

Effective Project-Based Learning Strategies to Enhance Critical Thinking, Creativity, Communication, and Collaboration Skill

Almendo Thio Lindra ^{1*}, C. Asri Budiningsih ¹, Rishe Purnama Dewi ²

¹ Universitas Negeri Yogyakarta, Yogyakarta

² Universitas Sanata Dharma, Yogyakarta

*Corresponding author: almendolock@gmail.com

ABSTRACT

This study aims to explicitly examine the effectiveness of Project-Based Learning (PBL) strategies in enhancing students' 21st-century skills, particularly the 4Cs: critical thinking, creativity, communication, and collaboration. The research involved 30 ninth-grade students from a junior high school in BSD Tangerang, who served as the research subjects selected through purposive sampling. Using a descriptive qualitative approach, data were collected through document analysis, classroom observations, and interviews with teachers and students. The data were analyzed using the stages of data reduction, data display, and conclusion drawing, and supported by pretest and posttest comparisons to assess skill improvement. The findings revealed significant increases in students' 4C skills after participating in various project-based activities such as group presentations, digital literacy projects, poster creation, and social projects. The results highlight the potential of PBL to foster both academic achievement and essential soft skills. These findings suggest that further research should explore the integration of PBL across different educational levels and disciplines to maximize its pedagogical impact in diverse learning contexts.

Keywords: Project Based Learning, 21st Century Skills, Learning Model

ABSTRACT

Penelitian ini bertujuan untuk menguji secara eksplisit efektivitas strategi Project-Based Learning (PBL) dalam meningkatkan keterampilan abad ke-21 siswa, khususnya 4C: berpikir kritis, kreativitas, komunikasi, dan kolaborasi. Penelitian ini melibatkan 30 siswa kelas sembilan dari sebuah sekolah menengah pertama di BSD Tangerang, yang menjadi subjek penelitian yang dipilih secara purposive sampling. Dengan menggunakan pendekatan kualitatif deskriptif, data dikumpulkan melalui analisis dokumen, observasi kelas, dan wawancara dengan guru dan siswa. Data dianalisis dengan menggunakan tahapan reduksi data, penyajian data, dan penarikan kesimpulan, serta didukung dengan perbandingan pretest dan posttest untuk menilai peningkatan keterampilan. Hasil penelitian menunjukkan adanya peningkatan yang signifikan dalam keterampilan 4C siswa setelah berpartisipasi dalam berbagai kegiatan berbasis proyek seperti presentasi kelompok, proyek literasi digital, pembuatan poster, dan proyek sosial. Hasil penelitian ini menyoroti potensi PBL untuk mendorong pencapaian akademik dan keterampilan lunak yang penting. Temuan ini menunjukkan bahwa penelitian lebih lanjut harus mengeksplorasi integrasi PBL di berbagai tingkat pendidikan dan disiplin ilmu untuk memaksimalkan dampak pedagogisnya dalam konteks pembelajaran yang beragam.

Kata Kunci: Pembelajaran Berbasis Proyek, Keterampilan Abad 21, Model Pembelajaran



Introduction

The Industrial Revolution's impact on Education 4.0 calls for major adjustments to teaching strategies in order to equip students to handle global issues. The 4C skills (Critical Thinking, Communication, Collaboration, and Creativity) are among the 21st-century talents that students need to possess (Handayani et al., 2023). These abilities are essential for developing people who can collaborate in groups, think critically, and come up with creative solutions to challenging issues. The actual situation, however, demonstrates that traditional teaching approaches continue to predominate in a number of educational establishments (Annisa et al., 2023). Memorization and teacher-based learning are less able to give pupils the space they need to develop 4C abilities to their full potential. Because of this, students typically take in material passively and are deprived of the chance to investigate and apply what they have learned in a real-world setting. Thus, in order to make learning more efficient and pertinent to the demands of the modern world, a more creative approach is required (Frida Nurmarliana & Mirna Nur Alia Abdullah, 2024).

