes. They interacted with peers and the instructor on Miro, presenting their critiques and reflections. In contrast, the control group students collaborated face-to-face, recording and analyzing their findings in workbooks.

For the fourth stage, both groups were required to submit design proposal portfolios and design process documents, as well as make a design presentation during the final week.

**4. Research Instruments**

4.1 Performance test

The research instrument was a performance test to collect learning data from two groups of students engaged in online and face-to-face collaboration. The course syllabus and assessment rubric for this test were developed by the University School of Fine Arts and Design. The assessment rubric was drafted by the discipline head and his team. The university's Academic Committee reviewed the draft and finalized it after three rounds of revisions.

The assessment rubric of the test consisted of three parts: design process, design product, and design presentation. The design process referred to the design development outcomes rather than the final design outcomes. The design product referred to the outcome of the design process. The design presentation referred to the design program's clear narration and graphic representation. The total score was 100 points, with 50 points for the design process, 30 points for the design product, and 20 points for the design presentation. The score

was divided into four ranks: exemplary (over 90 points), accomplished (80-90 points), approaching (70-79 points) and beginning (60-69 points). The course was evaluated by the instructor and two other instructors.

4.2 Questionnaire survey

Another research instrument was a questionnaire survey to collect students' perceptions of collaborative learning. The questionnaire items were adapted from validated and used questionnaires in prior studies and included five sections and 22 items on a five-point Likert scale. It measured five variables: peer interaction, teacher-student interaction, emotional engagement, social presence, and learning performance.

The questionnaire's content validity was assessed using the Index of Item Objective Congruence (IOC) method by three education experts. The IOC results exceeded 0.67, indicating that the questionnaire was suitable for data collection. Internal consistency was measured using Cronbach's alpha, yielding coefficients above 0.7, This level of reliability was considered satisfactory (Taber, 2018).

**5. Data Collection**

1) The researcher submitted the experimental plan to the university before the course started, and after gaining permission, the experiment commenced; 2) From the first to the eighth week of the course, the experimental and control groups were taught separately, with participants required to complete corresponding teaching activities and assignments according to the course schedule; 3) In the eighth week, both the two groups submitted their work, which was then graded by three instructors; 4) At the end of the eighth week, both groups were surveyed on their perception of collaborative learning, and data from performance tests and questionnaire surveys were collected.

**6. Data Analysis**

Descriptive statistics (means and standard deviations) were used to summarize performance test scores and Likert scale responses. Independent samples t-tests were conducted to compare the experimental and control groups' performance scores and perceptions of collaborative learning. The 5-point Likert scale was interpreted as follows (Pimentel, 2010): 1.00-1.79 (Strongly Disagree), 1.80-2.59(Disagree), 2.60-3.39(Neutral), 3.40-4.19 (Agree), 4.20-5.00 (Strongly Agree). All statistical analyses were performed using Jamovi software.

## Research Results

**Research question 1:** What are the differences in student performance in online and face-to-face collaboration in art design teaching?

Prior to analysis, assumptions of normality and homogeneity of variance were tested. Normal distribution was confirmed through Q-Q plots, which showed data points aligning closely with the 45-degree line. Levene's test for equality of variances yielded $p > 0.05$, indicating homogeneity of variance between groups. These results satisfied the assumptions for employing independent samples t-tests.

Table 1 The results of performance scores for control and experimental groups

| Variable | Group | N | Mean | SD | t-test | P value |
|---|---|---|---|---|---|---|
| Design Process | Control | 45 | 84.0 | 3.20 | -4.70 | < .001 |
| | Experiment | 45 | 87.1 | 3.13 | | |
| Design Product | Control | 45 | 83.4 | 2.93 | -4.31 | < .001 |
| | Experiment | 45 | 86.1 | 2.94 | | |
| Design Presentation | Control | 45 | 85.1 | 2.36 | -1.93 | 0.056 |
| | Experiment | 45 | 86.1 | 2.43 | | |

The results of the independent samples t-test showed that for the design process, the experimental group's mean score ($M = 87.1$, $SD = 3.13$) was significantly higher than the control group's ($M = 84.0$, $SD = 3.20$), $t(88) = -4.70$, $p < .001$. This finding indicated a statistically significant difference in design process performance between the two groups, suggesting online collaboration effectively enhanced students' design process performance. Similarly, for the design product, the experimental group's mean score ($M = 86.1$, $SD = 2.94$) was significantly higher than the control group's ($M = 83.4$, $SD = 2.93$), $t(88) = -4.31$, $p < .001$. This finding indicated a statistically significant difference in design product performance between the two groups. Online collaboration was effective in improving students' design product performance. However, for the design presentation, the experimental group's mean score was $M=86.1$, $SD=2.43$, and the control group's mean score was $M=85.1$, $SD=2.36$, $t(88) =-1.93$, $p=0.056$. This finding indicated that the difference in design presentation performance between the two groups was not significant.

