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Collaborative project-based learning enhances 4C skills in vocational fashion design students

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ABSTRACT

This study aimed to examine the effectiveness of Collaborative Project-Based Learning (CPBL) in enhancing students' critical thinking, creativity, communication, and collaboration (4C) skills in the Children's Fashion Design course. A quantitative quasi-experimental study employing a posttest-only control group design was conducted with 40 vocational fashion design students, equally assigned to experimental and control groups. Data were collected using a validated structured observation instrument (Aiken's V = 0.868; item validity = 0.905) and analyzed through descriptive statistics, Shapiro-Wilk normality, Levene's homogeneity, and independent-samples t-tests. Students receiving CPBL achieved significantly higher scores in critical thinking (54.65 vs. 46.00), creativity (54.30 vs. 42.30), communication (54.40 vs. 41.80), collaboration (54.70 vs. 42.30), and overall 4C competence (218.05 vs. 172.40) than the control group ($p < 0.001$). CPBL effectively promotes integrated 4C competencies and represents an appropriate pedagogical approach for strengthening twenty-first-century skills in vocational fashion education.



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Introduction

The swift development of the creative industry and the emergence of Industry 5.0 have reshaped the competencies expected from vocational higher education graduates, particularly in fashion design programs. In addition to technical expertise, graduates are increasingly required to demonstrate critical thinking, creativity, communication, and collaboration (4C) skills to solve complex design problems, adapt to industry changes, and work effectively in multidisciplinary environments (Dogruer et al., 2024; Wu et al., 2025; Zisch et al., 2024). However, many vocational graduates continue to demonstrate stronger technical competence than higher-order and collaborative skills, indicating a mismatch between educational outcomes and workforce expectations. Consequently, vocational institutions need learning approaches that integrate technical proficiency with twenty-first-century competencies (Roney, 2024; Salmani & Karande, 2026).

Despite these demands, learning in vocational fashion education remains predominantly teacher-centered and focuses on individual task completion. In the Children's Fashion Design course, students generally follow lecturers' instructions with limited opportunities to solve authentic problems, exchange ideas, or reflect critically on design decisions. Previous studies similarly report that conventional learning effectively develops procedural skills but provides insufficient opportunities to foster integrated critical thinking, creativity, communication, and

collaboration (Czap et al., 2023; Pieciak & Augustyniak, 2025). As a result, many graduates possess adequate technical abilities but still lack the collaborative and adaptive competencies required by the creative industry.

Project-Based Learning (PjBL) has been widely recognized as an effective approach for promoting active learning, problem solving, and higher-order thinking through authentic projects. Studies consistently demonstrate that PjBL enhances critical thinking, creativity, and collaborative learning by connecting theoretical knowledge with practical application (Admiraal et al., 2026; Kim et al., 2026). Nevertheless, most implementations position collaboration as a supporting activity rather than the core learning process, resulting in collaborative interactions that are often insufficiently structured to develop all four dimensions of 4C competencies simultaneously.

Collaborative Project-Based Learning (CPBL) extends conventional PjBL by integrating structured collaboration throughout every stage of project implementation, including collaborative problem identification, project planning, task distribution, design decision-making, peer evaluation, and collective reflection (Guo et al., 2026; Lee et al., 2024; Mudinillah et al., 2026). Although CPBL has shown positive outcomes in science, engineering, health sciences, and teacher education, empirical evidence in vocational fashion education remains limited. Furthermore, previous studies have generally examined individual competencies rather than the integrated development of critical thinking, creativity, communication, and collaboration, indicating both contextual and methodological gaps in the existing literature.

This study addresses these gaps by examining the effectiveness of Collaborative Project-Based Learning (CPBL) in improving students' 4C competencies in the Children's Fashion Design course within vocational higher education (Alfiah et al., 2026; Hwang et al., 2026; Liu, 2026). The novelty of this research lies in applying CPBL within vocational fashion design education, evaluating the integrated development of all four 4C competencies, and employing a structured observation instrument to capture authentic learning behaviors throughout the design project. The findings are expected to extend collaborative constructivist learning in vocational education while providing practical evidence for developing curricula and instructional strategies that better prepare graduates for the demands of the contemporary creative industry.

Method

This study employed a quantitative approach using a quasi-experimental design with a posttest-only control group design to examine the effectiveness of the Collaborative Project-Based Learning (CPBL) model in improving students' 4C competencies (critical thinking, creativity, communication, and collaboration) in the Children's Fashion Design course. The participants comprised 40 sixth-semester students enrolled in the Vocational Fashion Design Program at Aufa Royhan University, Padangsidempuan, during the 2025/2026 academic year. Total sampling was applied, whereby all students were included and equally assigned into an experimental group ($n = 20$), which received CPBL instruction, and a control group ($n = 20$), which received conventional teacher-centered instruction. To facilitate collaborative learning, students in each class were further organized into heterogeneous working groups based on their educational backgrounds, ensuring balanced participation throughout the project-based learning activities.

