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The Impact of Project Based Learning on Developing 21st Century Skills: A Mixed Methods Research

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ABSTRACT
In a constantly changing world, acquisition of 21st century skills is a crucial aspect of students' learning. This mixed method study examined the impact of Project Based Learning (PBL) on the development of 21st century skills of grade eight students in a private sector school of Karachi, Pakistan. For this purpose, students' expectations of how they want to learn science were explored. Based on the findings, a PBL based intervention was conducted using pre-experimental, one-group pretest and posttest design. Additionally, qualitative data were collected pre and post intervention through students' focus group interviews. Statistical tools were used to examine quantitative data whereas qualitative data were analyzed using thematic analysis. Findings revealed that students required more opportunities for hands-on activities, and experiments for learning science to enhance their motivation and practical skills. The quantitative results indicated that students involved in PBL showed significant improvement in all four skills including communication, collaboration, critical thinking and creativity. These findings support the integration of Project Based Learning (PBL) in science classroom practices in order to prepare students for the 21st century.

Keywords: 21st Century Skills, Project Based Learning, Pre-Experimental Design, Private School

Introduction
In today's era of globalization students are required to develop 21st century skills such as collaboration, critical thinking, creativity, communication and problem solving (Almazroui, 2023; Hatuwe et al., 2023; Sanchez-Garcia et al., 2025). These skills enable students to become successful individuals of the global society and help them succeed in school and beyond (Zulyusri, 2023). To prepare students with the competencies required to effectively contribute to the rapidly changing world, it is essential that they are able to think critically and creatively, communicate clearly, and collaborate effectively with others to solve real life challenges (Dilecki, 2023; Zuhri et al., 2025). Therefore, acquisition of these skills is crucial at the early and middle level of education, as they significantly contribute to students' personal and professional development (Mckinney, 2023; Rehman et al., 2024).

Unlike traditional methods that emphasize structured learning, memorizing basic facts, and standardized assessments, development of 21st century skills require involving students in real world application and problem solving (Sanchez-Garcia et al., 2025; Zulyusri, 2023; Zuhri, 2025). Therefore, educational systems worldwide are increasingly

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focusing on student centered approaches to develop students' essential skills (Sujino, et al., 2025; Zhang, 2023). One such approach gaining attention for developing these competencies is Project Based Learning (PBL), a pedagogy where students engage in collaborative, real world projects to solve complex problems (Zulyusri, 2023; Zuhri, 2025).

PBL in science education is specifically helpful to develop 21st century skills and promote a deeper comprehension of scientific concepts (Chen, et al., 2019; Krajcik et al., 2023; Markula & Aksela, 2022; Mckinney, 2023; Zulyusri, 2023). Furthermore, teachers' role as facilitator contributes vastly in developing a classroom environment that supports PBL in the shape of feedback, guidance and encouragement to students throughout the PBL (Chiu, 2020; Haatainen & Aksela 2021; Hatuwe et al., 2023).

There is increased focus on Project Based Learning as a recognized pedagogy in developed countries throughout the world with the potential to positively enhance students 21st century skills (Beckett et al., 2025; Bolick et al., 2024; Naqvi, 2023; Sujino, et al., 2025). However, the use of PBL remains relatively infrequent in schooling systems of most developing countries due to limited access to learning resources, teacher capacity, rigid curricula, and educational institutions struggle with inadequate facilities (Almazroui, 2023; Hatuwe et al., 2023; Sujino et al., 2025; Zhang, 2023). As is the case with other developing countries, in Pakistan too, teacher centered approaches are more commonly used, due to significant challenges faced the adoption of the PBL approach, particularly in non-elite schools (Hamid, 2025; Ali et al., 2024; Rehman, 2024; Zamir, 2023).

The Pakistani educational system struggles to effectively incorporate 21st century skills such as critical thinking, creativity, collaboration and communication (Hamid, 2025; Naqvi, 2023). The existing teaching practices remain predominantly teacher-centered and examination-oriented, which fails to align with the competencies required in the 21st century. It provides limited opportunities for students to engage in interactive, hands-on learning experiences (Hamid, 2025; Naqvi, 2023; Rehman, 2024). In addition, many Pakistani private schools continue to focus on assessment methods that emphasize rote learning and standardized exams, rather than encourage students to apply their knowledge critically in real-life situations. As a result, these practices hinder the development of creative and problem-solving skills of the students (Jamil et al., 2023; Rehman, 2024; Zamir, 2023).