**Research question 2:** What are the differences in student perception towards collaborative learning in online and face-to-face collaboration in art design teaching?

Prior to analysis, assumptions of normality and homogeneity of variance were tested. Q-Q plots confirmed normal distribution. Levene's test showed $p > 0.05$ for most variables, indicating equal variances; thus, independent samples t-tests were employed. However, for 'Student-instructor Interaction,' the p-value was less than 0.05, so a Welch t-test was applied.

Table 2 The results of perceptions questionnaire on peer interaction in collaborative learning

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 1 | I actively exchanged my ideas with group members. | Control<br>Experiment | 3.69<br>4.20 | 0.51<br>0.41 | Agree<br>Strongly Agree |
| 2 | I was able to develop new skills and knowledge from other members in my group. | Control<br>Experiment | 3.58<br>4.27 | 0.58<br>0.54 | Agree<br>Strongly Agree |
| 3 | I was able to develop problem solving skills through peer collaboration. | Control<br>Experiment | 3.58<br>4.20 | 0.58<br>0.46 | Agree<br>Strongly Agree |
| 4 | I was able to develop more comprehensive understanding of the topic through group discussion. | Control<br>Experiment | 3.58<br>4.40 | 0.54<br>0.50 | Agree<br>Strongly Agree |
| | Total | Control<br>Experiment | 3.61<br>4.27 | 0.35<br>0.34 | Agree<br>Strongly Agree |

| | | Statistic | df | p | Mean difference | SE difference | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| IWP | Student's t | -9.19 | 88 | <.001 | -0.661 | 0.072 | Cohen's d | -1.94 |

Results for the interaction with peers, the experiment group indicated the " Strongly Agree" level, and the control group indicated the "Agree" level. The results showed that the experimental group's mean score (M=4.27, SD=0.34) was significantly higher than the control group's (M=3.61, SD=0.35), t (88) =-9.19, p<.001(Table 2). This finding indicated a statistically significant difference between the two groups' perceptions of peer interaction in collaborative learning.

Table 3 The results of perceptions questionnaire on student-instructor interaction in collaborative learning

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 1 | Instructor encourage students to express their opinions. | Control<br>Experiment | 3.62<br>4.20 | 0.49<br>0.41 | Agree<br>Strongly Agree |
| 2 | Instructor is receptive to new ideas and others' views. | Control<br>Experiment | 3.91<br>4.38 | 0.42<br>0.49 | Agree<br>Strongly Agree |
| 3 | Instructor generally stimulates project work discussion. | Control<br>Experiment | 3.89<br>4.31 | 0.32<br>0.51 | Agree<br>Strongly Agree |
| 4 | The instructor accompanied the students in an appropriate way to favor learning within their work group. | Control<br>Experiment | 3.67<br>4.42 | 0.52<br>0.50 | Agree<br>Strongly Agree |
| 5 | The instructor guided their students to develop teamwork skills that allow them to work more effectively. | Control<br>Experiment | 3.89<br>4.27 | 0.49<br>0.45 | Agree<br>Strongly Agree |
| | Total | Control<br>Experiment | 3.80<br>4.32 | 0.27<br>0.31 | Agree<br>Strongly Agree |

| | | Statistic | df | p | Mean difference | SE difference | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| SII | Welch's t | -8.58 | 86 | <.001 | -0.520 | 0.060 | Cohen's d | -1.81 |

Results for the student-instructor interaction, the experiment group indicated the " Strongly Agree" level, and the control group indicated the "Agree" level. The results showed that the experimental group's mean score (M=4.32, SD=0.31) was significantly higher than the control group's (M=3.80, SD=0.27), t (86) =-8.58, p<.001(Table 3). This finding indicated a statistically significant difference between the two groups' perceptions of student-instructor interaction in collaborative learning.

