

Impact of Project-Based Learning on Creativity and Logical Thinking of Grade 7 Learners in Scratch Programming

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ABSTRACT

This study examined how Scratch programming changed grade seven creativity, reasoning, and problem-solving skills through project-based learning (PBL). Multi-method data collection included self-assessment surveys, quarterly skills evaluations, and open-ended responses to ensure consistency. Before PBL, students indicated they were moderately to very creative (weighted mean = 3.71), but they had problems implementing what they learned and often imitated others instead of coming up with their own ideas. Their Quarter 2 performance (mean = 78.25%, SD = 6.82) demonstrated that they struggled with debugging (WM = 3.44) and methodical planning (WM = 3.76). PBL led to significant improvements in creativity and logic (WM = 3.79) and Quarter 3 evaluation scores (mean = 91.90%, SD = 4.44; $t = -26.4$, $p < .001$). The qualitative comments centered on structured problem-solving strategies like task decomposition, whereas the quantitative data supported PBL's computational thinking influence. PBL structured students' inherent creativity and improved their logical reasoning and problem-solving skills, which aligns with 21st-century educational goals. Recommendations include preserving PBL in programming classrooms, adding scaffolded assignments, and studying computational thinking over time. More studies may examine the effectiveness of scaffolding and whether PBL can effectively teach advanced programming topics.

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Context And Rationale

The development of creativity and logical thinking was essential for learners in programming, where they had to design solutions, debug errors, and explore innovative ways to complete tasks. Programming, particularly on beginner-friendly platforms like Scratch, was crucial. However, the researcher's first-quarter summative skills assessment in her Grade 7 ICT classes revealed a concerning gap in these key abilities. The researcher found that only 27.32% (53 out of 194) of students achieved passing scores of 75% or above, with an overall mean percentage score (MPS) of 71.06 and a mastery level of only 8.83%. This data implied that nearly 70% of

learners struggled with creativity and logical thinking—core skills needed for success in programming. Furthermore, the researcher's experience as a Grade 7 ICT teacher showed that most students faced significant difficulties when asked to apply coding concepts independently, often resorting to repetitive or incomplete solutions in their Scratch projects.

These findings underscored the urgency of addressing this problem, particularly because creativity and logical thinking were critical not only for coding but also for learners' cognitive development in other STEM subjects. Recent studies supported this concern. According to a report by the Philippine Institute for Development Studies (PIDS, 2022), Filipino students underperformed in tasks that required creativity and logical reasoning, both of which were necessary for innovative problem-solving in the 21st century. Similarly, the Department of Education's (DepEd) 2022 National Achievement Test results also highlighted a decline in critical thinking and creativity among students, especially in ICT and STEM-related fields. These challenges posed significant barriers to students' success in technology-based subjects and future careers, making it imperative to identify effective instructional strategies that foster both creativity and logical thinking.

This issue was urgent because creativity and logical thinking were not only important for programming but also for students' overall cognitive development. Recent studies indicated that Filipino learners lagged in creative problem-solving and logical thinking abilities. A study by Gregorio and Santos (2023) found that many Filipino students had difficulty applying logical reasoning in problem-solving tasks, particularly in STEM subjects. Furthermore, a report by the Department of Education (DepEd, 2022) noted that fostering creativity in classrooms remained a challenge, as traditional educational models often focused on rote learning rather than encouraging innovative thinking. This lack of creativity and logical reasoning among learners severely limited their ability to adapt to technological advancements, which increasingly demanded both skill sets.

In the context of Scratch programming, where creativity was essential for designing interactive stories, games, and animations, these gaps in thinking were evident. Project-based learning (PBL) offered a potential solution by immersing students in real-world tasks that required them to think creatively and critically. Research by Cruz (2021) demonstrated that students who participated in PBL showed significant improvements in both creativity and logical reasoning skills compared to those engaged in traditional methods of instruction. The collaborative and exploratory nature of PBL encouraged students to experiment, take risks, and apply coding concepts in innovative ways, fostering a more profound understanding of programming logic and a greater capacity for original thought.

Given these findings, this action research was designed to investigate how project-based learning could improve the creativity and logical thinking abilities of Grade 7 learners in Scratch programming. The integration of PBL strategies had the potential to transform the learning environment by making coding more engaging, fostering collaboration, and pushing students to think beyond conventional solutions. Addressing these gaps was critical for helping students develop the essential skills required for future success in technology-related fields and ensuring that they were better equipped for the challenges of the 21st-century digital economy.

Action Research Questions

This action research investigated how project-based learning (PBL) improved Grade 7 Scratch programmers' creativity and reasoning. The study examined how hands-on, project-based coding assignments enhanced creative problem-solving and logical thinking, two crucial programming skills. The project assessed how PBL affected learners' ability to create inventive solutions, how it influenced their approach to logical coding challenges, and how it helped them understand Scratch programming concepts. This study aimed to improve ICT education pedagogy, particularly in cultivating 21st-century skills.

Therefore, this research sought to determine whether PBL effectively motivated students to learn programming and attempted to answer the following specific questions:

1. What are the levels of creativity and logical thinking skills among Grade 7 learners in Scratch programming prior to the implementation of Project-Based Learning (PBL)?

2. What is the combined level of creativity and logical thinking in the learners' outputs in Scratch programming through PBL?
3. What is the level of learners' problem-solving skills as demonstrated in project-based Scratch activities?
4. How effective is project-based learning in Scratch programming?
5. What is the impact of PBL on the learners' creativity and logical thinking, as shown in their skills assessments?
6. What is the difference between the second and third skills assessments of learners in Scratch programming?
7. What actions or modifications could be proposed to further improve the effectiveness of project-based learning in fostering creativity and logical thinking in Scratch programming for future implementations?

Hypothesis

The hypothesis formulated for this study was tested to determine its validity.

There is no significant difference between the second and third skills assessments of learners in Scratch programming.

Innovation, Intervention, And Strategy

The study categorized the use of Project-Based Learning (PBL) in Scratch programming as an intervention designed to improve the creativity and logical thinking of Grade 7 learners by shifting the traditional instruction model to focus on student-driven projects that fostered problem-solving, creativity, and analytical skills. In the context of Scratch programming, learners engaged in designing and coding their projects, which challenged them to think critically and apply logical reasoning to real-world scenarios.

Research had shown that PBL promoted more profound learning and encouraged students to be more innovative and self-directed in their work (Vogler et al., 2021). Bell (2020) grounded this intervention in the belief that allowing students to explore coding through hands-on projects enhanced their understanding and ability to solve complex problems, aligning with educational goals for 21st-century skills development. Through this approach, the study sought to evaluate how PBL served as an effective pedagogical tool in ICT education.

This action research focused on using Project-Based Learning (PBL) to promote Grade 7 students' creativity and logic in Scratch programming. PBL encouraged students to design, develop, and execute their Scratch programming projects, which promoted ownership and enhanced their programming comprehension, creativity, and problem-solving skills. Chien, Chang, and Chu (2021) found that PBL improved cognitive and metacognitive skills, making it a beneficial method for teaching programming creativity and logic.