The concept of Project-Based Learning (PBL) is not new, but it has recently gained the spot light in the education field. In the past decade, studies on PBL have increasingly been conducted and adopted across a diversity of educational institutions worldwide (Pan et al., 2023). Researchers have given a variety of definitions for PBL in which they all share several similar disciplines. In terms of its crucial functions, Stivers (2010) stated that PBL is an instructional approach that is built upon learning activities and real tasks that have brought challenges for students to solve. Bell (2010) therefore defined PBL as a student-driven (student-centered) approach to learning in which students are required to take part in a real project by developing a question or inquiry and under the supervision of teachers in order to create a project to share with the select audience. In other words, students involve designing their own inquiries, planning their learning, organizing their research, implementing a multitude of learning strategies, and evaluating their projects that have real-world applications beyond the classroom (Saimon et al., 2023). These activities give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations. When it comes to the teachers' role, Bell (2010) also expanded the definition of PBL to an approach in which teachers act as a facilitator (Azmi et al., 2024).

Students work together under the teachers' supervision in which they oversee each of the process and approve each choice before the students embarks in a direction, toward a common goal (Yalcin & Shah, 2025). In short, PBL has originally developed from the root of constructivism theory in which learning is considered as a mental construction; that is, students learn by constructing new ideas or concepts based on their current or prior knowledge. This approach empowers learners to pursue content knowledge on their own, demonstrate their new understandings through a variety of presentation modes, and gain valuable skills that will build a strong foundation for their future in the global economy (Calamlam et al., 2022).

The features of real-world PBL have been accepted and discussed across the disciplines, and the concept of authentic content is the key to PBL. This task helps promote students' interest and foster their motivation to learn under the connection between academic purposes and external social, political, and environmental processes. Real-world problems are also presented in PBL when students are allowed to choose their own topics based on a current social or life situation under the facilitation of their teachers (Alhayat et al., 2023). Bell (2010) also insisted that the students' choice of a topic, is based on questions that have piqued their natural curiosity. This task provides the project team a chance to be more responsible for choosing and structuring their projects as they research real-world questions, pose solutions to real-world problems, and design real-world products in a rigorous way (Franco et al., 2023).

Project-based learning (PBL) is one strategy thought to be able to get beyond the drawbacks of traditional approaches. This approach gives students the chance to learn by investigating actual tasks that call for critical thinking, effective communication, teamwork, and creative problem-solving

(Alhayat et al., 2023). Project-based learning is therefore focused on the development of broader skills in addition to academic results (Ullah et al., 2023). This study is to examine how the use of project-based learning techniques can enhance students' 4C skills in light of this background. Using a qualitative methodology, this study investigates the method's efficacy in developing students' skills as well as potential implementation issues. It is anticipated that the findings of this study will help teachers create more efficient teaching methods that meet the needs of students in the contemporary world (Saimon et al., 2023).

Learning success is dependent on students' past knowledge as well as the learning environment or conditions. A student's ability, interest, motivation, and level of learning activity are some of the aspects that affect their success in the learning process. Furthermore, well-planned education and learning that is backed by qualified teachers will be able to effectively develop the 4C skills. The 4C skills in question are communication, collaboration, critical thinking and problem-solving, and creative thinking. Since many occupations and expanding industries want workers to be creative, creative thinking or creative thinking abilities encourage pupils to think outside the box, generate ideas, envision novel situations, and create outstanding work (Malahito & Quimbo, 2020). Critical Thinking and Problem-Solving Skills are part of the 4C skills that must be mastered by students in order to have the ability to think analysis, interpretation, precision, accuracy, solve problems, and express their arguments based on the knowledge they learn. Critical thinking skills are defined as high-level thinking skills where not only memorizing but also using the material that has been learned to be adapted to each problem (Cartner & Hallas, 2020).

Applying critical thinking and problem-solving techniques in the classroom is necessary to help students become comfortable constructing arguments, evaluating the reliability of sources, and coming to their own conclusions (Eckardt et al., 2018). The ability to recognize, evaluate, and resolve a problem in a creative and rational manner in order to arrive to the best choices and judgments is a component of critical thinking skills. Testing the veracity of a statement, separating pertinent information from extraneous information, recognizing cause and effect, critically analyzing what is read, comprehending the content, and coming up with solutions are the six markers of critical thinking and problem-solving abilities. The development of communication skills can be achieved by giving students the chance to express their thoughts and opinions during class discussions, both in groups and with the teacher. Learners will be able to process ideas, information, and phenomena through communication in order to convey them both orally and in writing. Presenting information and voicing arguments or ideas are the two ways that communication abilities are demonstrated (Guo et al., 2020).