Data were collected through a structured observation instrument designed to assess students' 4C competencies throughout the implementation of the learning process. The instrument consisted of 60 observation items covering four dimensions: critical thinking, creativity, communication, and collaboration, each rated using a four-point Likert scale. Content validity was established through expert judgment using Aiken's V, yielding an overall validity coefficient of 0.868 and an average item validity of 0.905, indicating that the instrument was highly valid for research purposes. Observations were conducted independently by two trained observers to enhance scoring consistency and reduce observer bias. Data analysis was performed using SPSS software through descriptive statistics, followed by the Shapiro-Wilk normality test, Levene's homogeneity test, and independent-samples t-tests (Welch's t-test was applied when the homogeneity assumption was violated) with a significance level of 0.05 to determine differences in 4C competencies between the experimental and control groups.

Results and Discussions

Table 1 presents the descriptive statistics of students' 4C skills in both the experimental and control groups after the learning intervention. Across all measured dimensions, students who participated in Collaborative Project-Based Learning (CPBL) demonstrated higher mean scores than those who received conventional instruction.

Table 1. Descriptive Statistics of Students' 4C Skills

Variable	Group	n	Min	Max	Mean	SD
Critical Thinking	Control	20	35	57	46.00	7.99
	Experimental	20	48	60	54.65	4.64
Creativity	Control	20	35	50	42.30	5.86
	Experimental	20	47	60	54.30	4.32
Communication	Control	20	35	50	41.80	5.59
	Experimental	20	48	60	54.40	4.39
Collaboration	Control	20	35	50	42.30	5.86
	Experimental	20	48	60	54.70	4.01
Overall 4C Skills	Control	20	155	195	172.40	12.17
	Experimental	20	198	238	218.05	11.98

Students in the experimental group consistently achieved higher posttest scores across all four competencies than those in the control group. The largest mean difference was observed in overall 4C skills (218.05 vs. 172.40), followed by collaboration (54.70 vs. 42.30), critical thinking (54.65 vs. 46.00), communication (54.40 vs. 41.80), and creativity (54.30 vs. 42.30). In addition, the experimental group exhibited smaller standard deviations across all variables, suggesting more consistent performance among students following the CPBL approach. Before hypothesis testing, the data were examined for normality using the Shapiro–Wilk test and for homogeneity of variance using Levene's test.

Table 2. Assumption Tests

Variable	Shapiro-Wilk (Control)	Shapiro-Wilk (Experimental)	Levene's Sig.	Homogeneity
Critical Thinking	0.134	0.362	0.000	Not Homogeneous
Creativity	0.315	0.101	0.062	Homogeneous
Communication	0.051	0.134	0.247	Homogeneous
Collaboration	0.069	0.098	0.020	Not Homogeneous
Overall 4C Skills	0.470	0.161	0.914	Homogeneous

The Shapiro–Wilk test indicated that all datasets were normally distributed, as all significance values exceeded 0.05. Levene's test further revealed homogeneous variances for creativity, communication, and overall 4C skills, whereas the assumptions of equal variances were violated for critical thinking and collaboration. Therefore, Welch's independent-samples t-test (Equal Variances Not Assumed) was applied to the latter variables, while the standard independent-samples t-test was used for the remaining variables. Independent-samples t-tests were conducted to compare students' 4C skills between the experimental and control groups.

Table 3. Independent-Samples t-Test Results

Variable	Mean Difference	t	df	p	Decision
Critical Thinking	8.65	4.186	30.49	<0.001	Significant
Creativity	12.00	7.374	38	<0.001	Significant
Communication	12.60	7.927	38	<0.001	Significant
Collaboration	12.40	7.808	33.62	<0.001	Significant
Overall 4C Skills	45.65	11.958	38	<0.001	Significant

Independent-samples t-tests demonstrated statistically significant differences between the experimental and control groups across all dimensions of 4C skills ($p < 0.001$). The strongest effect was observed for the overall 4C score ($t = 11.958$), indicating a substantial improvement among students exposed to CPBL. Significant differences were also found for communication ($t = 7.927$), collaboration ($t = 7.808$), creativity ($t = 7.374$), and critical thinking ($t = 4.186$). These findings consistently indicate that students participating in Collaborative Project-Based Learning achieved significantly higher 4C competencies than those receiving conventional instruction.

Overall, students taught through the Collaborative Project-Based Learning model achieved superior outcomes across every component of the 4C competencies compared with students receiving conventional instruction. The statistically significant differences observed in all comparisons confirm the effectiveness of CPBL in fostering critical thinking, creativity, communication, collaboration, and the integrated development of twenty-first-century competencies in the Children's Fashion Design course (Table 4).