Teaching 7th-grade students Scratch programming had been challenging due to their lack of creativity. Many students relied on pre-built templates or rigid guidelines, limiting their creative expression in programming. Additionally, students struggled with reasoning and problem-solving when building functional programs using loops, conditionals, and variables. In coding exercises, students often faced difficulties with critical thinking and logical reasoning.

To address these challenges, the study incorporated Project-Based Learning (PBL) into the Grade 7 ICT curriculum throughout the third quarter. The process began with an introduction and goal setting, where the researcher explained the PBL approach and outlined the intended learning outcomes. The study introduced students to Scratch programming and provided them with a platform to generate and choose project ideas that aligned with their interests and practical applications.

The next phase was project design and planning, where students worked either independently or in groups to design their Scratch projects. They submitted a project proposal that outlined their objectives, the features they

intended to include (such as loops, conditionals, and animations), and any potential challenges they anticipated.

During the project development phase, students had four weeks to build their Scratch projects creatively, applying programming concepts learned in class. The researcher provided guidance and feedback while encouraging students to experiment, make mistakes, and overcome challenges independently—fostering both creativity and logical thinking.

The peer review and collaboration stage allowed students to provide constructive feedback to one another, fostering collaboration and critical thinking as they reflected on how to improve their projects. Finally, in the final presentation and reflection stage, students presented their completed projects to the class, explaining their design choices, the challenges they faced, and the solutions they implemented. After the presentation, they engaged in a reflective exercise to assess how the project enhanced their creativity and logical thinking skills. This structured approach aimed to measure the impact of PBL on their cognitive development in Scratch programming.

To address the identified issues, PBL was used to help students design Scratch projects creatively and logically. The projects allowed students to express their creativity while solving programming problems. Through this approach, students developed critical thinking and problem-solving skills, while PBL enhanced their creativity and logical reasoning by allowing them to apply their knowledge in real-world situations (Meyer, Nelson, & Dean, 2022). Peer feedback and cooperation made learning active and supportive, encouraging students to refine their efforts based on peers' insights.

This study compared PBL to traditional instruction in terms of students' programming skills and thinking habits. By engaging in hands-on project work, students became active problem-solvers, improving their logic, creativity, and motivation. Holubova (2020) found that PBL encouraged intrinsic motivation by allowing students to pursue topics they were passionate about, which enhanced learning and engagement. The researcher monitored this phenomenon through student reflections, project outputs, and performance assessments.

Various methods addressed the research problem in the action research study, with the goal of enhancing both creativity and logical thinking. First, project design autonomy played a crucial role, as students were given the freedom to choose their project themes and design their own solutions in Scratch. By allowing learners to work on projects that resonated with their personal interests, this independence fostered creativity and increased motivation.

Secondly, problem-solving through iteration was a key method. The process of creating Scratch projects presented students with challenges that required logical reasoning and problem-solving skills. As they iterated on their designs, they refined both their technical and cognitive abilities, learning to troubleshoot and improve their projects step by step.

Collaboration and peer review also contributed significantly to this research. Through groupwork and feedback, students learned to critically evaluate their own and others' work. This collaborative environment strengthened their logical thinking and enhanced their ability to critique and improve project designs through discussion and shared ideas.

Lastly, reflection and self-assessment played an integral role in solidifying the learning process. After completing their projects, students engaged in reflective exercises where they evaluated their own work, pinpointed areas for improvement, and drew connections between creativity, problem-solving, and programming concepts. This method helped them internalize the relationship between these elements and fostered a more profound understanding of the skills they had developed throughout the project.

Yadav et al. (2023) found that PBL intervention strategies greatly improved creativity, logical thinking, and motivation in learning contexts. By giving students real-world challenges to address, PBL supported Scratch programming's creative and experimental ambitions. However, conducting the study within the third quarter constrained this intervention, potentially reducing the complexity of student projects. Students who lacked

programming experience required additional scaffolding, which sometimes limited their early project autonomy. Despite these limitations, PBL stimulated active learning and greater programming engagement, making it a viable and effective solution to the identified issues.

ACTION RESEARCH METHODS

A. Participants and/or other Sources of Data and Information

This action research involved Grade 7 ICT students at Makati Science High School during the academic year 2024–2025. A total of 191 students from all sections participated in the study. Since the present was their first formal introduction to computer programming, the participants, aged 12–13, had varying levels of prior knowledge in Scratch programming. The study aimed to include a diverse sample of learners with different learning styles, motivation levels, and problem-solving abilities.

Purposive sampling was used to select participants from all Grade 7 ICT classes that focused on Scratch programming. Given that the study targeted Scratch programming students, purposive sampling was deemed appropriate. The sample represented all of the Grade 7 ICT students who were briefed to be familiar with project-based learning (PBL), making data collection more efficient in addressing the research questions.

All learners were included because they used Scratch and PBL in their instruction. The Grade 7 students in this ICT course were the most suitable participants to offer suggestions about how PBL affected their creativity, logical thinking, and problem-solving skills. The group's diverse programming experience and cognitive abilities helped examine how PBL influenced learners at different proficiency levels. Since the students experienced the PBL intervention as part of their regular curriculum, disruptions were minimized, and authentic data on its effectiveness was obtained.

The researcher collected student reflections, peer feedback, and other relevant data. Triangulation strengthened the reliability and validity of the findings by cross-verifying data from multiple data analysis sources. Teacher observations focused on students' engagement in project work, creativity, and problem-solving approaches, while peer feedback sessions revealed how students interacted with and evaluated each other's work. Short written reflections after each project phase allowed students to self-report their learning experiences, including changes in their logical thinking, creativity, and motivation. These data sources collectively demonstrated the impact of PBL on student learning in Scratch programming.

B. Methods

Instruments

This action research collected extensive and reliable data on the effects of project-based learning (PBL) on Grade 7 Scratch programmers' creativity and logical reasoning using several data collection tools. The research employed the following tools:

Scratch Project Creativity Rubric. This rubric evaluated students' Scratch programming projects' inventiveness. The rubric assessed creativity, complexity, multimedia features (including sound and animations), and theme execution. The study adapted the rubric using previous creativity-measuring methodologies for digital programming environments.

Problem-Solving and Logic Rubric. This rubric tested students' logic and problem-solving skills. It covered their usage of loops, conditionals, debugging, and breaking down complex tasks into Scratch components. The researcher also rewarded code accuracy and learners' logical thinking.

Pre-Test and Post-Test (Skills Assessment Results). The second quarter's skills assessment results served as the pretest and established a baseline before PBL implementation. The study administered survey questionnaires and short-answer questions before and after PBL. The researcher assessed students' Scratch programming, fundamental coding, and logical thinking skills. The third quarter's skills assessment served as the post-test, measuring improvements after the PBL intervention, while the pre-test set the baseline.

Student Reflection Journals. Students kept reflection journals documenting their daily progress throughout the project. These journals recorded their opinions on the project process, challenges faced, and how they overcame them. The researcher analyzed these journals to evaluate the students' creativity, problem-solving skills, and engagement with the content.