Project Based Learning (PBL) has the potential to enhance 21st century skills, particularly in science learning. It enables students to work on projects that address authentic problems, leading to deeper and more engaging learning experiences (Ali, 2024; Rahman, 2025). However, in the Pakistani educational milieu, the science teachers' role is specifically limited to delivering the content from the text book, as such, they unable to provide a constructive learning environment to foster students' skills (Farooq, 2023; Ilyas & Saeed, 2021; Jamil et al., 2023; Naqvi, 2023; Tahir, 2011). The widespread implementation of PBL in Pakistani schools is impeded by a combination of various factors such as resource limitations, insufficient teacher training, incompatible curricula and traditional assessment methods. Therefore, these challenges are making it difficult for teachers of science to implement and sustain PBL practices in classrooms (Farooq, 2023; Jamil et al., 2023; Tahir, 2011; Zamir, 2023). Addressing these challenges requires a combined effort from all stakeholders to promote students centered approaches such as PBL that create an environment conducive to the development of students 21st century skills (Hamid, 2025; Ilyas, 2022). Moreover, to effectively implement PBL, it is essential to understand students' interests, learning preferences, and

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existing skill levels. This study aims to examine the effects of PBL on science students' skills such as collaboration, critical thinking, creativity and communication based on the expectations and needs of grade eight students of a private school.

Purpose of the Study

The purpose of this mixed method study was to administer an intervention to grade eight science students via Project Based Learning to develop 21st century skills. For this purpose, needs analysis regarding how they wanted to learn science was conducted with grade eight students of a private school. Students' pre-test and post-test scores were measured to compare the development of their 21st century skills. Furthermore, post intervention perceptions of the students regarding Project Based Learning (PBL) approach were also examined.

Research Questions

How do science students of grade eight want to learn science?

What are students' perceptions regarding learning of science after the PBL based intervention?

What is the difference in pre and post scores of communication, collaboration, critical thinking, and creativity skills of grade eight students taught through project based learning at private school of Karachi?

Hypothesis

H01 There is no significant difference between the pre-test and post-test scores of communication skills of the students taught through project-based learning approach.

H02 There is no significant difference between the pre-test and post-test scores of collaboration skills of the students taught through project-based learning approach.

H03 There is no significant difference between the pre-test and post-test scores of critical thinking skills of the students taught through project-based learning approach.

H04 There is no significant difference between the pre-test and post-test scores of creativity skills of the students taught through project-based learning approach

Literature Review

21st century skills refer to a broad set of abilities such as communication, collaboration, critical thinking, creativity and problem solving essential for success in today's changing world (Almazroui, 2023). Schools are required to shift from teacher-centered approaches to student-centered, competency-and skills based education, as this will play a pivotal role for preparing students for the future (Zhang, 2023; Zuhri et al., 2025). Skills development is integrated into the curriculum to enhance students' academic achievement and to facilitate them to solve problems, think critically, communicate and collaborate effectively, and participates in lifelong learning (Ali, 2024; Dilekci, 2023; Rehman, 2024). Research shows that even though teachers recognize the significance of 21st century skills, they lack support in delivering and evaluating these effectively (Naqvi et al., 2023).

Communication skills are crucial for holistic development of students at the school level. These competencies allow students to express their views; listen effectively to derive meaning from the interaction (Wilcox et al., 2017). Collaboration skills allow students to effectively work with others in groups to attain a common goal (Ali, 2024). It should be the focus of learning process as it improves students' capability to work and interact with each other in order to promote deeper understanding and engagement.

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Therefore, to facilitate collaboration it is essential to create a learning environment based on the real-life context which enables students to share their ideas and get the feedback (Ali, 2024; Hussein, 2021)

Critical thinking is self-directed and self-monitored thinking to analyze the available facts, observations and arguments to form a judgment (Heard, 2020; Zuhri et al., 2025). It develops independent thinking and problem solving skills of the individuals and plays major role in their personal and professional life (Zuhri et al., 2025). Supportive learning environment that is engaging and encouraging for the students, and appropriate teaching strategies promote students' higher order thinking capabilities. Therefore, Educational Institutions are expected to contribute to the development of their students' critical thinking skills (Hatuwe et al., 2023). Creative thinking is a multi-faceted cognitive process enables students to solve problems in a different way and come up with unique and original solutions (Wilcox et al., 2017). Research shows that creativity thinking skills nurtured and developed by providing a supportive and flexible learning environment to the students (Hamid, 2024; Zulyusri, 2023).

