



The Project-Based Learning Model Using E-Catalog Teaching Materials to Foster Creativity of Culinary Arts Students in the Cake Decoration Course

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ABSTRACT

Purpose: This study aimed to develop and evaluate E-Catalog teaching materials supported by a Project-Based Learning (PjBL) approach to foster culinary arts students' creativity in the Cake Decoration course. **Methods:** This study employed a research and development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The research was conducted in the Culinary Arts Laboratory, Faculty of Engineering, Universitas Negeri Medan, involving 64 students from the Culinary Arts Education Study Program, Class of 2022. Data were collected through observation, creativity assessment rubrics, student response questionnaires, and lecturer interviews. The data were analyzed descriptively to evaluate student engagement, creativity, and responses to the E-Catalog teaching materials. **Results:** The findings showed that 48 students (75%) were actively involved in the PjBL activities, 60 students (92%) used the E-Catalog as a reference during project development, and 55 students (85%) completed their projects within the predetermined time. The average creativity score increased from 67/100 before implementation to 80/100 after implementation. The creativity rubric showed mean scores of 4.0/5 for originality and 4.3/5 for detail and accuracy. Expert validation indicated very good ratings across content quality, material accuracy, learning objective suitability, design and layout, and technical usability, with mean scores ranging from 4.5 to 4.8 out of 5. Student responses also indicated positive acceptance, with an overall satisfaction score of 88%. **Conclusion:** The developed E-Catalog teaching materials were considered feasible and positively received by students as a digital learning resource supporting Project-Based Learning in the Cake Decoration course. The descriptive findings indicate an improvement in students' creativity and engagement following the implementation of the E-Catalog-supported PjBL activities.



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INTRODUCTION

Creativity is an essential competency in vocational and higher education because students are expected not only to acquire technical knowledge but also to generate ideas, solve practical problems, and produce innovative products. This competency is particularly important in culinary education, where students need to integrate technical skills, aesthetic judgment, product presentation, and individual ideas. Cake Decoration is a practice-oriented course that requires students to combine technical, visual, aesthetic, and creative competencies through the development of cake designs and finished products. Students are required to explore themes, select decorative elements, arrange compositions, and transform ideas into attractive cake products. Previous studies have shown that project-oriented learning can support creativity in culinary education, including cake and pastry production (Dharmayanthi et al., 2022; Noviyanti et al., 2023 ; Safitri, 2023).

Project-Based Learning (PjBL) provides a relevant learning framework for practice-oriented subjects because it organizes learning around meaningful projects and tangible products. Through PjBL, students participate in planning, developing ideas, carrying out project activities, solving problems, and evaluating the resulting products. These activities provide opportunities for students to connect theoretical knowledge with practical experiences while developing independence, creativity, and decision-making skills. Research has consistently demonstrated the potential

of PjBL to support creative thinking and creativity development (Andini & Rusmini, 2022 ; Chen et al., 2022 ; Fitri et al., 2024 ; Han et al., 2022 ; Rafik et al., 2022) . Tarigan et al., (2025) further emphasized the integration of creativity and project-based learning, while Lesman et al.(2023) reported that PjBL can support creativity and critical-thinking skills in vocational creative-product learning. In culinary and vocational contexts, PjBL has also been associated with creativity, innovation, and learning motivation in cake, pastry, and food-processing activities (Setyobudi, 2025). Falah et al., (2024) additionally highlighted the relationship between project-based learning, managerial competencies, and student creativity.

In addition to the learning model, appropriate learning resources are important for supporting project-oriented learning, particularly in visually oriented subjects such as Cake Decoration. Students need accessible references concerning cake designs, themes, decorative elements, materials, equipment, techniques, and product presentation. Digital learning media can provide such information while allowing students to access visual examples during project planning and development. Previous studies have demonstrated the potential of digital learning media to support creativity and learning in different contexts. Gurning et al., (2024) examined Canva-based learning media in relation to creativity and learning outcomes, while Abin et al. (2023) investigated Canva as a digital learning medium for influencing students' creativity skills. In Cake Decoration learning, developed Canva-based learning media for wedding-cake sketching to support culinary students' hard skills, while recent research has also examined digital flipbook media for Cake Decoration learning (2026). These studies indicate the increasing relevance of digital resources in supporting visual and practical culinary learning.