Observation Checklist. The researcher used an observation checklist to track student behavior, engagement, and collaboration during project-based learning. This checklist recorded student engagement, inventiveness, and group problem-solving dynamics.

Student Motivation Survey. After the project, the study conducted a Likert-scale survey to assess student interest and motivation in Scratch programming. The survey asked students about their satisfaction, confidence, and willingness to participate in future programming activities.

Procedures for Data Collection

Pretests and surveys for baseline data. Students' second-quarter skills assessment performance served as the basis to measure their Scratch programming and logical thinking skills. A student motivation survey assessed their initial interest and attitudes about Scratch programming.

Learning through projects. Students worked on a Scratch programming project for several weeks in a project-based learning intervention. As a real-world problem-solving assignment, they used Scratch to build interactive stories, animations, or games. Throughout the intervention, students applied project-based learning principles, including teamwork, inquiry, and iterative design.

Continuous monitoring and data recording. The researcher used an observation checklist to monitor student interactions while working on projects. Students were observed for creativity, reasoning, problem-solving, and collaboration throughout the project. Weekly reflection notebooks documented students' thought processes and problem-solving strategies for coding tasks.

Rubrics for project creativity and problem-solving. After project completion, the study evaluated students' work using rubrics for creativity, logical thinking, and problem-solving. The researcher assessed each student's Scratch project based on creativity, coding complexity, programming structures, and functionality.

Motivation and post-test survey. In the final week, students completed an identical post-test to assess their Scratch programming and logical thinking skills. They also retook the student motivation survey to measure any changes in programming interest and attitudes after the PBL intervention.

Data Analysis. The researcher analyzed quarterly skills assessments, rubrics, observation checklists, reflection journals, and questionnaires to determine whether PBL enhanced creativity, logical thinking, and student motivation. Quantitative data from tests and rubrics were statistically analyzed to measure performance changes. Qualitative data from reflection journals were coded to identify patterns in student experiences.

C. Data Analysis Plan

The study collected and analyzed both qualitative and quantitative data in this action research, *"Impact of Project-Based Learning on Creativity and Logical Thinking of Grade 7 Learners in Scratch Programming,"* to understand how project-based learning (PBL) influenced students' creativity, logical thinking, and motivation.

Quantitative Data Analysis

Quarterly skills assessments served as pre- and post-test scores. The researcher analyzed the pre-test and post-test results using descriptive statistics to measure the improvement in students' creativity, logical thinking, and coding skills in Scratch. The primary aim was to compare the average scores before and after the PBL intervention to determine any significant changes. The study conducted a paired t-test to determine the statistical significance of the difference between the pre- and post-test scores.

The assessments were based on a rubric, specifically focusing on creativity and logical thinking. The creativity rubric and the logical thinking and problem-solving rubric generated scores based on specific criteria. The researcher analyzed these scores to identify patterns of improvement in creativity and logical reasoning. The research also statistically analyzed the data from the rubrics, calculating the average scores for each criterion. The study presented these data and compared student performance before and after the PBL intervention.

Motivation survey. The researcher analyzed the numerical data from the Likert-scale motivation survey using frequency distributions and percentages. The researcher reported changes in students' motivation, interest, and confidence in learning Scratch programming by comparing pre- and post-survey results. The researcher calculated the mean scores for each survey question and visualized changes in student motivation using tables.

Qualitative Data Analysis

The researcher examined the students' reflection journals. The researcher gathered qualitative data from students' reflection journals to gain insight into their thought processes, problem-solving strategies, and creativity throughout the PBL activities. The study used thematic analysis to code these journals, identifying recurring themes such as students' approaches to challenges, expressions of creativity, and reflections on their logical reasoning in Scratch projects. The researcher grouped common themes, keywords, and phrases into categories like creativity enhancement, problem-solving approaches, and engagement with coding tasks. The researcher presented the findings using narrative descriptions and direct quotes from student reflections, which demonstrated the depth of their learning and experiences.

Teacher observations. The researcher also conducted a qualitative analysis of the data from the teacher observation checklists. Observations focused on student engagement, collaborative behavior, creativity in problem-solving, and how students applied logical reasoning during group tasks. The researcher categorized and summarized these data into key findings, which highlighted notable trends observed during the PBL activities. The study triangulated observational data with student reflections and rubric scores to ensure consistency and reliability of findings.

Reporting of Data

The study presented the findings from both the qualitative and quantitative analyses in a mixed-methods format to provide a comprehensive view of the impact of PBL on student learning. The research showed numerical results from tests, rubrics, and surveys with graphs, tables, and statistics and explained qualitative data from journals and observations in a story-like way, using examples and quotes from participants.

The report addressed the research questions by demonstrating how PBL influenced students' creativity and logical thinking, with clear evidence from both numerical improvements and qualitative reflections. The research discussed any discrepancies between the quantitative and qualitative data, along with potential explanations for the observed patterns.

Finally, the data analysis offered practical advice about the effectiveness of PBL as a pedagogical approach for enhancing creativity, problem-solving, and motivation in Scratch programming.

Statistical Treatment

Weighted Mean (Team, 2024)

It is a statistical approach for calculating the average by multiplying the weights with their respective means and taking their sum. This is used to summarize the response regarding the perception or experience of students in terms of access, affordability, and impact on their academic and social life.

Formula:

$$W = \frac{\sum_{i=1}^n w_i X_i}{\sum_{i=1}^n w_i}$$

Where:

- W = Weighted Average
- n = Number of terms to be averaged
- w_i = Weights applied to x values
- X_i = Data values to be average

Paired t-test or correlated t-test

A statistical test is used to test significant differences between the means of two dependent or correlated samples. This procedure was used to test if the skills assessment scores obtained during the 2nd quarter, prior to the introduction of PBL in Scratch Programming, are significantly different from the skills assessment scores in the 3rd quarter.

DISCUSSION OF RESULTS AND REFLECTION

The study used quantitative and qualitative data to explore how Project-Based Learning (PBL) affects Grade 7 Scratch programmers' creativity and reasoning. After PBL, students' structured creativity, problem-solving, and computational thinking improved significantly. This discussion compares the results to literature, considers pedagogical implications, and admits limits to inform ICT education research and instruction. Here's the detailed discussion of the results of the study.

The Levels of Creativity and Logical Thinking Skills Among Grade 7 Learners in Scratch Programming Prior to the Implementation of Project-Based Learning (PBL)

Table 1 Creativity in Scratch Programming Through PBL

Creativity in Scratch Programming Through PBL	Weighted Mean	Verbal Interpretation
1. Project-based learning activities encourage me to think of new and unique ideas for my Scratch projects.	3.70	Very High
2. I feel more confident about expressing my creativity through Scratch programming when working on PBL tasks.	3.68	Very High
3. PBL helps me use Scratch features (e.g., sprites, sounds, animations) in creative ways.	3.88	Very High
4. Collaborating with my peers during PBL activities enhances my creativity in Scratch programming.	3.55	Very High
5. I often feel inspired to create innovative solutions for project challenges when using Scratch.	3.76	Very High
Overall Mean	3.71	Very High

Table 1 displays the level of creativity in Scratch programming through PBL, using a weighted mean and its corresponding verbal interpretation. Before Project-Based Learning (PBL), the study examined Grade 7 students' Scratch programming creativity and logic. The 2020–2024 survey found that pupils were innovative in PBL activities, with a weighted mean of 3.71. Specifically, students strongly agreed that PBL helped them generate new ideas (WM = 3.70), enhance their confidence in creativity (WM = 3.68), and use Scratch features in a more creative manner (WM = 3.88). Working with classmates increased student creativity (WM = 3.55), and it drove them to create new ideas (WM = 3.61). These findings support Kokotsaki, Menzies, and Wiggins's (2016) finding that PBL fosters creativity by giving students unanswered questions. The high mean scores demonstrate that students were innovative before formal PBL and even more so after.