Students' needs analysis is essential to understand their expectations, and learning preferences, which helps educators to develop relevant and engaging instructional materials and methods to support their understanding, motivation and development of essential skills. Research highlights that educational interventions may fail to engage learners effectively unless they are not tailored to address student s' specific needs (Fatimah et al., 2024; Rahmani et al., 2023). Thus, conducting a needs analysis is essential for tailoring instructional practices to ensure that learning is effective, motivating and relevant, thereby better supporting learning outcomes. Dezola et al., 2023)

Project Based Learning is a student centered approach where learners are involved in real-world tasks to explore and solve complex problems or challenges over an extended period of time (Chiu, 2020; DeCoito & Briona, 2023). Unlike traditional, teacher-led classrooms where students passively involved in traditional lectures, students work on complex tasks in teams and groups making the learning experience more engaging and relevant (Ali, 2024; Zhang et al., 2023). Students are involved in sustained inquiry for in-depth exploration and problem solving to demonstrate their knowledge and skills, which they actively apply to produce a public product or project for real audiences (Dilecki, 2023; Majud, 2024; Zhang et al., 2023). Through this process, they develop deeper understanding of content along with necessary skills like collaboration, critical thinking, creativity, communication, problem solving, and time management (Rehman, 2024; Sanchez-Garcia et al., 2025). Moreover, participation in PBL hands on learning and real-life application can lead to greater motivation, engagement and knowledge retention in elementary and middle school students (Chen & Yang, 2019; Dole et al., 2017). PBL empowers students to take responsibility for their own learning, set goals, manage tasks, and increase confidence for lifelong learning (Hussein, 2021; Zhang, 2023). Furthermore, Project Based Learning consistently enhance academic performance, deepen students' analytical and reflective reasoning and produces significant learning gains in K-12 science classrooms (Hafeez, 2022; Mckinney, 2023). Research highlights strong positive relationships between PBL and student motivation for enhanced science achievement. Therefore, schools are increasingly implementing Project Based Learning to integrate 21st century skills effectively in the classrooms. It is considered a dynamic and engaging learning approach to prepare students for the opportunities and challenges of the 21st century (Rehman, 2024; Zuhri et al., 2025).

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Methodology

This study used mixed methods approach involving both qualitative and quantitative methods to enhance the validity and depth of findings (Creswell & Clark, 2018). The students' needs regarding how they wanted to learn science were explored, along with their perceptions regarding PBL. This was done through focus group discussions. From the quantitative perspective, this study used pre-experimental, one-group pretest- posttest design. Quantitative methods focus on measuring variables and analyzing numerical data to identify statistically significant relationship among variables (Creswell, 2012).

The study was conducted in one of the private schools of Karachi. This school was selected because management provided access for conducting focus groups and intervention. This school caters to a diverse student population in terms of socioeconomic background. A purposive sampling technique was used to explore students' needs and expectations regarding their classroom learning practices of science. It is a commonly used technique in qualitative research to select participants who can provide in-depth information about the phenomenon (Creswell & Clark, 2011). The criteria for purposive selection of participants were that all students be enrolled in grade eight science course. According to He (2021), grade eight students are capable of reflecting meaningfully on their expectations and learning experiences. Since the students were studying science, they were able to provide in-depth information via focus group interviews.

From the quantitative perspective, this study used pre-experimental, one group pretest and posttest design. This design examines the impact of an intervention by comparing students' performance pre and post intervention (Creswell, 2014). The participants of the experiment consisted of 30 grade eight students from a selected private school. The participants were chosen through purposive sampling, ensuring that all students enrolled in grade eight were included in both pretest and posttest of the study. According to Creswell (2014), pre-experimental design usually involves a single group ranging from 15 to 40 participants to examine measurable change pre and post intervention.