Table 4 The results of perceptions questionnaire on emotional engagement in collaborative learning

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 1 | The collaborative work was fun. | Control | 3.96 | 0.64 | Agree |
| | | Experiment | 4.27 | 0.45 | Strongly Agree |
| 2 | I liked the feeling of solving problems in collaborative work. | Control | 3.91 | 0.42 | Agree |
| | | Experiment | 4.36 | 0.48 | Strongly Agree |
| 3 | I feel that my opinions have been taken into account in collaborative work. | Control | 4.04 | 0.48 | Agree |
| | | Experiment | 4.36 | 0.48 | Strongly Agree |
| 4 | In this collaborative work, my peer and instructor interactions made me feel valuable. | Control | 3.89 | 0.53 | Agree |
| | | Experiment | 4.38 | 0.49 | Strongly Agree |
| | Total | Control | 3.95 | 0.41 | Agree |
| | | Experiment | 4.34 | 0.36 | Strongly Agree |

| | | Statistic | df | p | Mean difference | SE difference | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| EE | Student's t | -4.83 | 88 | <.001 | -0.389 | 0.080 | Cohen's d | -1.02 |

Results for the emotional engagement, the experiment group indicated the " Strongly Agree" level and the control group indicated the "Agree" level. The results showed that the experimental group's mean score (M=4.34, SD=0.36) was significantly higher than the control group's (M=3.95, SD=0.41), t (88.0) =-4.83, p<.001(Table 4). This finding indicated a statistically significant difference between the two groups' perceptions of emotional engagement in collaborative learning.

Table 5 The results of perceptions questionnaire on social presence in collaborative learning

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 1 | I could comfortably participate in the collaborative work. | Control | 3.76 | 0.53 | Agree |
| | | Experiment | 4.20 | 0.41 | Strongly Agree |
| 2 | I could easily contact my team mates. | Control | 3.84 | 0.42 | Agree |
| | | Experiment | 4.31 | 0.47 | Strongly Agree |
| 3 | I could comfortably communicate during the collaborative work. | Control | 3.87 | 0.34 | Agree |
| | | Experiment | 4.22 | 0.47 | Strongly Agree |
| 4 | I feel part of a learning community in my group. | Control | 3.67 | 0.52 | Agree |
| | | Experiment | 4.42 | 0.50 | Strongly Agree |

Table 5

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 5 | I could develop good work relationships with my team mates. | Control | 3.89 | 0.49 | Agree |
| | | Experiment | 4.27 | 0.45 | Strongly Agree |
| | Total | Control | 3.80 | 0.30 | Agree |
| | | Experiment | 4.28 | 0.29 | Strongly Agree |

| | | Statistic | df | p | Mean difference | SE difference | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| SP | Student's t | -7.79 | 88 | <.001 | -0.480 | 0.062 | Cohen's d | -1.64 |

Results for the social presence, the experiment group indicated the " Strongly Agree" level, and the control group indicated the "Agree" level. The results showed that the experimental group's mean score (M=4.28, SD=0.29) was significantly higher than the control group's (M=3.80, SD=0.30), t (88) =-7.79, p<.001(Table 5). This finding indicated a statistically significant difference between the two groups' perceptions of social presence in collaborative learning.

Table 6 The results of perceptions questionnaire on learning performance in collaborative learning

| | Item Statement | Group | Mean | SD | Interpretation |
|---|---|---|---|---|---|
| 1 | I gain knowledge through collaborative work. | Control | 3.96 | 0.48 | Agree |
| | | Experiment | 3.93 | 0.54 | Agree |
| 2 | The collaborative work we did in my group helped me to effectively complete the various tasks and activities required by the course. | Control | 3.89 | 0.49 | Agree |
| | | Experiment | 4.00 | 0.37 | Agree |
| 3 | Overall, the learning activities and assignments of this course met my learning expectations. | Control | 3.89 | 0.53 | Agree |
| | | Experiment | 4.09 | 0.60 | Agree |
| 4 | Overall, I am satisfied with my collaborative learning experience in this course. | Control | 4.02 | 0.58 | Agree |
| | | Experiment | 4.22 | 0.70 | Strongly Agree |
| | Total | Control | 3.94 | 0.41 | Agree |
| | | Experiment | 4.06 | 0.42 | Agree |

| | | Statistic | df | p | Mean difference | SE difference | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| LP | Student's t | -1.39 | 88 | 0.168 | -0.122 | 0.088 | Cohen's d | -0.293 |

Results for the learning performance, the experiment group and the control group indicated the "Agree" level. The results showed that the experimental group's mean score (M=4.06, SD=0.42) was slightly higher than the control group's (M=3.94, SD=0.41), t (88) =-1.39, p=0.168(Table 6). This finding indicated that the difference in perception of learning performance between the two groups was not significant.