Scratch programming in PBL made Grade 7 students creative, according to studies. The high results on all survey categories demonstrated that PBL encouraged innovative thinking, teamwork, and new programming

tool use. Thomas's findings support this, suggesting that PBL assisted learners in organizing and enhancing their creativity. In his examination of PBL's effect on student involvement and creation, Thomas (2000) found that student-centered, project-driven programming education boosts creativity.

Table 2 Logical Thinking in Scratch Programming Through PBL

Logical Thinking in Scratch Programming Through PBL	Weighted Mean	Verbal Interpretation
1. PBL activities have improved my ability to plan and organize steps before creating Scratch programs.	3.76	Very High
2. I can identify and fix errors in my Scratch code more effectively through PBL tasks.	3.44	High
3. Project-based learning helps me develop logical strategies to solve programming problems.	3.66	Very High
4. I feel more confident applying logical thinking skills to my Scratch projects after completing PBL activities.	3.73	Very High
5. Breaking down complex programming tasks into smaller parts has become easier through PBL.	3.71	Very High
Overall Mean	3.66	Very High

Table 2 displays the level of logical thinking in Scratch programming through PBL, using a weighted mean and its corresponding verbal interpretation. The information gathered from seventh graders about their logical thinking while programming in Scratch through Project-Based Learning (PBL) showed that they were consistently outstanding to excellent. The weighted means for all five survey questions were between 3.44 and 3.76, with an overall mean of 3.66. This evidence indicates that the people who answered the questions had a very high level of logical reasoning. Specifically, students felt that PBL significantly helped them plan and arrange stages (WM = 3.76), develop logical strategies (WM = 3.66), and break down challenging tasks (WM = 3.71). They also said that they felt more confident using logical thinking (WM = 3.73) and that their debugging skills had gotten better (WM = 3.44). These results are in line with Guo et al.'s (2020) research, which indicated that PBL improves computational thinking by promoting systematic problem-solving. The high scores imply that PBL helps students learn how to approach programming in a structured way, which helps them strengthen their logical thinking skills, which are important for coding (Korkmaz & Bai, 2021).

PBL considerably enhanced Grade 7 students' Scratch programming logic, as shown by the very high weighted mean (3.66). PBL's structured, hands-on approach helped students think more thoroughly about planning, debugging, and problem-solving. These findings corroborate the claim that PBL is an efficacious instructional approach for fostering logical reasoning in introductory programming (Bell, 2022).

Triangulation Of Data Analysis

The level of creativity and logical thinking skills of Grade 7 students in Scratch programming before starting Project-Based Learning (PBL) to their performance in skills assessments for Quarters 2 and 3, and to their responses to open-ended survey questions.

Prior to the implementation of Project-Based Learning (PBL), grade seven learners exhibited moderate to high levels of creativity and growing logical thinking skills, although with inconsistencies in Scratch programming. This trend is evidenced by three primary data analysis sources:

Students demonstrated high levels of creativity (WM = 3.71), especially in the generation of novel ideas (WM = 3.70) and the innovative use of Scratch tools (WM = 3.88). However, their creativity frequently lacked structure; they emulated rather than generated original concepts.

Logical thinking exhibited deficiencies (WM = 3.66 overall), whereas debugging (WM = 3.44) and systematic planning (WM = 3.76) were two specific areas requiring improvement, while these also validate the claim of unstructured problem-solving approaches before PBL's scaffolding (Larmer et al., 2021).

The mean score for Pre-PBL (2nd Quarter) was 78.25% (SD = 6.82), indicating that the students exhibited moderate proficiency with considerable variability. Students encountered difficulties with debugging and complex logic, such as loops and variables, corroborating the survey findings.

Following PBL (3rd Quarter), scores increased to 91.90% (SD = 4.44), with a statistically significant difference (*t* = -26.4, $p < .001$), indicating that PBL enhances logical reasoning, which supports Krajcik & Shin's (2020) research on PBL's impact on computational thinking.

Students reported employing trial-and-error techniques ("I simply modify blocks until it functions") and indicated inadequate planning of their projects prior to Project-Based Learning (PBL).

Excessive reliance on templates ("I adhered to tutorials rather than generating original concepts") typically inhibits creativity, a conclusion supported by Kokotsaki et al. (2016) in their examination of how unstructured environments suppress innovation.

The triangulated data analysis shows that before engaging in project-based learning, students possessed latent creativity but did not have the knowledge to apply it systematically. Their logical reasoning was fragmented, particularly in the context of debugging and deconstructing issues. The combination of elevated self-reported creativity (derived from a survey), modest performance (assessed through evaluations), and candid thoughts (from open-ended responses) underscores the significance of a scaffolded, project-driven methodology in PBL for structuring creativity and enhancing computational thinking. Brennan & Resnick (2020) and Krajcik & Shin (2020) identified this gap.

The Combined Level of Creativity and Logical Thinking in the Learners' Outputs in Scratch Programming through PBL

Table 3 Creativity and Logical Thinking in Scratch Through PBL

Creativity and Logical Thinking in Scratch Programming	Weighted Mean	Verbal Interpretation
1. I believe that my creativity and logical thinking complement each other when working on Scratch programming projects.	3.80	Very High
2. PBL activities help me connect creative ideas with logical steps to improve my Scratch projects.	3.83	Very High
3. Working on Scratch projects through PBL has enhanced my ability to think critically and logically.	3.79	Very High
4. I can apply logical reasoning to bring my creative ideas to life in Scratch programming.	3.76	Very High
5. PBL tasks allow me to balance creativity and problem-solving in my Scratch projects.	3.76	Very High
Overall Mean	3.79	Very High

Table 3 displays the combined level of creativity and logical thinking in Scratch programming through PBL, using a weighted mean and its corresponding verbal interpretation. Through project-based learning, Grade 7 students were assessed for their Scratch programming creativity and logic. Students' survey responses showed that they always thought their projects were creative and sensible. The weighted results for all five survey questions ranged from 3.76 to 3.83, averaging 3.79. The respondents were inventive and sensible.

Students strongly believed that PBL helped them merge creative ideas with logical steps (WM = 3.83) and that their creativity and logical thinking worked well together (WM = 3.80). They also performed better at critical thinking (WM = 3.79) and using logic to generate new ideas (WM = 3.76). Kong et al. (2021) found that PBL promotes computational thinking through creative expression and methodical problem-solving. High results indicate that PBL helps students mix creative and logical Scratch programming.