Prior to the intervention, the researcher conducted focus group interviews with grade eight students after obtaining permission from the school administration. Anonymity and confidentiality were ensured throughout the research process. As such a total of six focus group discussions were conducted, each consisting of five students to explore students' needs and expectations of how they would like to learn science and regarding their perceptions of PBL. Focus group interview is one of the most effective ways to collect qualitative data and in-depth insights of the participants (Krueger & Casey, 2000). The focus group discussions were transcribed and analyzed using thematic analysis as recommended by Creswell (2012). Recurring themes and patterns were identified, coded, and categorized to provide deeper context for interpreting the students' expectations. Whenever students are directly quoted, grammatical errors have not been rectified as quotations were presented verbatim.

For conducting experiment in grade eight, the pretest was administered to all participants prior to the intervention to evaluate students' level of 21st century skills. For this purpose, collaboration, creativity, critical thinking and communication skills rubrics were used as quantitative data collection tools. The collaboration skills rubric contains four dimensions, the critical thinking skills rubric has five dimensions, and the communication and creativity skills rubric include three dimensions, measured using a 4-point Likert-type scale. These rubrics were adapted in alignment with the principles of the (NCIEA, 2023) framework. The intervention was conducted by the researcher for a period of 12 weeks. The duration of the science period is 45 minutes scheduled twice a

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week. Students engaged in structured PBL units on climate change where they were involved in real-life problems, worked in groups to research, and to investigate the solution of the problem. Upon completion of the intervention, post-test was administered to the students using same rubrics for the comparison of the scores to determine any improvements in the development of students' 21st century skills. The quantitative data were analyzed using a paired sample t-test to determine whether there was a statistically significant difference between the two sets of scores.

Findings from Focus Groups (Pre-Intervention)

Major themes generated from students' focus group discussions to explore their needs and expectations of learning science are discussed below.

Learning through Outdoor Activities

Students from focus group 2 and focus group 4 of grade eight recognized the need to involve students in outdoor activities to make learning more engaging and enjoyable. One of the students ST_4 of focus group 2 believed that learning in this manner could improve their understanding and retention. While emphasizing the need to understand the science concepts more effectively through outdoor learning activities, she commented:

"I enjoy learning outside the classroom. In outdoor activities it is easy for me to understand difficult concepts and I can remember things for longer time. I am more interested to learn in this way than learning in the classroom."

Another student, ST_3 of focus group 4 similarly underscored the importance of engaging students in outdoor activities to enhance their motivation to learn science. He expressed his views by saying: "Science is not a boring subject. Teacher should take us outside to show us different things. She can give examples to motivate us."

Learning Science through Experiments and Projects

Students from focus group 3 and focus group 4 highlighted that they wanted to participate in learning activities that provide hands-on learning experiences such as, learning through examples, drawings, diagrams, and experiments. One of the students ST_2 of focus group 3 shared her perspective by emphasizing the importance of learning science through activities and experiments as a way to increase motivation. In her words, "I think that if our teacher gives more examples about the topic, more experiments and activities then students will take more interest in the subject of science."

Students of focus groups 2 and focus group 6 emphasized that they should be given opportunities to conduct experiments in science, such as process of evaporation, condensation, and chemical reactions to promote deeper learning. In this connection, ST_5 of focus group 2 expressed her views by saying,

"Science is not a subject that we write in copies and learn everything. Science is more about practical. If for example we are learning evaporation teacher should tell us that how evaporation will take place, and give us live examples so we can understand the process of evaporation."

Moreover, students from focus group 5, and focus group 6 recognized the significance of involving students in real life applications to make learning more relevant and meaningful. While emphasizing the need to better comprehend the science concepts through different models and projects for in-depth understanding, ST_3 of focus group 5 commented:

"I want science teachers to clear our concepts so I don't have to memorize everything such as formulas, elements and compounds. Understanding is the most

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important thing so I want my teachers to show us the models of different things and make us do projects that really help us to understand better."

Interest in developing Practical Skills through Hands on Learning Activities

Students from focus group 2, and focus group 5, believed that learning through activities, experiments, and projects not only enhance their motivation to learn but also equip them with a diverse set of skills. They identified various skills that they wanted to enhance through science learning, including communication, building confidence, problem solving and time management. Emphasizing the need to build confidence while communicating with others, ST_2 of focus group 5 said:

"I want to build the confidence to talk to others so I want to understand the way of talking to others and the ways of presenting to the audience with confidence, I mean, I want to improve my communication skills."