An E-Catalog is one form of digital learning resource that can integrate textual explanations, images, examples, materials, equipment, and other learning information into an accessible and structured medium. This format is particularly relevant to Cake Decoration because students require visual references before developing their own project designs. Previous studies have demonstrated the feasibility and usefulness of digital catalogs and E-Catalogs in learning. Afi et al., (2021) developed a digital catalog as a learning medium, while (Prasetyo & Alrianingrum, 2021) developed a digital catalog for history learning. Sukardi et al. (2021) developed an interactive E-Catalog to support digital literacy, and (Astuti & Rudyatmi, 2024) developed an E-Catalog using the ADDIE model. Utami et al., (2024) also explored E-Catalog-based learning resources in the digital transformation of education. More specifically, (Mayasari et al., 2022) developed an E-Catalog for pastry learning using Canva and reported high feasibility and positive student responses. These findings suggest that E-Catalogs can function as practical digital resources for visually oriented and product-based learning.

Although previous studies have demonstrated the potential of Project-Based Learning (PjBL) to improve students' creativity, creative thinking, and learning outcomes, its integration with structured digital learning resources in higher-education Cake Decoration learning remains limited. PjBL has been shown to enhance creative thinking when supported by appropriate learning media and project activities (Wibowo & Ahmad, 2023). Similar findings have been reported in culinary education, including the implementation of PjBL in patisserie learning and Culinary Arts Education (Auliana et al., 2023 ; Lastariwati et al., 2022) . Other studies have demonstrated that project-based teaching materials can also support students' creativity (Diarini et al., 2024 ; Irdalisa et al., 2024) . However, the integration of an E-Catalog as a structured visual learning resource within PjBL activities for Cake Decoration remains insufficiently explored.

Based on this gap, the present study focuses on the development and evaluation of E-Catalog teaching materials to support Project-Based Learning in the Cake Decoration course of the Culinary Arts Education Study Program at Universitas Negeri Medan. The novelty lies in integrating Cake Decoration visual references, project sketches, themes, materials, equipment, techniques, and project-related information into an E-Catalog that supports students throughout the project development process. This integration is expected to complement the benefits of PjBL in developing creativity and active learning (Anggreani et al., 2023 ; Masdarini et al., 2024) . The study aims to develop and evaluate the E-Catalog and describe students' creativity, engagement, and responses following its implementation.

The E-Catalog is expected to provide an accessible and visually organized learning resource that supports project planning, design exploration, and product development. The use of digital learning resources in project-oriented activities can facilitate students' creative thinking and engagement, particularly when learning involves active exploration and authentic tasks (Zhang & Ma, 2023). By combining digital learning resources with PjBL activities, students are expected to have greater opportunities to develop and express creative ideas through Cake Decoration projects. Therefore, this study contributes to the development of digital and project-oriented learning resources for culinary arts education, particularly in higher education.

METHOD

Research Design

This study employed a Research and Development (R&D) design using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The study focused on developing and evaluating E-Catalog teaching materials to support Project-Based Learning (PjBL) in the Cake Decoration course. During the implementation stage, a one-group pretest-posttest design was used to describe changes in students' creativity before and after the implementation of the E-Catalog-supported PjBL activities. The research design consisted of pretest (O_1), intervention (X), and posttest (O_2), represented as O_1-X-O_2 .

Participants and Research Procedure

The research was conducted in the Culinary Arts Laboratory, Faculty of Engineering, Universitas Negeri Medan. The participants consisted of 64 students of the Culinary Arts Education Study Program, Class of 2022. All participating students completed the creativity assessment before and after the implementation of the E-Catalog-supported PjBL activities. The development procedure followed the five stages of the ADDIE model. In the Analysis stage, observations and lecturer interviews were conducted to identify students' learning needs, course characteristics, existing learning resources, and difficulties encountered in Cake Decoration learning. The analysis focused on the need for visual references and learning resources that could support students in developing Cake Decoration projects.

In the Design stage, the structure and content of the E-Catalog were planned based on the learning objectives and identified needs. The E-Catalog was designed to include Cake Decoration concepts, visual references, themes, design examples, materials, equipment, decoration techniques, project sketches, and project instructions. The learning activities were organized to support the stages of Project-Based Learning.