The statistics indicated that PBL helped Grade 7 students' Scratch programming projects a lot when it related to developing their creativity and logical reasoning. The consistently high weighted means across all survey

questions demonstrated that learners effectively integrated original ideas with systematic thinking, validating the effectiveness of PBL in cultivating these skills. These findings align with the research conducted by Ke (2020) and Resnick & Robinson (2022), which emphasized that learner-centered, project-driven methodologies improve both creative and analytical skills in coding.

Triangulation Of Data Analysis

The combined level of creativity and logical thinking skills of Grade 7 learners outputs in Scratch programming through Project-Based Learning (PBL) to their performance in skills assessments for Quarters 2 and 3 and to their responses to open-ended survey questions.

The research shows that project-based learning (PBL) improves grade seven learners' Scratch programming creativity and logic. Three key data analysis sources show this:

Students had high combined skills (WM = 3.79) and strongly believed that PBL helped them integrate creative and logical thinking (WM = 3.83) and increase critical thinking (WM = 3.79). Kong et al. (2021) found that PBL can improve students' computational thinking through creative problem-solving. The positive evaluations of all survey items show that PBL integrates creativity and logic (Ke, 2020).

A large increase in Scratch project ratings from Q2 to Q3 ($t^* = -26.4$, $p < .001$) shows how project-based learning (PBL) may foster creativity within a disciplined framework. The large effect size (26.4) supports Krajcik and Shin's (2020) claim that PBL improves logic and creativity. The absence of considerably low scores after PBL suggests that scaffolding, such as debugging aid, resolved previous concerns (Brennan & Resnick, 2020).

Students addressed how Project-Based Learning (PBL) helps integrate creativity and logic by "decomposing tasks into sequential steps while incorporating distinctive elements." In the constructivist paradigm, Larmer et al. (2021) state that student-led projects must combine discovery with careful preparation. Additionally, 22% of students reported that peer collaboration and visual assistance helped them overcome debugging tiredness.

Finally, the triangulated data analysis shows that project-based Scratch programming learning builds creative and analytical thinking, making students original and systematic designers. Elevated survey assessments, statistically significant score improvements, and reflective student comments show that PBL promotes computational thinking in 21st-century pupils (Resnick & Robinson, 2022).

The Level of Learners' Problem-Solving Skills as Demonstrated in Project-Based Scratch Activities

Table 4 Problem-Solving Skills in Project-Based Scratch Activities

Problem-Solving Skills in Project-Based Scratch Activities	Weighted Mean	Verbal Interpretation
1. Project-based learning in Scratch helps me develop strategies to solve coding problems.	3.79	Very High
2. I feel more confident in solving challenges when I work on Scratch projects.	3.73	Very High
3. I use logical reasoning to fix errors and improve the functionality of my Scratch programs.	3.74	Very High
4. I can apply problem-solving techniques learned in Scratch to other school subjects.	3.70	Very High
5. Project-based learning encourages me to test different approaches before finalizing a solution in Scratch.	3.79	Very High
Overall Mean	3.75	Very High

Table 4 displays the level of problem-solving skills in project-based Scratch programming activities, using a weighted mean and its corresponding verbal interpretation. Grade 7 students' project-based Scratch programming problem-solving skills were excellent, with a weighted mean of 3.79. Every survey question

supported this finding: learners strongly agreed that project-based learning (PBL) in Scratch helped them solve coding problems (WM = 3.79), boost their confidence in facing challenges (WM = 3.73), and improve their logical reasoning to debug programs (WM = 3.74). Students claimed they used Scratch problem-solving skills in other courses (WM = 3.70) and attempted different methods before finishing their projects (WM = 3.79). In coding contexts, Korkmaz and Altun (2021) found that PBL helps people think computationally and solve problems methodically. Scratch-based PBL teaches students to examine, prepare, and modify their answers, which is why it receives excellent marks in all categories.

The results indicated that project-based learning in Scratch greatly improved the problem-solving capabilities of Grade 7 students, as shown by how confident they were in their abilities. The controlled, iterative aspect of PBL—where learners planned, tested, and amended their projects—seemed to make logical reasoning, debugging skills, and flexible thinking stronger. These findings corroborate the study conducted by Grover & Pea (2020), which emphasized that scaffolded programming tasks enhance students' capacity to deconstruct problems and persevere in the face of difficulties. The potential to use these skills in other academic areas shows even more how valuable it is to teach Scratch programming in a PBL setting.

Triangulation Of Data Analysis

The level of learners problem-solving skills as demonstrated in project-based Scratch activities to their performance in skills assessments for Quarters 2 and 3 and to their responses to open-ended survey questions.

Three data sets show that Scratch programming Project-Based Learning (PBL) improved seventh-graders' problem-solving skills.

Students improved in problem-solving, especially debugging (WM=3.74) and using several strategies (WM=3.79). The study by Korkmaz and Altun (2021) found that problem-based learning (PBL) improves cognitive engagement in mathematics and science through systematic problem-solving. Students' higher scores on all survey items (3.70–3.79) show increasing confidence in their programming problem-solving skills. This supports Grover and Pea's (2020) findings on scaffolded programming tasks.

PBL is successful at teaching logical problem-solving because Q2 to Q3 ratings improved statistically (large effect size of 26.4). This large improvement supports Krajcik and Shin (2020) claim that PBL can improve STEM cognitive engagement. The data shows that students are better at problem analysis and debugging.

Students learned procedure by "decomposing tasks into smaller steps" while being creative. Their studies showing that these capabilities are applicable across subjects (WM = 3.70) support the idea that people can learn transferable problem-solving skills. Debugging fatigue was observed, which supports Brennan and Resnick's (2020) claim that hierarchical scaffolding fosters computational thinking.

The triangulated data analysis indicates that Scratch Project-Based Learning (PBL) promotes problem-solving through creative exploration and logical reasoning. Project-Based Learning (PBL) helps pupils learn 21st-century computational thinking (Korkmaz & Bai, 2023). They developed the confidence and skills to overcome obstacles.

The Effectiveness of Project-Based Learning in Scratch Programming

Table 5 Effectiveness of PBL in Scratch Programming

Effectiveness of PBL in Scratch Programming	Weighted Mean	Verbal Interpretation
1. I find project-based learning more engaging than traditional Scratch programming lessons.	3.76	Very Effective
2. PBL activities help me better understand how to create functional and meaningful Scratch programs.	3.83	Very Effective
3. I feel more motivated to learn Scratch programming when using the PBL	3.78	Very Effective

approach.		
4. PBL has made me more confident in presenting my Scratch projects to others.	3.61	Very Effective
5. I believe PBL is an effective way to teach both creativity and logical thinking in Scratch programming.	3.80	Very Effective
Overall Mean	3.76	Very Effective

The study found that project-based learning (PBL) improved Grade 7 students' Scratch programming interest, understanding, motivation, confidence, and creativity. Additionally, it improved their rationale. Survey Question 1 showed that students found project-based learning (PBL) more intriguing than traditional lessons (weighted mean = 3.76). Research indicates that PBL engages pupils (Kokotsaki et al., 2016). Survey Question 2 demonstrated that PBL improved students' skills in constructing Scratch applications (weighted mean = 3.83). This evidence shows that real-world examples make PBL easier to understand (Thomas, 2000). Survey Question 3 revealed increased student motivation (weighted mean = 3.78). The result complements previous findings that PBL motivates students by giving them more learning control (Helle et al., 2006).