Collaboration is one of the abilities that helps students develop relationships and take ownership of their own and other people's lives. Collaboration may occur during the learning process in order to provide each other with helpful information (Anggraini & Wulandari, 2020). Through cooperative activities, a process of learning from one another and resolving each person's shortcomings can be carried out in an effort to achieve goals. Teachers have a key role in creating cooperative learning activities for kids. Respect and the ability to compromise or discuss are two indications of collaborative skills. In order for students to become accustomed to being receptive and open in locating or sharing novel concepts, ideas, or viewpoints with others, they must be taught creative and inventive thinking techniques. Collaboration exercises can help foster students' creativity in the classroom (Annisa et al., 2023). Students can collaborate creatively with others through group chats with their pals. Curiosity, adaptability, and originality are the three markers of creative and inventive thinking abilities, according to Greenstein in Zubaidah (2018). Learning materials that provide students with information are necessary for learning activities. Furthermore, learning resources help teachers by making the subject matter easier to teach. In every educational unit, textbooks are among the most often used learning resources (Tadayonifar & Entezari, 2020).

In facing these challenges, innovation is needed in learning methods that can increase students' active involvement in the learning process. Project-Based Learning (PBL) is one of the effective approaches to help students develop 4C skills through project-based learning that demands exploration, collaboration, and real problem solving. With this approach, students are challenged to complete project-based tasks that are relevant to their lives (Eckardt et al., 2018). In addition to improving understanding of academic concepts, this model also trains students' interpersonal skills, independence, and creativity in solving a problem. One of the advantages of Project-Based Learning is its ability to encourage students to think critically and systematically. For example, in the Digital literacy project activity, students can develop analytical skills by conducting hands-on experiments, testing hypotheses, and drawing conclusions based on empirical evidence (Tadayonifar & Entezari, 2020). This method allows them to learn from real experiences, not just theories taught in class. The results showed that students who engaged in project-based experiments had a deeper understanding of scientific concepts than those who relied solely on the teacher method.

In addition, Project-Based Learning also plays a role in improving students' communication skills. In the Group Presentation activity, students are given the opportunity to organize and convey their ideas effectively in front of the class. This skill is very important in the working world, where the ability to convey ideas clearly is one of the main factors of professional success (Frida Nurmarliana & Mirna Nur Alia Abdullah, 2024). Through group presentations, students not only learn public speaking but also develop self-confidence and teamwork skills. On the other hand, creativity is also an aspect that is developed through the application of Project-Based Learning, especially in the Poster Production activity. In this method, students are invited to present information in an interesting and innovative visual form. This process involves creative processing of ideas so that students can express their understanding in a more free and flexible way (Pangrazio et al., 2020). The enhancement of these creative skills is very important, considering that today's world places great emphasis on innovation and the ability to think out-of-the-box in solving problems.

In addition to critical thinking, communication, and creativity, Project-Based Learning is also effective in improving students' collaboration skills. Social project activities encourage students to work in teams, share tasks, and find solutions together to problems around them. This social project not only improves academic understanding but also fosters empathy, social awareness, and the ability to work in a harmonious group. Thus, students not only learn theory in the classroom, but also apply it in real life. Despite its many advantages, the implementation of Project-Based Learning in the education system still faces several challenges. One of them is the limited time and resources needed in project implementation (Fegely et al., 2020). Teachers also need to have special skills in guiding students in order to achieve maximum results. Therefore, training for educators as well as support from educational institutions are needed so that this learning model can be implemented effectively. Based on this background, this study aims to analyze the effectiveness of Project-Based Learning in improving students' 4C skills. By understanding the impact of this method, it is expected that educational institutions can adopt and develop more innovative learning strategies. As cited by DeFilippi (2001), in 1997 Smith and Dodds defined project-based learning as the theory and practice of utilizing real-world work assignments on time-limited projects for facilitating individual and collective learning and reach performance objectives (Cheng-Huan Chen, 2019). The results of this study can also serve as a reference for educators in creating a more interactive and experiential learning environment, so that students are better prepared to face the challenges of the world of work and life in the 21st century.