In the Development stage, the initial E-Catalog was produced and evaluated by three expert validators. The validation covered content quality, material accuracy, suitability of learning objectives, design and layout, and technical usability using a five-point rating scale. Comments and recommendations from the validators were used to revise the E-Catalog before implementation. This can be seen from the following diagram:

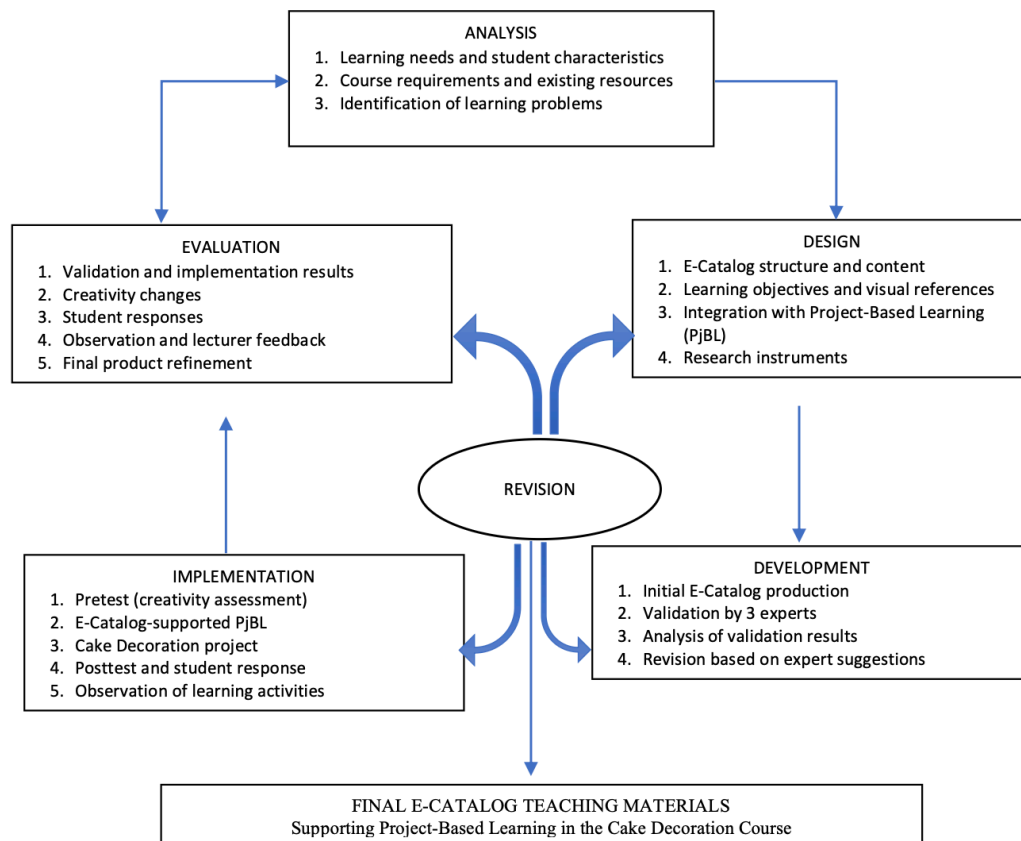


Figure 1. Research and development procedure using the ADDIE model

The Implementation stage involved the use of the developed E-Catalog in PjBL activities. Students first completed a creativity pretest. They then used the E-Catalog as a reference for exploring Cake Decoration designs, selecting themes, developing design ideas and sketches, preparing materials and equipment, and completing the Cake Decoration project. Student participation and use of the E-Catalog were observed during the learning activities. After completing the project, students completed the creativity posttest and a response questionnaire concerning the E-Catalog. Lecturer interviews were also used to obtain supporting information regarding the implementation and usability of the learning resource.

The Evaluation stage involved reviewing the expert validation results, student responses, observations, lecturer feedback, and changes in students' creativity scores. The findings were used to determine the feasibility and implementation outcomes of the developed E-Catalog and to make final product refinements.

Research Instruments

The instruments consisted of an expert validation questionnaire, student response questionnaire, observation sheet, creativity assessment rubric, and lecturer interview guide. The expert validation questionnaire assessed content quality, material accuracy, suitability of learning objectives, design and layout, and technical usability. The student response questionnaire assessed design quality, ease of use, content relevance, and overall satisfaction.