One of the students ST_1 of focus group 6 considered time management an essential skill for the students to acquire and described how this ability can help her in her daily life. In her words:

"I want to learn the skills that will help me in my daily life such as time management, how to manage time. If we take our meals on time, sleep on time and if we do physical activities, it will help us to improve our digestive system."

Another student of focus group 3 emphasized improving problem solving skills through hands-on science activities. In this connection, ST_4 expressed her thoughts in her words:

"I like to improve my ability to solve the problems. I want to think deeply during any science activity, what is going on and how I can find the solution and what would be the output. I find all this very interesting."

The findings of the focus groups discussion highlighted students' needs and expectations pertaining to science learning. They viewed science as a practical subject and expressed more interest for incorporating hands on learning activities. They considered outdoor learning as more enjoyable and engaging, and also recognized the need of real-life application for the comprehension of the science concepts. In addition, learning through experiments and projects emerged as a preferred method. They believed that hands-on learning can contribute towards the acquisition of their skills such as communication and confidence building. Some of the students placed a slightly greater emphasis on problem solving skills and time management skills. Although students were not familiar with the term Project Based Learning (PBL), they demonstrated ideas consistent with it, which led to the implementation of a PBL intervention.

Quantitative Analysis

To examine the effectiveness of the Project Based Learning on students 21st century skills (communication, collaboration, critical thinking and creativity), a paired sample t-test was conducted to compare students' scores pretest and posttest. This test was selected to determine whether there is a significant change or difference between two related groups. Before data analysis, descriptive statistics (mean, standard deviation) were calculated for both pretest and posttest scores. Statistical significance was established at $p < .05$, all analyses were performed using SPSS version 22.

Hypothesis 1

There is no significant difference between the pre-test and post-test scores of communication skills of the students taught through project-based learning approach.

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Table 1: Paired Sample Statistics Result

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total_PreCommunication	4.83	30	1.367	.250
	Total_PostCommunication	5.70	30	1.291	.236

Table 2: Paired Sample Test Result

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Total_PreCommunication Total_PostCommunication	-.867	.776	.142	-1.156	-.577	-6.117	29	.000

A paired sample t-test was conducted to compare communication skill scores pre and post PBL intervention. There was a statistically significant increase in posttest scores (M= 5.70 , SD= 1.29) compared to pre-test scores (M= 4.83 SD= 1.36), t (29) = -6.12, p <0.001. These results suggest that the PBL intervention had a significant positive effect on students' communication skills. Therefore, it rejects the first null hypothesis that there is no significant difference between the pre-test and post-test scores of communication skills of the students taught through project-based learning approach.

Hypothesis 2

There is no significant difference between the pre-test and post-test scores of collaboration skills of the students taught through project-based learning approach.

Table 3: Paired Sample Statistics Result

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total_PreCollaboration	6.87	30	2.360	.431
	Total_PostCollaboration	8.83	30	2.214	.404

Table 4: Paired Sample Test Result

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Total_PreCollaboration Total_PostCollaboration	-1.967	1.520	.277	-2.534	-1.399	-7.089	29	.000

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A paired sample t-test was conducted to compare collaboration skill scores pre and post PBL intervention. There was a statistically significant increase in posttest scores (M= 8.83, SD= 2.21) compared to pre-test scores (M= 6.87, SD= 2.36), t (29) = -7.09, p <0.001. These results suggest that the PBL intervention had a significant positive effect on students' collaboration skills. Therefore, it rejects the second null hypothesis that there is no significant difference between the pre-test and post-test scores of collaboration skills of the students taught through project-based learning approach.

Hypothesis 3

There is no significant difference between the pre-test and post-test scores of critical thinking skills of the students taught through project-based learning approach.