Although previous research has widely highlighted the benefits of Project-Based Learning (PBL) in developing 21st-century competencies, the majority of these studies have focused on higher education settings or specific STEM areas. There is a conspicuous lack of empirical study into the direct influence of PBL on junior high school pupils, particularly in interdisciplinary situations involving social and digital literacy projects. This constraint creates a vacuum in knowing how PBL

can be systematically applied and measured at the middle school level. Addressing this gap is critical for establishing age-appropriate techniques that promote the comprehensive development of 4C abilities in young learners.

In contrast to earlier studies that highlighted student motivation or involvement without providing measured outcomes, this study combines qualitative observations with quantitative pretest-posttest comparisons. By concentrating on ninth-grade students in a real-world classroom setting, this study provides a data-driven evaluation of how PBL improves critical thinking, creativity, communication, and teamwork. This approach sheds new light on the tangible benefits of PBL at the intermediate level, when such instructional tools are underexplored. The importance of this study stems from its ability to inform evidence-based curriculum design, which better prepares students for future academic and professional challenges.

Methods

This research uses a qualitative approach with a descriptive method to analyze the impact of project-based learning on students' 4C skills. The research subjects consisted of intermediate-level students involved in a learning project designed to improve critical thinking, communication, collaboration, and creativity skills. Data collection techniques include direct observation in the classroom, interviews with teachers and students, and document analysis of project results done by students (Anggraini & Wulandari, 2020). Data analysis was conducted using data reduction, data presentation, and conclusion-drawing methods (Rehman et al., 2024). To measure the improvement of students' 4C skills, a comparative analysis was conducted between the results before and after the application of project-based learning methods (Alhayat et al., 2023). The improvement of 4C skills was calculated using the formula:

$$P = \frac{x_1 - x_2}{x_1} \times 100\%$$

P = Percentage of improvement in student skills,

X₁ = Value before the application of project-based learning methods,

X₂ = Value after the application of project-based learning methods.

The efficiency of project-based learning in improving student competences is assessed using this computation for each of the 4C skills (Azmi et al., 2024). Thus, the data analysis results provide a clear picture of how project-based learning affects students' skill development. The study ran from July to December and involved students in consistent weekly activities. This study included 30 ninth-grade students from a junior high school in BSD Tangerang, chosen by purposive sampling. This school was chosen because of its urban setting, which provides an ideal atmosphere for conducting real-world project-based learning scenarios. Due to the nature of qualitative research, the participants are referred to as research subjects rather than statistical samples. The purposive sample technique was utilized to identify students who were actively participating in classroom projects, allowing researchers to acquire detailed insights into the development of 4C skills. Weekly activities allowed for continual monitoring and prompt assessment, ensuring that data was collected and evaluated efficiently throughout the study period.

Data Analysis Techniques

The study used a descriptive qualitative data analysis technique to determine the efficacy of Project-Based Learning (PBL) in improving students' 4C skills: critical thinking, creativity, communication, and collaboration. Data analysis was carried out in three steps: data reduction, data display, and conclusion drafting. This method enabled the researchers to methodically condense

massive amounts of qualitative data gathered through observations, interviews, and document reviews into relevant patterns and insights. The efficiency of PBL was further investigated by comparing pretest and posttest results using statistical analysis, such as mean differences, standard deviations, and t-tests, to give quantitative support for qualitative conclusions.

Research Instruments.

This study's equipment comprised observation sheets, interview guides, and tools for document analysis. Observation sheets were used to monitor students' behavioral changes and participation in classroom activities connected to each of the four Cs. Interview guides provided an organized technique to elicit students' and teachers' perspectives on the learning process and outcomes. Document analysis was performed on student project outputs such as posters, presentations, and reports. These instruments were created to capture both the process and the outcome of learning in a project-based setting, allowing the development of 4C abilities to be tracked in several dimensions.

Data Collection Methods (Triangulation)

Actually, the study used triangulation for data collecting. Three separate techniques—classroom observation, interviews, and document analysis—were used to assure data reliability and validity. The goal of this triangulation was to cross-verify findings and improve data dependability by comparing information from various sources and perspectives. For example, observed student conduct in group projects was compared to interview replies and artifacts created during the projects. This multidimensional approach reduced bias, reinforced evidence consistency, and provided a more comprehensive picture of how PBL affected the development of students' 4C skills.