The creativity assessment rubric was used to assess students' creative performance in Cake Decoration projects before and after implementation. The assessment included the creativity indicators specified in the research instrument, particularly originality and detail and accuracy. The scores were converted to a 100-point scale using:

$$\text{Score} = \frac{\text{Obtained Score}}{\text{Maximum Score}} \times 100$$

The observation sheet was used to document student participation during PjBL activities, while the lecturer interview guide provided supporting information concerning the implementation and usability of the E-Catalog.

Validity and Reliability

The E-Catalog was validated by three experts with relevant expertise in learning content, instructional media, and/or Cake Decoration. The validation process consisted of assessment of the initial product, identification of aspects requiring improvement, revision based on expert recommendations, and evaluation of the revised product. The validation scores were calculated using the mean score for each assessed aspect and converted into percentages according to the predetermined feasibility criteria. The validation results ranged from 4.5 to 4.8 out of 5, indicating a very good level of feasibility. The creativity assessment instrument was reviewed through expert judgment before implementation.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Mean, standard deviation, frequency, and percentage were used to describe the expert validation, student responses, and creativity scores. The pretest and posttest creativity scores were compared using a one-group pretest-posttest analysis. The normality of the paired differences was examined using the Shapiro-Wilk test. Because the paired differences did not meet the normality assumption, the Wilcoxon signed-rank test was used to examine the difference between pretest and posttest scores at a significance level of $\alpha = 0.05$. The magnitude of change was described using the mean difference and 95% confidence interval (CI). Effect size was calculated using Cohen's d_z :

$$dz = \frac{D}{SD_D}$$

where D is the mean difference between posttest and pretest scores and SD_D is the standard deviation of the paired differences. N-Gain was also calculated to describe the relative improvement in students' creativity:

$$x = \frac{\text{Posttest} - \text{Pretest}}{100 - \text{Pretest}}$$

Observation and lecturer interview data were analyzed descriptively and used as supporting information for interpreting student engagement and the usability of the E-Catalog. Because the study used a one-group pretest-posttest design without a control group, the statistical results were interpreted as evidence of changes following implementation, rather than definitive evidence of a causal effect.

Ethical Considerations

Participants were informed about the purpose and procedures of the study and their involvement in the learning and assessment activities. The collected data were used for research purposes, and students' identities were kept confidential in the analysis and reporting of the findings.

RESULTS

The E-Catalog teaching materials were developed using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. At the Analysis stage, the learning needs, student characteristics, course requirements, and existing learning resources for the Cake Decoration course were identified. The analysis indicated the need for visually oriented and easily accessible teaching materials that could support students during project planning and product development.

At the Design stage, the E-Catalog was structured to provide conceptual explanations, visual references, examples of cake decoration designs, project instructions, and learning activities aligned with the Project-Based Learning (PjBL) stages. The E-Catalog was subsequently developed and reviewed by three expert validators. The validation covered content quality, material accuracy, suitability of learning objectives, design and layout, and technical usability.

The validation results showed mean scores ranging from 4.5 to 4.8 out of 5, indicating that the E-Catalog was considered highly feasible for implementation. The highest score was obtained for the suitability of learning objectives (4.8/5), followed by content quality (4.7/5), while material accuracy, design and layout, and technical usability each obtained a mean score of 4.5/5. Recommendations from the validators were used to refine the E-Catalog before its implementation.



Figure 2. Desain E-Katalog

The E-Catalog was implemented in the Cake Decoration course with 64 Culinary Arts Education students. The implementation followed the PjBL stages, beginning with project orientation and planning, followed by selection of cake decoration themes, preparation of sketches, determination of materials and equipment, product development, and presentation or completion of the final project. The E-Catalog served as a visual and instructional reference throughout these activities.

Student participation during the implementation showed that 48 of 64 students (75.00%) were actively involved in the project activities. Furthermore, 60 students (93.75%) used the E-Catalog as a learning reference, while 55 students (85.94%) completed their projects within the specified time. These findings indicate that the E-Catalog was used by most students during the PjBL activities and supported the completion of the cake decoration projects. Student responses were analyzed based on four aspects: design quality, ease of use, content relevance, and overall satisfaction. The results are presented in [Table 1](#).