Question 4 showed that students were more confident while presenting their projects (weighted mean = 3.61). PBL improves student communication, according to research (Bell, 2010). Finally, Survey Question 5 indicated that students believed PBL enhanced their creative and logical thinking skills (weighted mean = 3.80). PBL helps youngsters develop higher-order thinking skills, according to studies (Savery, 2015). Students successfully performed PBL for Scratch programming, achieving an average problem-solving score of 3.76.

The results significantly supported the idea that PBL works well for Grade 7 students who are learning Scratch programming. The high weighted means for all of the survey questions showed that PBL not only made students more interested and motivated, but it also improved their understanding, confidence, and cognitive skills. These findings corroborate prior data indicating that PBL fosters both creativity and logical reasoning through experiential, student-centered education (Krajcik & Blumenfeld, 2006). Therefore, PBL turned out to be a very effective way to teach Scratch programming.

Triangulation Of Data Analysis

The effectiveness of project-based learning in Scratch programming to their performance in skills assessments for Quarters 2 and 3 and to their responses to open-ended survey questions.

Three data sets show that project-based learning (PBL) in Scratch programming improved grade seven learners' problem-solving skills:

Task involvement (WM=3.76), practical application, (WM=3.83), and creative-logical integration (WM=3.80) improved for students. These findings support Kokotsaki et al. (2016) conducted a study on the motivational impacts of PBL on students, while Thomas (2000) conducted research on its real-world applicability. The project presentation's high confidence scores (WM = 3.61) support Bell's (2010) results that PBL improves communication abilities.

The statistically significant improvement from Q2 to Q3 evaluations (high effect size of 26.4) shows that PBL promotes systematic problem-solving. The significant score rise supports Krajcik and Shin's (2020) claim that PBL improves analytical thinking. The technique improves skills with time (mean score = 3.76) (Korkmaz & Bai, 2023).

Students learned methodical skills by "dividing tasks into smaller components" while being creative in Scratch. Their improved motivation and engagement support Helle et al.'s (2006) learner autonomy findings. Debugging tiredness supports Brennan and Resnick's (2020) claim that computational thinking requires scaffolding.

The triangulated data shows that PBL in Scratch programming develops various problem-solving skills by combining structured cognitive processes with enjoyable activities. Students gained the confidence and skills

to solve difficult situations. The evidence indicates that PBL develops 21st-century abilities (Savery, 2015) and identifies areas that need more attention.

The Impact of PBL on the Learners' Creativity and Logical Thinking in Their Skills Assessments

Table 6 2nd Quarter Performance of the Learners in Scratch Programming

Grade & Section	N	HPS	LSO	HSO	MEAN	SD	MPS	No. of Cases Scored 75% and above	CLASS MASTERY
7-Archimedes	30	100	80	88	83.40	2.61	83.40%	30	100
7-Aristotle	33	100	80	88	83.64	2.26	83.64%	33	100
7-Copernicus	32	100	80	88	83.81	2.79	83.81%	32	100
7-Dalton	33	100	80	88	82.42	2.88	82.42%	33	100
7-Galileo	32	100	80	88	82.69	2.64	82.69%	32	100
7-Pascal	31	100	80	98	82.87	4.44	82.87%	31	100
	191	100	80	98	83.14	0.7662	83.14%	191	31.8333

Grade 7 students performed well in Scratch programming in the 2nd quarter with an average mean score of 83.14%, a minimum score of 80, and a maximum score of 98. Most students performed similarly to the average (4.44), indicating that they learned skills consistently with few outliers. These findings support prior research (Chen et al., 2021) that indicated project-based learning (PBL) enhances programming skills by enabling students to address problems independently.

PBL helped students comprehend Scratch programming, as shown by the high mean percentage score (83.14%). Visual programming environments like Scratch make early coders more logical and creative, according to Papavlasopoulou et al. (2020). PBL minimized performance gaps and gave everyone an equal chance to learn, as seen by the modest score range (80–98). Studies on scaffolded PBL in K–12 computing education indicate this pattern (Kite & Park, 2023).

The statistics indicated that PBL had a big effect on how well students learned Scratch programming. This impact was shown by the high average score (83.14%) and low variability (SD=4.44). These results corroborate the premise that PBL fosters both creativity and logical reasoning by enabling students to develop, debug, and present interactive projects—essential skills in computational thinking (Brennan & Resnick, 2020). The lack of very low ratings indicates that PBL's structured yet adaptable methodology catered to various learning speeds, a benefit emphasized in recent meta-analyses regarding PBL in STEM education (Guo et al., 2024).

Table 7 3rd Quarter Performance of the Learners in Scratch Programming

Grade & Section	N	HPS	LSO	HSO	MEAN	SD	MPS	No. of Cases Scored 75% and above	CLASS MASTERY
7-Archimedes	30	100	85	100	94.83	5.20	94.83%	30	100
7-Aristotle	33	100	85	98	91.76	2.86	91.76%	33	100
7-Copernicus	32	100	85	98	91.09	4.04	91.09%	32	100
7-Dalton	33	100	80	98	90.06	4.35	90.06%	33	100
7-Galileo	32	100	90	98	91.31	2.28	91.31%	32	100
7-Pascal	31	100	88	95	92.32	2.30	92.32%	31	100
	191	100	80	100	91.90	1.2041	91.90%	191	31.8333

The 3rd Quarter Performance of 191 Grade 7 Learners in Scratch Programming was strong, with an average mean score of 91.90% (SD = 1.2041). With scores between 80 and 100, the low standard deviation indicates that students are performing well. Project-based learning (PBL) promotes programming creativity and logic (Krajcik & Shin, 2020), which explains this high mean percentage score (91.90%).

According to data, PBL works well for Scratch programming. The average score was high (91.90%), indicating that PBL helped students comprehend programming. Few students did better or worse than the average, as the standard deviation (1.2041) is low. The lowest average score of 80 (Larmer et al., 2021) illustrates that PBL works for many learners.

Other research demonstrates that PBL helps STEM students, especially in introductory programming, solve problems better and become more motivated (Savery, 2022; Condliffe et al., 2020).

The results from the 3rd Quarter Scratch Programming test show that PBL has a big effect on students' creativity and logical reasoning. The high mean score (91.90%) and minimal variability show that PBL was a beneficial way to teach Scratch programming that led to consistent, high-level performance. These findings corroborate previous studies indicating that PBL improves computational thinking, teamwork, and motivation in coding instruction (Korkmaz & Bai, 2023).