Research Procedure

The research was divided into numerous clearly defined phases. First, 30 ninth-grade pupils from a junior high school in BSD Tangerang were chosen using simple random sampling. The students then took part in a series of PBL activities geared toward developing the 4Cs, including group presentations (communication), poster making (creativity), digital literacy projects (critical thinking), and social projects (collaboration). These exercises were carried out over several weeks, allowing for ongoing observation and assessment. Data were collected during project implementation and examined throughout. Following the activities, students' skills were tested using posttests, and the findings were compared to pretest scores to evaluate improvement. The approach included both formative and summative evaluations, offering thorough insights into the efficacy of the PBL strategies implemented.

Results And Discussion

Result

The findings demonstrate that project-based learning has a beneficial effect on students' 4C skill development. Pupils gain the ability to collaborate and create original ideas, as well as to critically voice their opinions and participate more actively in conversations. Additionally, teachers' methods of instruction changed, becoming more facilitators rather than one-way suppliers of materials.

Table 1. Student Activity Observation Results

No	Assessment Aspect	Before Implementation	After Implementation
1	Critical Thinking	60%	85%
2	Communication	55%	80%
3	Collaboration	58%	88%
4	Creativity	62%	90%

Table 1 shows how students' 4C skills (critical thinking, communication, cooperation, and creativity) improved before and after project-based learning was implemented in the classroom. The statistics reveal a significant increase in all competencies, with critical thinking going from 60% to 85% and creativity from 62% to 90%. Communication and collaboration also experienced significant growth, rising from 55% to 80% and 58% to 88%, respectively. When students were exposed to real-world projects, their participation in learning activities increased.

Table 2. Student Project Analysis Results

No	Project Type	Dominant 4C Aspects	Final Results
1	Group Presentation	Communication	Increased 80%
2	Poster Production	Creativity	Increased 85%
3	Digital literacy project	Critical Thinking	Increased 88%
4	Social Project	Collaboration	Increased 90%

Table 2 shows the results of multiple student projects, each focusing on a different core competency of the 4Cs. Group presentations mostly improved communication skills, whereas poster production stressed creativity, with an 80% and 85% improvement, respectively. Digital literacy initiatives were the most effective at improving critical thinking (88%), while social programs saw the greatest increase in collaboration (90%). This table demonstrates how targeted PBL activities can effectively improve various student skills through meaningful, task-oriented learning.

Following the adoption of project-based learning, students' critical thinking abilities improved, demonstrating their increased capacity for in-depth problem analysis. Prior to using this approach, pupils tended to passively absorb information without considering different viewpoints. However, students are able to create more rational and fact-based arguments after being assigned project responsibilities that call for analysis and problem-solving. This approach promotes students to be more engaged in assessing information and making well-informed decisions, as seen by the 85% improvement in critical thinking. Therefore, project-based learning gives students the opportunity to practice more sophisticated thought processes. Students' communication skills also significantly improved after project-based learning was implemented. The fact that this competency increased from 55% before implementation to 80% after it shows that students feel more at ease voicing their ideas and opinions. Projects involving group presentations assist students in improving their capacity for organized and cogent communication. They can also develop their active listening skills and provide relevant responses by participating in project chats with their peers. This illustrates how effectively the project-based learning methodology teaches students to communicate both orally and in writing. PBL in this study indicates a learning process in which students are engaged in working on authentic projects and the development of products (Cheng-Huan Chen, 2019).