Table 1. Student Responses to the E-Catalog

Aspect	Mean Score (5)	Percentage
Design quality	4.20	84%
Ease of use	4.30	86%
Content relevance	4.60	92%
Overall satisfaction	4.50	90%

The results indicate positive student responses across all assessed aspects. The highest mean score was obtained for content relevance (4.60/5; 92%), suggesting that students perceived the materials as relevant to the learning activities in the Cake Decoration course. Ease of use obtained a mean of 4.30/5 (86%), while design quality obtained 4.20/5 (84%). Overall satisfaction reached 4.50/5 (90%).

These results indicate that students generally responded positively to the E-Catalog as a learning resource supporting project-based activities. Students' creativity was assessed using the same creativity assessment before and after the implementation. The descriptive results are presented in Table 2.

Table 2. Descriptive Statistics of Students' Creativity Scores

Measurement	N	Mean	SD	Minimum	Maximum
Pretest	64	67.00	7.55	52.08	84.32
Posttest	64	80.00	13.37	57.31	98.00
Difference	64	13.00	10.49	-7.69	32.08

The mean creativity score increased from 67.00 (SD = 7.55) in the pretest to 80.00 (SD = 13.37) in the posttest. The mean difference was 13.00 points (SD = 10.49). Of the 64 students, 55 students showed an increase in their scores, whereas 9 students showed a decrease.

The mean N-Gain score was 0.427, indicating a measurable gain in creativity scores following the implementation. However, because the study used a one-group pretest-posttest design without a comparison group, this increase should be interpreted as a change observed following the implementation rather than definitive evidence that the E-Catalog alone caused the improvement. The creativity rubric also provided information on students' project characteristics. The mean score for originality was 4.0 out of 5, while detail and accuracy obtained 4.3 out of 5. These results suggest that students were able to produce cake decoration projects with relatively strong attention to both originality and technical detail.

Inferential Analysis of Creativity Scores

To determine whether the difference between the pretest and posttest scores was statistically significant, the distribution of the paired differences was first examined using the Shapiro-Wilk test. The result was $W = 0.962$, $p = .045$, indicating that the distribution of the paired differences deviated significantly from normality at the .05 level. Therefore, the Wilcoxon signed-rank test was used for the paired comparison.

The Wilcoxon analysis showed a statistically significant difference between the pretest and posttest creativity scores, $W = 103.00$, $p < .001$. The mean difference was 13.00 points, with a 95% confidence interval of 10.38–15.62. The standardized effect size, calculated as Cohen's d_z , was 1.24, indicating a large standardized difference between the pretest and posttest scores.

Table 3. Inferential Analysis of Pretest–Posttest Creativity Scores

Analysis	Result
Mean difference	13.00
95% CI	10.38–15.62
Shapiro-Wilk	$W = 0.962$, $p = .045$
Wilcoxon signed-rank	$W = 103.00$, $p < .001$
Cohen's d_z	1.24
Mean N-Gain	0.427

The inferential results demonstrate that students' creativity scores were significantly higher after the implementation than before it. Nevertheless, the absence of a control or comparison group limits the extent to which the observed improvement can be attributed specifically to the E-Catalog teaching materials.

Overall, the findings demonstrate that the E-Catalog teaching materials developed through the ADDIE process received high feasibility ratings from the expert validators, with scores ranging from 4.5 to 4.8 out of 5. During implementation, most students used the E-Catalog and participated in the PjBL activities, while student responses were positive across design, usability, content relevance, and overall satisfaction.

Students' mean creativity score increased from 67.00 to 80.00, with a mean improvement of 13.00 points. The Wilcoxon signed-rank test confirmed a statistically significant pretest-posttest difference ($p < .001$), accompanied by a large standardized effect size ($dz = 1.24$). These findings support the use of the E-Catalog as a feasible and positively received teaching resource for supporting Project-Based Learning in the Cake Decoration course. However, because the study employed a one-group pretest-posttest design, the findings should be interpreted as evidence of observed improvement following implementation, rather than definitive causal evidence of effectiveness.