Table 5: Paired Sample Statistics Result

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total_PreCritical Thinking	9.57	30	2.161	.394
	Total_PostCritical Thinking	11.03	30	2.282	.417

Table 6: Paired Sample Test Result

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Total_PreCritical thinking Total_PostCritical thinking	-1.467	1.833	.335	-2.151	-.782	-4.382	29	.000

A paired sample t-test was conducted to compare critical thinking skill scores pre and post PBL intervention. There was a statistically significant increase in posttest scores (M= 11.03, SD= 2.28) compared to pre-test scores (M= 9.57, SD= 2.16), t (29) = -4.38, p <0.001. These results suggest that the PBL intervention had a significant positive effect on students' critical thinking skills. Therefore, it rejects the third null hypothesis that there is no significant difference between the pre-test and post-test scores of critical thinking skills of the students taught through project-based learning approach.

Hypothesis 4

There is no significant difference between the pre-test and post-test scores of creativity skills of the students taught through project-based learning approach.

Table 7: Paired Sample Statistics Result

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total_PreCreativity	4.73	30	1.311	.239

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	Total_PostCreativity	5.40	30	1.329	.243

Table 8: Paired Sample Test Result

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	T	df	Sig. (2-tailed)
Pair 1	Total_PreCreativity Total_PostCreativity	-.667	.758	.138	-.950	-.384	-4.817	29	.000

A paired sample t-test was conducted to compare creativity skill scores pre and post PBL intervention. There was a statistically significant increase in posttest scores (M= 5.40, SD= 1.32) compared to pre-test scores (M= 4.73, SD= 1.31), t (29) = -4.82, p <0.001. These results suggest that the PBL intervention had a significant positive effect on students' creativity skills. Therefore, it rejects the fourth null hypothesis that there is no significant difference between the pre-test and post-test scores of creativity skills of the students taught through project-based learning approach.

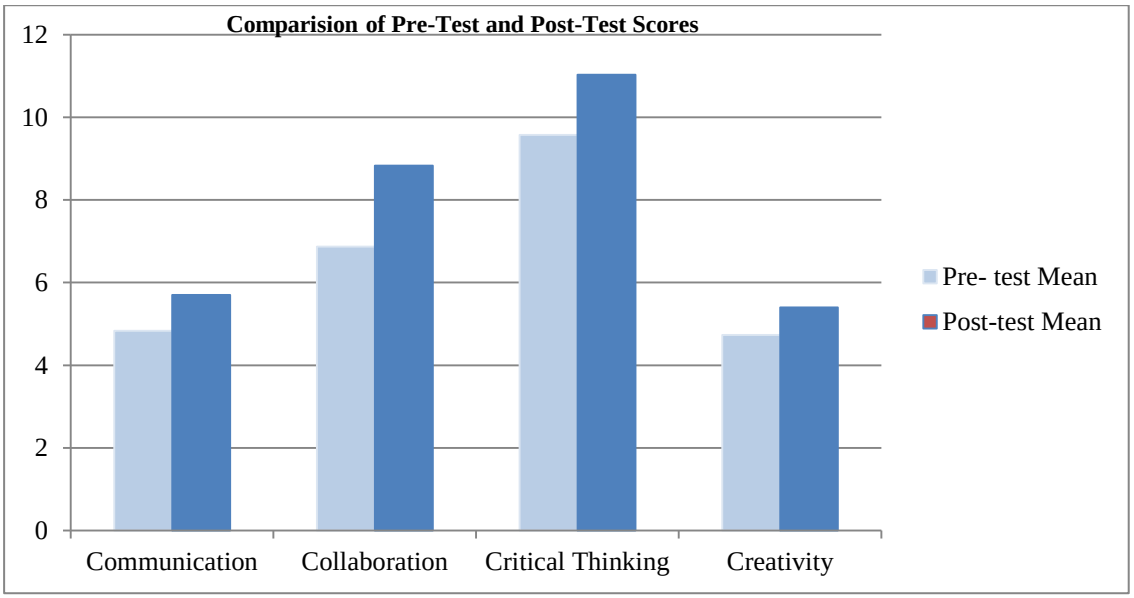

Figure 1: Comparison of Pre-Test and Post-Test Scores

Figure 1 presents a comparison of pre-test and post-test mean sores across four skills. The results indicate an increase in scores for all skills. Mean scores increased from 4.83 to 5.70 in communication, 6.87 to 8.83 in collaboration, 9.57 to 11.03 in critical thinking, and 4.73 to 5.40 in creativity. All gains were statistically significant (p<.05), with the highest improvement in collaboration and the least in creativity, indicating the invention's overall effectiveness, particularly in enhancing collaboration and critical thinking skills.