One of the main features of the project-based learning approach is collaboration, which increased from 58% to 88%, according to the study. Students must collaborate to create plans, assign duties, and resolve problems as a group when working on group projects. Due to clearly defined roles in the project, students who had previously been less engaged in teamwork became more involved. In order for every student to participate as much as possible, teachers also have a part to play in promoting group dynamics. This rise in cooperation demonstrates that project-based learning enhances social skills, which are essential in the workplace, in addition to individual ability. Following the adoption of project-based learning, students' inventiveness increased the most, rising from 62% to 90%. Students are allowed to experiment with new concepts and come up with creative solutions in projects like scientific experiments and poster creation. Pupils are encouraged to think creatively and develop original solutions to the problems at hand. This enhancement demonstrates how project-based learning gives students more freedom to express themselves and allows them to The results demonstrated that PjBL had a more positive impact on students' academic achievement than direct

instruction allowing creativity to flourish. In the current world, when constant innovation is necessary, this is crucial (Guo et al., 2020). In Chen & Yang's (2019) review, the effects of PjBL and teachers' direct instruction on students' academic achievement in primary, secondary, and tertiary education were compared (Chen et al., 2019).

In general, students' 4C skills improved as a result of the use of project-based learning. This approach not only enhances academic comprehension but also fosters pupils' resilience and self-assurance in the face of adversity. Students are more inclined to study and solve problems on their own in an environment that is more dynamic and participatory. This demonstrates that one of the effective strategies to raise educational standards in the digital age is project-based learning. It is advised that educators and schools incorporate more project-based learning strategies into the curriculum in light of the study's findings (Yalcin & Shah, 2025). Another key element in the effectiveness of this approach is giving teachers the tools and training they need to use it. Project-based learning can be a useful tool in developing students who are more capable and prepared for the future if given the proper support. Incorporating projects into curriculum is neither new nor revolutionary; however, its benefits are inevitable in the process of teaching and learning. A teacher in Washington State who has used project-based instruction in his math and science classes reported that many students find meaning and justification for learning by working on project after a long period struggling in most academic settings. He also stated that by facilitating learning of content knowledge as well as reasoning and problem-solving abilities, project-based learning can help learners to prepare for state assessments and meet state standards. Brewster and Fager (2000) indicated that engagement and motivation from PBL lead to high achievement (Cheng-Huan Chen, 2019)

Students who are engaging in stimulating projects are exposed to and develop a wide range of skills and competencies such as collaboration, critical thinking, project planning, decision making, time management skills, social and communication skills, and problem-solving skills. With projects, students use higher-order thinking skills rather than memorizing facts in an isolated context without a connection to how and where they are used in the real world. Furthermore, while some of these skills are self-reported through student surveys or other methods of evaluation, at other times the evidence for their development is not clearly stated. When assessing the effectiveness of PBL, academic results are a good indicator to measure success. However, PBL also can change a variety of skills and learners' attitudes that may not be measured using standardized testing. One of the major positive attributes associated with PBL is the engagement and motivation which are represented in teachers' note on their improvement in attendance, more class participation, and greater willingness to do homework.

Table 3. Statistical description

Learning Model	Test	Mean	Std. Deviation	N
Group Presentation	Pre-test	55.00	6.80	30
	Pos-test	80.00	5.50	30
Poster Production	Pre-test	58.00	7.20	30
	Pos-test	85.00	5.30	30
Digital literacy project	Pre-test	60.00	7.50	30
	Pos-test	88.00	5.00	30
Social Project	Pre-test	62.00	7.90	30
	Pos-test	90.00	4.80	30

Table 3 shows a statistical comparison of the pretest and posttest outcomes for each PBL activity. All four types of projects resulted in significant increases in student performance, with average scores rising by more than 20 points in each case. Following implementation, standard deviation numbers fell, indicating more consistent learning results for pupils. These findings support the usefulness of PBL not just in raising average achievement but also in reducing learning gaps.

The outcomes of project-based learning showed a significant rise in post-test scores above pretest scores across all activity kinds, according to the statistical description table. After being given the chance to practice public speaking in groups, students' communication abilities significantly improved, as seen by the mean score in Group Presentation rising from 55.00 to 80.00. Following the intervention, students' score variation was more evenly distributed, as seen by the post-test standard deviation of 5.50, which was lower than the pretest's (6.80). This implies that the group-presenting approach enhanced students' communication abilities in addition to their comprehension of the subject matter. The average score in Poster Production increased from 58.00 on the pretest to 85.00 on the post-test. Students can use their imagination to graphically communicate knowledge with this activity, which improves their comprehension of the subject matter. After creating posters, students' learning results were more consistent, as seen by the post-test's standard deviation of 5.30, which was lower than the pretest's (7.20). This enhancement demonstrates how the project-based method fosters deeper conceptual understanding in pupils by encouraging creativity and exploration.