DISCUSSION

The E-Catalog teaching materials obtained high feasibility ratings from the three expert validators, with mean scores ranging from 4.5 to 4.8 out of 5. This indicates that the content, learning objectives, design, and technical aspects were considered appropriate for the Cake Decoration course. This finding is consistent with previous studies showing that digital catalogues can provide structured and visually accessible learning resources (Afi et al., 2021 ; Sukardi et al., 2021 ; Utami et al., 2024). The high level of E-Catalog use (93.75%) and positive student responses, particularly for content relevance (92%) and overall satisfaction (90%), further indicate that the material was relevant to students' project activities.

The positive responses may be related to the visual characteristics of Cake Decoration learning, which requires students to observe examples before developing their own designs. The E-Catalog provided visual references and organized instructions that could be accessed during project development. This condition is relevant to Project-Based Learning (PjBL), in which students are expected to plan, develop, and complete concrete projects. Previous studies have reported that PjBL can support creativity through active project involvement, decision-making, problem solving, and product development (Fitri et al., 2024 ; Chen et al., 2022 : Andini & Rusmini, 2022) . Similar findings have been reported in culinary education, including cake decoration learning (Noviyanti et al., 2023 ; Safitri, 2023) .

Students' mean creativity scores increased from 67.00 (SD = 7.55) in the pretest to 80.00 (SD = 13.37) in the posttest, with a mean difference of 13.00 points. The Wilcoxon signed-rank test showed a statistically significant difference between the pretest and posttest scores ($W = 103.00$, $p < .001$), with a 95% confidence interval of 10.38–15.62 and a large effect size (Cohen's $dz = 1.24$). The mean N-Gain was 0.427. The creativity rubric also showed mean scores of 4.0/5 for originality and 4.3/5 for detail and accuracy. These findings suggest that students demonstrated improvement in creative performance after participating in the E-Catalog-supported PjBL activities.

The observed improvement may be explained by the complementary roles of the E-Catalog and PjBL. The E-Catalog provided visual stimuli and procedural references, while PjBL provided opportunities for students to develop, modify, and transform ideas into concrete cake decoration products. Thus, the E-Catalog can function as a digital learning scaffold that supports idea generation, decision-making, and product development rather than replacing the PjBL model. This interpretation is consistent with previous research linking PjBL with creative thinking and the use of digital visual media with creative learning activities

However, the statistically significant pretest-posttest difference should not be interpreted as definitive evidence that the E-Catalog independently caused the improvement. The study employed a one-group pretest-posttest design without a control group; therefore, factors such as lecturer guidance, students' prior experience, repeated practice, and peer interaction may also have contributed to the observed changes. In addition, the participants were drawn from a single cohort, which limits the generalizability of the findings.

Overall, the findings indicate that the E-Catalog was highly feasible and positively received and that students' creativity scores increased significantly following its implementation within PjBL. The contribution of the study therefore lies in demonstrating the integration of a visually oriented digital teaching resource into PjBL for Cake Decoration learning. Future research should use a comparison group and broader samples to determine the specific contribution of E-Catalog-supported PjBL to students' creativity development.

CONCLUSION

The implementation of Project-Based Learning (PjBL) supported by the E-Catalog was associated with an increase in students' observed creativity scores in the Cake Decoration course. The mean creativity score increased from 67.00 to 80.00, and the pretest-posttest difference was statistically significant based on the Wilcoxon signed-rank test ($W =$

103.00, $p < .001$), with a large effect size (*Cohen's dz* = 1.24). The E-Catalog also received high feasibility ratings from experts and positive responses from students, indicating that it was a suitable digital teaching resource for supporting project-based Cake Decoration learning.

The scientific contribution of this study lies in demonstrating how a visually oriented E-Catalog can be integrated into PjBL as a digital learning resource to support students' idea development, decision-making, and creative product development in culinary education. For lecturers, the E-Catalog can be used as a practical visual reference to complement project-based activities and facilitate students' access to learning materials during project development. However, the findings should be interpreted within the scope of the study, as the participants were from a single cohort and the one-group pretest-posttest design did not include a control group. Therefore, the observed increase cannot be attributed solely to the E-Catalog.

Future research should employ quasi-experimental or experimental designs with control groups, involve participants from multiple institutions, and use validated creativity assessment instruments with appropriate reliability and inter-rater reliability procedures. Further studies should also examine whether improvements in creativity are retained over time and investigate the specific contribution of E-Catalog-supported PjBL compared with conventional learning approaches.

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