## Discussions and Conclusions

This study investigated differences in art design students' performance and perceptions of collaborative learning in online and face-to-face settings. The results indicated that the experimental group performed better than the control group in the design process and design product; however, the two groups were comparable in the design presentation.

The experimental group's better performance in the design process and product highlights the potential benefits of online collaborative technology for art design education. This finding is consistent with Cho et al. (2016), who found that visually-supported collaborative technology can improve student achievement.

Improved performance in the design process and product may be attributed to digital platforms' unique features, including continuous access to resources, visualizing collaboration, and interactive tools that facilitate easy sharing and iteration of design artifacts (Fleischmann, 2018). These features could promote a more fluid and dynamic creative process, allowing students to work at their own pace. Additionally, it enhanced teachers' real-time ability to monitor and intervene in students' learning processes. Teachers can accurately identify students' needs and provide timely, targeted feedback. This interactive model helps build a more supportive and responsive learning environment. Dreamson (2017) confirmed that teacher intervention in the collaborative process is one of the key variables determining the quality of the outcomes.

These features collectively improved the efficiency and quality of the design process and product, explaining the superior performance of the experimental group in this regard. However, it was noteworthy that both groups performed similarly in design presentations, likely due to the fact that presentations rely primarily on oral expression and demonstration skills rather than collaboration tools. This finding suggested that while online collaboration

tools were more suited to supporting the design process and outcomes, additional strategies may be needed to enhance students' oral expression abilities.

In addition, the study showed significant differences between the two groups' perceptions of peer interaction, teacher-student interaction, emotional engagement, and social presence in collaborative learning; The experimental group reported higher-quality interactions, more positive emotions, and a stronger sense of psychological connection with other learners. However, there was no significant difference in perceived learning performance between the two groups, with both groups believing their academic performance had improved.

This finding suggested that online collaborative technology positively impacted interaction, emotional engagement, and social presence compared to face-to-face collaboration (Hernández-Sellés et al., 2019; Molinillo et al., 2018). The collaborative platform offered unique affordances for communication and collaboration that are not easily replicated in traditional classroom settings. Asynchronous forums, real-time collaborative tools, and multimedia-sharing capabilities may foster more sustained and in-depth interactions. Moreover, the experimental group's reported positive emotional engagement and social presence may be attributed to the online collaborative platform's dynamic, real-time, and equitable interaction modes. It increased the frequency and quality of interactions and feedback, allowing students to observe how their own and their peers' ideas merge and evolve and how their individual contributions impact the development of the entire project. It made students feel more included and connected, enhancing their emotional engagement and social presence in collaborative learning.

Notably, although the experimental group outperformed the control group on learning performance indicators for the design process and product, both groups reported positive subjective perceptions of their learning performance, with no significant difference. This revealed a discrepancy between objective and subjective measures of learning performance. The students could use their personal criteria to assess their learning performance. Future research could employ qualitative methods like interviews to explore students' self-evaluation criteria, which could help improve the design of online collaborative learning environments.

The findings provide empirical evidence for the effectiveness of digital collaboration in art design education and practical insights for improving online collaborative teaching methods, which could benefit students across various disciplines.

## Limitations of the study

Since this study's sample was exclusively from participants with Chinese backgrounds, the generalizability of the findings is limited. In addition, the students participating in the experiment all majored in environmental design within the art design field. Therefore, it could not be assumed that the results fully represent all art design students.

## Recommendations

1. Administrators should promote collaborative technologies in art design education, while educators should integrate collaborative learning activities to maximize their potential.

2. Future studies should incorporate instructor and administrator perspectives to comprehensively view online collaborative projects and inform improved pedagogical and management strategies.

3. It is crucial to include participants from diverse countries and regions in future studies to increase the generalizability of results.

4. Educators should utilize online collaborative platforms' unique features to enhance interaction and emotional engagement in art design education, while developing additional strategies to support students' oral presentation skills.

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