With an average pretest score of 60.00 rising to 88.00 on the post-test, the Digital literacy project activity also showed a notable rise. Students can develop their critical thinking abilities by personally exploring, observing, and analyzing a phenomenon through science activities. Students' comprehension becomes more consistent after taking part in the experiment, as seen by the post-test standard deviation of 5.00, which is lower than the pretest standard deviation of 7.50. . Technology is a significant support in PBL, enabling students to accomplish challenging tasks independently, which might otherwise be beyond their capabilities (Eckardt et al., 2018). This finding demonstrates how experiment-based learning can improve students' capacity for analysis and problem-solving. When compared to other activities, the highest average score in Social Project increased from 62.00 on the pretest to 90.00 on the post-test. Students can collaborate in groups, have discussions, and find solutions to real-world problems through social project activities. This approach helps pupils develop a more even comprehension, as evidenced by the post-test standard deviation of 4.80, which is lower than the pretest standard deviation of 7.90. These findings demonstrate that working together on social projects enhances students' interpersonal abilities in addition to their academic performance.

It is evident from the overall findings that the project-based learning approach improves student learning outcomes. To increase student engagement and deep understanding of the materials, they suggested project-based learning (PBL). The significant improvement in the average post-test score suggests that this method works well for raising students' comprehension and proficiency. Furthermore, the smaller post-test standard deviation for all activities shows that this approach not only raises average student achievement but also closes the comprehension gap between students. Project-based learning may therefore be a way to increase the efficiency of instruction in the classroom. A significance threshold of 0.05 can be used to determine that the project-based learning method's intervention was the cause of the observed changes in learning outcomes rather than an accident. These findings demonstrate that this approach significantly enhances students' comprehension in a number of areas, such as cooperation, communication, creativity, and problem-solving. Therefore, in order to help students develop better 21st-century abilities, educators and educational institutions are encouraged to include this method more widely in the curriculum.

Tabel 4. Summary of t-test results

Learning Model	t-value	df	p-value
Group Presentation	15.65	58	<0.001
Poster Production	16.53	58	<0.001
Digital Literacy Project	17.01	58	<0.001
Social Project	16.59	58	<0.001

Table 4 shows the t-test analysis results, which reveal statistically significant differences in pretest and posttest scores for all project categories. Each learning model—group presentation, poster production, digital literacy, and social project—had a p-value less than 0.001, indicating significant evidence against the null hypothesis. The high t-values (15.65 to 17.01) show that the observed skill improvements are robust. These findings provide strong evidence that PBL has a positive impact on students' development of 4C abilities.

The study's t-test analysis shows that students' performance has significantly improved across all learning tasks. A strong quantitative indicator of the effect of project-based learning on different 4C abilities was provided by the data, which contrasted pretest and posttest scores for group presentations, poster creation, digital literacy projects, and social projects. The observed improvements are unlikely to have happened by accident, according to the substantial t-values and matching p-values of less than 0.001. Assuming that the pretest and posttest scores were gathered from separate samples, the independent t-test was utilized to evaluate the differences between the two sets of scores. This method entailed figuring out the t-value for every activity after determining the standard error of the mean difference. The consistency and resilience of the learning gains are shown by the significant differences between the pretest and posttest means as well as the very low standard deviations in the posttest results.

Student performance improved dramatically with each exercise, as evidenced by t-values that ranged from roughly 15.65 to 17.01. These high t-values show a considerable effect size, indicating that students' communication, critical thinking, teamwork, and creativity skills were significantly improved by the use of project-based learning techniques. The consistency of these gains across several learning tasks provides additional evidence of the intervention's efficacy. Furthermore, the p-values' statistical significance supports the validity of the study's conclusions. The null hypothesis, which states that there is no difference between pretest and posttest scores, can be reliably rejected if the p-value for each test is less than 0.001. The claim that project-based learning improves average performance levels and decreases score variability among students, resulting in more consistent learning outcomes, is supported by this statistical evidence.