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Findings from Focus Groups (Post-Intervention)

Major themes that were developed from analysis of data from students focus groups following PBL intervention are discussed below.

Increased Motivation and Engagement

Students of grade eight reported high level of motivation compared to traditional instruction as they perceive the task relevant to their lives. One of the students ST_3 of focus group 2 described in his words, "I like working on projects which is about real life problems and finding the solution of the problem by my self is really interesting." Similarly, another student ST _5 of focus group 3 appreciated the practical application of PBL that enhances their motivation to learn. In his words,

"Our teacher involved us in activities which are not from the book we had more fun and excitement working on it because it is related to our lives. This way we can understand the concepts well and remember the information for a longer time."

Students of grade eight appreciated the choice their teacher gave them to select the topic, and designing and presenting the final project, and more control of their learning process. One of the students ST_4 of focus group 1 commented,

"In a group we decide the topic ourselves and research the topic for the solution. We also design the project with our own ideas, we present and explain the presentation to others which is really exciting and motivating for us."

Improved Collaboration

A recurring theme among student responses was a positive attitude towards group work. Many students recognized the increase in their ability to collaborate with their classmates effectively. One of the students ST_3 of focus group 4 shared in his words,

"Working in groups helped me work together with other students. I can share my ideas with others and also listen to others opinion. It is very helpful and easier for us to find the solution of the problem working together."

Another students ST_2 focus group 5 shared his perspectives of developing the ability to negotiate with others, he expressed by saying,

"When we work in groups we listen to others opinions, sometimes we agree with each other and sometimes we don't but together we are able to complete the project on time and try to improve it and make it better. It was fun working with others in group."

Many students appreciated the collaborative nature of PBL that enhance their ability to collaborate effectively with other students however; few students also identified challenges while working with others. In this regard, ST_5 of focus group 4 commented,

"It is difficult for us sometimes to divide the work among members of the group. Some students work hard and work more and some work less. We tried to divide the task equally to all the students in the group. Some students are more responsible of completing their work on time."

Enhanced Communication Skills

Grade eight students highlighted improvements in their communication skills. They reported increased confidence while contributing their ideas in group discussions. ST_5 of focus group 1 commented, "When we work in groups, we discuss problems and solutions to each other, every student share their ideas and actively participate in the discussion."

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The requirement of presenting the project to the large audience helped students to articulate their ideas more clearly. They highlighted increased confidence while speaking in front of others specially while presenting their final projects. ST_2 of focus group 3 expressed her thoughts in her words,

"I feel that now I am more confident after presenting my project to others. I share with them the solution of the problem that how we can save our environment. It is very interesting that everyone listens to me and asks questions about my project. This is the way I can develop my confidence to speak."

Some students stated initial anxiety to speak in front of others, but gradually developed confidence through constant practice and support of the classmates. They considered that it develops their ability to communicate their thoughts and listen actively to other students. ST_4 of focus group 2 shared her views by saying,

"I was not always very confident speaking to others. I do not participate in class discussions very actively but after I presented my project to my classmates, I felt better speaking in front of others with confidence."

Similarly, another student also reported reluctance speaking to others, in this regard, ST_1 of focus group 6 expressed, "I was very shy, but discussing to other students in groups and presenting my project in front of others in the classroom helped me improve my confidence."

Overall, the students underscored the significance of incorporating Project Based Learning (PBL) for science learning as a way to improve their motivation and engagement. They believed that this approach not only help them to enhance their understanding of the complex science concepts, but further promote the development of their diverse set of skills such as collaboration, communication and confidence building.

Discussion

The primary aim of this study was to examine the impact of a Project Based Learning (PBL) on the development of students' 21st century skills such as communication, collaboration, critical thinking and creativity. The data revealed that students recognized science as a practical subject and expressed more interest for doing hands on learning activities, and projects. They believed that real life applications for comprehension of the science concepts can support the enhancement of their practical skills. This is consistent with the prior research that PBL activities engage students in real world challenges and authentic problem solving to promote essential skills (Bell, 2010; Mckinney, 2023; Krajcik et al., 2023; Shengqiang et al., 2025). According to Dole et al. (2017), PBL can be very effective for diverse learners, including those with different learning styles and needs.