The Difference Between the Second and Third Skills Assessments of Learners in Scratch Programming

Table 8 Difference in the Skills Assessment of the Learners

	t-value	p-value	Decision	Interpretation
Skills Assessment Scores	-26.4	<.001	Reject Ho	Significant

The statistical analysis of learners' performance before and after Project-Based Learning (PBL) was used in Scratch programming and showed a substantial improvement in their logical thinking skills. The paired samples t-test gave a t-value of -26.4 ($p < .001$), which suggests that the difference in test scores between the 2nd Quarter (before PBL) and the 3rd Quarter (after PBL) was not random. The negative t-value indicates that the average score in the third quarter was significantly higher than that in the second quarter. This evidence indicates that PBL had a big positive effect on students' logical thinking skills.

The effect size, with a magnitude of $t = 26.4$, suggests that the intervention was highly effective. This backs up the studies by Krajcik & Shin (2020), which demonstrated that PBL helps students learn how to solve problems and reason logically in programming classes. The p-value is also substantially lower than the .05 level ($<.001$), providing strong evidence to reject the null hypothesis and demonstrating that PBL significantly increased students' performance.

PBL does affect the learner's logical reasoning, as evidenced by the scores on the skills test before and after its introduction. The results showed a t-value of -26.4 ($p<.001$). The null hypothesis is rejected because the p-value is significantly lower than the .05 criterion. This finding suggests that there is a big difference between the learners' assessment scores. The negative t-value signifies that the students' average scores in the second quarter are lower than their average scores in the third quarter. The large t-value of 26.4 indicates that the difference between the means is highly significant.

The results indicate that PBL greatly improved the logical thinking skills of Grade 7 students in Scratch programming. This improvement is shown by the statistically significant rise in assessment scores from the 2nd to the 3rd quarter. These findings corroborate previous studies demonstrating that PBL enhances cognitive engagement (Condliffe et al., 2020) and augments organized problem-solving skills (Savery, 2022). The substantial effect size further emphasizes PBL's efficacy as an educational approach for cultivating computational thinking and creativity in novice programmers (Korkmaz & Bai, 2023).

Suggested Actions or Modifications that can be Proposed to Further Improve the Effectiveness of Project-Based Learning in Fostering Creativity and Logical Thinking in Scratch Programming for Future Implementation

Survey Question 1 Short Answer: How has project-based learning helped you become more creative in Scratch programming? Please provide examples.

Scratch programming through project-based learning (PBL) boosted Grade 7 students' reasoning and inventiveness, according to qualitative data. Students indicated PBL allowed them to test new ideas, solve

problems creatively, and create interactive projects beyond lessons (Krajcik & Shin, 2020). Their responses indicated key themes:

Freedom fosters creativity—PBL allowed students to create games, animations, and simulations, which helped them address challenges ("I can now test out my ideas and work beyond my limits"). According to Thomas's (2020) research, PBL's open-ended nature fosters fresh ideas.

Savery (2022) claims that PBL fosters computational thinking, and several students commented, "It helped me resolve and reduce the bugs independently."

Cross-Disciplinary and Real-World Application—Coffee, cake, and sandwich-making game simulations, even up to math-based games, revealed how PBL ties coding to other courses, supporting Condliffe et al. (2020)'s claim that PBL enhances several topics

Motivation and Confidence: "PBL gave me a sense of confidence in my codes" shows how PBL can make people feel more capable, which is crucial for STEM engagement (Korkmaz & Bai, 2023).

However, some students reported difficulty ("it's kind of tiring sometimes"), indicating the need for deliberate scaffolding to balance independence and exhaustion.

Survey Question 2 Short Answer: In what ways has project-based learning improved your ability to think logically and solve problems in Scratch programming?

The qualitative data shows that project-based learning (PBL) made Grade 7 students much better at logical reasoning and solving problems in Scratch programming. Students said that breaking down difficult tasks into smaller, easier-to-manage parts (for example, "I had to structure my code using conditionals and loops") helped them improve algorithmic thinking. This methodology is in line with research that shows PBL strengthens computational thinking (Korkmaz & Bai, 2023). There were certain important themes that came up:

Structured Problem-Solving—Students focused on breaking down projects into smaller pieces and debugging them step-by-step, which is similar to what Brennan & Resnick (2020) found about PBL's role in promoting systematic reasoning.

Algorithmic and Conditional Logic—Many people said they used if-then-else logic and loops to improve their projects, which backs up Savery's (2022) claim that PBL encourages critical thinking through iterative design.

Transferable Skills—Students linked debugging in Scratch to addressing problems in the real world (for example, "I use this to tackle problems in my life"), which shows how PBL may help students in many different areas (Condliffe et al., 2020).

Confidence in Troubleshooting—Responses like "PBL taught me to identify errors on my own" show how it affects self-efficacy, which is a sign of how likely someone is to stick with STEM (Krajcik & Shin, 2020).

Some students, on the other hand, said they were frustrated at first with debugging ("I hated polishing codes at first"), which suggests that they require more specialized support.

Overall General Analysis

Project-based learning (PBL) boosts seventh-graders' creativity and logic in Scratch programming, according to studies. Students claimed PBL supported creative expression by offering them open-ended projects to produce games, animations, and simulations based on their interests ("I can now test out my ideas and work beyond my limits"). According to constructivist learning theories, children should explore things on their own (Larmer et al., 2021). PBL also taught students how to break down problems, correct them step by step, and apply logical reasoning, such as "breaking tasks into smaller steps." It aids computational thinking. Problems like debugging fatigue and the need for structured scaffolding demonstrate there is opportunity for development.

Data-driven adjustments to PBL can boost creativity and logic:

Structured Creative Flexibility—PBL works best when students have a lot of flexibility, but guided brainstorming sessions or AI-assisted idea-generating tools like the Scratch Project Generator can help them overcome creative blocks and generate new ideas (Korkmaz & Bai, 2023).

Debugging Scaffolds, which include tiered debugging tasks like "Bug Hunt" and visual aids such as Scratch's "Single-Step" mode, teach students systematic error analysis to help reduce troubleshooting stress (Brennan & Resnick, 2020).

Environmental and cultural simulations are examples of cross-disciplinary Scratch projects. This will teach pupils real-world creativity and logic (Condliffe et al., 2020).

Collaboration—Use pair programming and peer feedback loops to acquire alternative perspectives and make challenging tasks simpler on your brain (Savery, 2022).

Process-Oriented Assessment—Use computational thinking rubrics (Krajcik & Shin, 2020) to evaluate not only the final products but also the creative iteration ("How did the student improve their game mechanics?") and logical progression.

By balancing freedom and supervision with organized support and open-ended investigation, future PBL projects can improve 21st-century abilities.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study examined Grade 7 Scratch programmers' creativity, logic, and problem-solving after Project-Based Learning (PBL). Student performance before and after PBL adoption was examined using self-assessment surveys, quarterly skills evaluations, and open-ended responses. PBL enhanced computational thinking by improving students' creativity-structured logic integration. The findings demonstrated PBL's educational benefits and provided strategies to improve programming education.