Table 4. Summary of Research Findings

Variable	Control Mean	Experimental Mean	p-value	Conclusion
Critical Thinking	46.00	54.65	<0.001	CPBL significantly improved critical thinking
Creativity	42.30	54.30	<0.001	CPBL significantly improved creativity
Communication	41.80	54.40	<0.001	CPBL significantly improved communication
Collaboration	42.30	54.70	<0.001	CPBL significantly improved collaboration
Overall 4C Skills	172.40	218.05	<0.001	CPBL significantly enhanced overall 4C competencies

The findings indicate that Collaborative Project-Based Learning (CPBL) significantly improved students' integrated 4C competencies in the Children's Fashion Design course. Students in the experimental group achieved higher overall 4C scores ($M = 218.05$, $SD = 11.98$) than those in the control group ($M = 172.40$, $SD = 12.17$; $t = 11.958$, $p < 0.001$). This improvement suggests that structured collaboration throughout the project process promotes active knowledge construction through authentic problem solving, discussion, and reflection rather than passive task completion. These findings support constructivist learning theory and extend previous evidence regarding the effectiveness of collaborative learning in vocational education (Asiatun et al., 2025; Kolanur et al., 2026; Prihatin & Gunawan, 2024). Critical thinking improved significantly, with the experimental group scoring 54.65 compared with 46.00 in the control group ($t = 4.186$, $p < 0.001$). Although statistically significant, the improvement was smaller than that of the other 4C dimensions, indicating that critical thinking may require longer learning experiences to develop optimally. Throughout CPBL, students analyzed design requirements, evaluated alternatives, justified design decisions, and reflected on project outcomes, strengthening analytical reasoning in authentic vocational contexts. Creativity also increased substantially (54.30 vs. 42.30; $t = 7.374$, $p < 0.001$) because collaborative discussions encouraged idea generation, design refinement, and continuous peer feedback. These findings are consistent with previous studies demonstrating that project-based learning enhances critical inquiry and creativity through authentic and collaborative learning experiences (Aritonang, 2022; Koh, 2026; Kurniawati, 2023; Nurjanah et al., 2024; Romanchuk & Lisohor, 2025; Sarangi & Ramachandran, 2023; Sutianah & Sobandi, 2022; Thio et al., 2025).

Communication and collaboration likewise improved significantly, with communication scores increasing from 41.80 to 54.40 ($t = 7.927$, $p < 0.001$) and collaboration scores from 42.30 to 54.70 ($t = 7.808$, $p < 0.001$). These improvements resulted from structured collaborative activities, including presenting ideas, negotiating design decisions, exchanging feedback, distributing responsibilities, and completing projects in heterogeneous teams. Such authentic interactions strengthened interpersonal competencies that are less likely to develop through teacher-centered instruction. These findings reinforce social constructivist theory and previous research highlighting the role of collaborative project-based learning in improving communication and teamwork (Amroni et al., 2024; Farida & Sukraini, 2024; François, 2022; Marwa et al., 2024; Masruri et al., 2024; Muhtar et al., 2025; Purnawati & Sari, 2023; Sabil, 2026). Nevertheless, the effectiveness of CPBL may also be influenced by group dynamics, students' initial collaborative abilities, and lecturers' facilitation. Compared with previous studies, this research provides stronger evidence by demonstrating that CPBL simultaneously develops all four dimensions of 4C competencies within the context of vocational fashion education. Earlier studies generally focused on individual competencies or different educational settings, whereas this study confirms that structured collaboration can effectively integrate critical thinking, creativity, communication, and collaboration throughout authentic fashion design projects. These findings address both contextual and methodological gaps identified in previous research while extending the application of collaborative constructivist learning in vocational education (Guo et al., 2026; Lee et al., 2024; Mudinillah et al., 2026).

The findings suggest that CPBL offers a comprehensive instructional framework for strengthening technical and transferable competencies simultaneously in vocational fashion education. Beyond improving students' academic performance, the model prepares graduates with the critical, creative, communicative, and collaborative skills increasingly required by the contemporary creative industry. Therefore, CPBL has important theoretical implications for collaborative constructivist learning and practical implications for curriculum development and competency-based instructional design in vocational education (Kurniawati, 2023; Miranda et al., 2025; Nurmawati et al., 2022; Uçar, 2024).

Conclusions

This study concludes that Collaborative Project-Based Learning (CPBL) is effective in improving students' 4C competencies in the Children's Fashion Design course. The implementation of CPBL enabled students to achieve significantly higher critical thinking, creativity, communication, collaboration, and overall 4C scores

than those taught through conventional learning. These findings indicate that collaborative, authentic, and project-oriented learning activities provide a more meaningful learning environment for vocational fashion design students by integrating technical design practice with essential twenty-first-century skills. Therefore, CPBL can be recommended as an instructional model to strengthen students' professional readiness in vocational fashion education.

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