The t-test results, in summary, offer strong proof that project-based learning is a very successful strategy for improving students' 4C abilities. The notable variations between pretest and posttest results demonstrate how this teaching strategy can raise academic performance and develop critical 21st-century abilities. These results imply that incorporating project-based learning into curriculum can result in significant and quantifiable gains in student performance, which has significant ramifications for educational practice.

Discussion

The study highlights how crucial project-based learning (PBL) is for developing 21st-century competencies, especially the four Cs: critical thinking, creativity, communication, and teamwork. The authors contend that rote memorization and other standard teaching techniques are insufficient in preparing pupils for problems they may face in the real world. PBL creates an atmosphere where students may apply their knowledge in real-world situations by involving them in practical projects. This method encourages a more active learning process in addition to bridging the gap between theory and practice.

Using a descriptive qualitative methodology, the study collected data via observations, interviews, and document analysis. Using a straightforward random sampling method, a group of intermediate-level students was chosen to take part in a variety of project-based activities. Improvements in the 4Cs were measured using pretest and post-test scores, and statistical analysis verified that the improvements were significant. A thorough assessment of the PBL model's influence on students' skill development was made possible by this methodological framework.

The study's findings demonstrated significant gains in communication and critical thinking abilities. For example, students' average scores on the Digital Literacy Project increased from 60 to 88, demonstrating improved analytical skills. Students were able to hone their oral communication abilities through group presentations, which resulted in a more assured and well-spoken way of expressing themselves. These results imply that PBL fosters both good interpersonal communication and critical analysis.

Additionally, PBL implementation greatly increased creativity and collaboration. Poster productions and social initiatives gave students a chance to collaborate, exchange different viewpoints, and come up with ideas as a group. Students were able to take on different responsibilities through the planned group work, which improved group cohesiveness and individual accountability. Solving complicated, real-world challenges in today's dynamic contexts requires an improvement in teamwork and creative expression.

The study concludes with compelling evidence that project-based learning is a very successful approach for raising students' 4C proficiency. PBL's capacity to improve academic performance and cultivate critical 21st-century competencies is demonstrated by the steady increase in post-test scores across a range of activities. The study also emphasizes how crucial it is for teachers to facilitate learning and use resources appropriately in order to optimize the advantages of this strategy. All things considered, including PBL into the curriculum seems to be a viable approach to creating creative, well-rounded students who are more equipped to face obstacles in the future.

Previous research has consistently demonstrated the benefits of Project-Based Learning (PBL) in improving students' 21st-century skills; however, many of these studies have concentrated on higher education or STEM-related disciplines (e.g., Thomas, 2000; Markham, 2011). This creates a significant gap in studying how PBL influences skill development among intermediate-level students, particularly across academic topics and socio-cultural situations. Unlike previous studies, this research focused on junior high school students and included transdisciplinary initiatives such as social and digital literacy tasks. By doing so, it provides new insights into the applicability of PBL at the middle school level, where such pedagogical interventions are frequently underutilized.

Furthermore, whereas previous research, such as Kokotsaki, Menzies, and Wiggins (2016), emphasized the motivating components of PBL, few studies have empirically correlated skill gains to tangible pretest and posttest results. This study presents statistical proof of increasing 4C abilities, proving not only student engagement but also measurable skill development in communication, collaboration, critical thinking, and creativity. These findings confirm that, when carefully designed and scaffolded, PBL is both theoretically sound and practically beneficial in promoting holistic student development. The findings consequently provide convincing evidence for more structured and data-driven PBL implementation in a variety of educational scenarios.

Conclusion

The study found that implementing project-based learning activities significantly improved students' 4C skills (critical thinking, creativity, communication, and collaboration). This was demonstrated by the significant increase in posttest scores across all project types, as well as qualitative data obtained through classroom observations and student interviews. These findings show that students improved not only their academic comprehension, but also their engagement, confidence, and collaboration in the learning process. Based on this evidence, project-based learning is a very effective technique for developing crucial 21st-century abilities. Involving students in real-world projects fosters deeper comprehension and practical skill development, allowing them to bridge the gap between academic knowledge and real-world application. Furthermore, PBL promotes an inclusive and participatory classroom climate, encouraging students to take responsibility of their learning. When properly implemented with good teacher facilitation, adequate resources, and

structured curriculum design, PBL not only improves academic performance but also cultivates important soft skills necessary for future success.

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