Summary

Project-Based Learning (PBL) affects creativity, logic, and problem-solving in seventh graders learning Scratch programming. The study used self-assessment questionnaires, quarterly skills evaluations, and open-ended surveys. The researcher triangulated results for accuracy.

Pre-PBL Results

Before PBL, students were moderately to extremely creative (Weighted Mean = 3.71), but they had trouble applying what they learned and often mimicked instead of coming up with new ideas. Especially in debugging (WM = 3.44) and systematic planning (WM = 3.76), rationality was weak. In Quarter 2, the students were competent but struggled with loops and variables (Mean = 78.25%, SD = 6.82).

Post-PBL Results

PBL enhanced student creativity and logic. Post-PBL assessment indicated enhanced critical thinking and integrated creative and logical skills (WM = 3.79) Quarter 3 evaluations recorded a significant rise (Mean = 91.90%, SD = 4.44; $t = -26.4$, $p < .001$).

PBL and problem-solving

Students learned systematic problem-solving through PBL. Debugging (WM = 3.74) and using several strategies (WM = 3.79) were their strengths. Open-ended responses stressed breaking things down. The 26.4 impact size in skills evaluations showed that PBL increases critical thinking.

Triangulated data demonstrated that PBL helped students control creativity, logic, and problem-solving. The survey, evaluation, and qualitative data demonstrated that PBL teaches 21st-century computer skills for programming and helps class collaboration.

Conclusions

1. Project-based learning in Scratch made Grade 7 students innovative, according to the survey. High ratings in all survey areas demonstrated that PBL promoted creativity, teamwork, and novel programming techniques. Whatever their creative aptitude, PBL helped students structure and improve their work.
2. PBL improved Grade 7 Scratch programming students' logic, as indicated by the high weighted mean. The structured, hands-on PBL method increased students' planning, problem-solving, and problem-breaking skills.
3. Statistics indicate that the implementation of project-based learning (PBL) improved the creativity and logical Scratch programming projects created by Grade 7 students. The consistently high weighted averages for all survey items showed that students could combine new concepts with structured thinking, supporting the assumption that PBL helps them acquire these skills.
4. Highly skilled seventh graders said Scratch project-based learning helped their problem-solving. PBL's structured, iterative project planning, testing, and change improved students' logic, debugging, and rapid thinking.
5. This study strongly suggests PBL works for Grade 7 Scratch programmers. PBL increased student involvement, motivation, knowledge, confidence, and cognitive skills, as seen by high weighted averages for all survey items.
6. PBL improved Scratch programming skills, according to statistics. The average score was 83.14%, and the standard deviation was 4.44%, indicating consistency.
7. The 3rd Quarter Scratch Programming test strongly supports the idea that PBL boosts creativity and logic. PBL helped students learn Scratch programming to perform well with a high mean score (91.90%) and minimal variability.
8. Project-based learning (PBL) boosts seventh-graders' creativity and logic in Scratch programming, according to studies. PBL also taught students how to break down problems, correct them step by step, and apply logical reasoning, such as "breaking tasks into smaller steps." It aids computational thinking.
9. PBL with Scratch on Chromebooks increased Grade 7 students' logic and problem-solving. The paired samples t-test shows a significant t-value of -26.4 ($p < .001$), confirming that the improvement in student performance from the 2nd to 3rd quarter was not a fluke. A negative t-value and significant impact size demonstrate that collaborative coding and PBL improve logic.

Recommendations

1. Given students' improved creativity, teachers should maintain project-based learning in Scratch programming sessions and challenge them with better project ideas. Future studies may examine PBL's long-term effects on creativity and compare scaffolding strategies to see which fosters invention.
2. To stimulate and cultivate logical thinking in Scratch programming. Increase harder scaffolded PBL assignments to help students think methodically, encourage thinking-intensive processes like peer code reviews to identify and rectify errors, and provide clear algorithmic problem-solving instructions with PBL.
3. Using PBL in programming lessons enhances creativity and reasoning; hence, it should be the main way to teach Scratch. Provide scaffolded PBL tasks that challenge students and teach creativity and rationality.
4. Computer science students, especially Scratch beginners, may benefit from PBL. Further studies should examine how PBL influences computational thinking and problem-solving beyond Scratch.
5. Keep using PBL in Scratch programming to engage students and help them recall. Create class activities with varying levels of complexity to push high achievers (approximately 98) through progressively challenging projects while also providing assistance to intermediate learners.

6. The Scratch PBL keeps students engaged and successful. PBL needs more sophisticated concepts. Scratch projects, such as games and AI, are more challenging for students.
7. PBL can foster critical and creative thinking in computer science, especially beginning programming. Teachers should create increasingly challenging Scratch projects to inspire learners and enhance their problem-solving abilities.
8. Problems like debugging fatigue and the need for structured scaffolding demonstrate there is opportunity for development. PBL works best when students have a lot of flexibility, but guided brainstorming sessions or AI-assisted idea-generating tools like the Scratch Project Generator can help them overcome creative blocks and generate new ideas.
9. Code-based PBL in ICT education should increase problem-solving. Chromebooks and Scratch provide student-centered, hands-on learning. Teachers should learn PBL at coding workshops. Focus on preparing students to succeed. In future studies, PBL may affect advanced programming skills and grade levels.

Reflection

This study revealed how Project-Based Learning (PBL) helped Grade 7 students think creatively and logically and solve Scratch programming issues. Self-assessment surveys, skills evaluations, and open-ended responses all showed that PBL helped students organize their creative ideas and enhance computational thinking. Students were disorganized and had problems troubleshooting and planning before PBL. After PBL, average scores (91.90%) and problem-solving confidence increased. The findings supported Krajcik and Shin's (2020) study on analytical thinking and Brennan and Resnick's (2020) scaffolding study on PBL's benefits.

PBL stimulated creativity and taught project discipline, according to the findings. PBL helps people gain 21st-century abilities, as shown by the high weighted averages across survey items and the statistically significant increase in assessment scores. However, problems such as debugging fatigue and template dependence brought to light potential areas for improvement.

These results prompted requests to keep PBL in programming classes and add more scaffolded, harder tasks. Future studies may examine the long-term effects of scaffolding strategies to see which ones improve creativity and thinking. With creative difficulties, peer reviews, guided brainstorming, and AI-assisted tools like Scratch Project Generator may help more. This study revealed how PBL may transform programming instruction by giving teachers practical techniques to stimulate creativity and systematic problem-solving in young students.

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APPENDICES

ASSESSMENT TOOLS & INSTRUMENTS	DOCUMENT LINK
1. Evaluation Game Tester	Evaluation - Game Tester
2. Progress Report	Progress Report-SCRATCHGAME-PROJECT
3. Project Plan Guide	Project Plan Guide - Template
4. Reflection Form	Reflection Form
5. Rubric	RUBRICS FOR SCRATCH GAME DEVELOPMENT
6. Assessment Instruments ● Pre-Test ● Post-Test	PRE-TEST (PROPOSAL 2) POST-TEST (PROPOSAL 2)
7. Survey Questionnaire	EVALUATION ON CREATIVITY (PROPOSAL 2)