The results of the experiment indicated a statistically significant improvement in students' scores of 21st century skills from pretest to posttest. The students showed a significant improvement in 21st century skills after participating in PBL units. This suggests that PBL was effective in developing students' skills such as communication, collaboration, critical thinking and creativity. These results were aligned with previous research that supports the effectiveness of student-centered and collaborative nature of PBL as conducive in developing 21st century skills (Beckett, 2023; Bell, 2010; Zuhri, 2025). While prior research affirms that PBL promotes 21st century skills across all four domains and highlights its positive effects on student engagement and motivation, the effectiveness of PBL on student outcomes is not always consistent and often depends on its implementation and context (Condiffe, et al., 2017).

Students described more motivation and engagement while doing PBL projects based on

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real-life application. This aligns with previous studies indicating that Project Based Learning increases intrinsic motivation by involving students in authentic problems. As a learner centered approach, PBL emphasizes activating student engagement by encouraging inquiry, autonomy, and awakening their natural curiosity (Chiu, 2020; Markula & Aksela, 2022; Zhang, 2022).

Conclusion

Findings from the focus group discussions indicated that students of grade eight expected to be involved in active learning environment that offers the opportunity for hands-on learning activities, and real-life applications and projects. They believed that learning through such approaches can effectively contribute towards their motivation and active participation in the science classroom. This further enhances their confidence and interest for the acquisition of practical skills.

The findings of the experimental study provide evidence that Project Based Learning (PBL) has a significant impact on students' 21st century skills. Students, who engaged in PBL units, demonstrated high levels of communication, collaboration, critical thinking and creativity skills in their posttest as compared to pretest. Students of grade eight acknowledged the practical nature of PBL for enhancing their motivation and engagement and further development of essential skills such as communication, collaboration and improved confidence. Therefore, integrating PBL in classroom practices can be effective for enhancing students' essential skills to meet the demands of the 21st century.

This study involved a limited and context -specific sample and educational setting, which may limit the generalizability of the findings to the broader student population. Future mixed methods studies may expand the sample to include more diverse educational settings and student populations.

References

Ali, R.U., Khalil, S., & Afzal, A. (2024). Effect of Project-Based Approach on Teaching and Learning at Higher Level. PJER, 7, 1. 24-37.

Almazroui, K.M. (2023). Project Based Learning for 21st –Century Skills: An Overview and Case study of Moral Education in the UAE: Social Studies, 114(3), 125-136. http://doi.org/10.1080/00377996.2022.2134281

Beckett, G.H. (2023). Project-Based Learning for 21st-Century Skills: The Five 7C's for L2 Students. Docens Series in Education, 5, 40-57.

Bell, S. (2010). Project-based learning for the 21st century skills for the future. The Clearing House: A Journal of Educational Strategies, Issues and Ideas 83(2), 39-43. https://doi.org/10.1080/00098650903505415

Bolick, M.A., Thomassen, M., Apland, J., Spencer, O., Nicole, F., Tran, S.K.N., Voigt, M., & Lazar, K.B. (2024). Project-Based Learning in interdisciplinary Spaces: A Case Study in Norway and the United States. Education Sciences, 14(8). https://doi.org/10.3390/educsci14080866

Chen, C.H., & Yang, Y.C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. Educational Research Review, 26, 71-81.

Chiu, C.F. (2020). Facilitating k-12 teachers in creating apps by visual programming and project-based learning. International Journal of Emerging Technologies in Learning (iJET), 15(1), 103-118. https://doi.org/10.3991/ijet.v15i01.11013

Condiffle, B., Quint, J., Visher, M.G., Bangser, M.R., Drohojowska, S., Saco, L., &

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 9 (September) (2025)

Nelson, E. (2017). Project Based Learning: A Literature Review. 1-78. New York, NY: MDRC

Creswell, J.W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). Sage Publications.

Creswell, J., & Plano Clark, V. (2011). Designing and conducting mixed methods research (2nd ed.). Thousand Oaks, CA: Sage.

Cresswell, J. W. (2012). Educational research: Planning, conducting and evaluating qualitative and quantitative research (4th ed). Pearson.

Creswell, J. W., & Plano Clark, V.L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

DeCoito, I., & Briona, L.K (2023). Fostering an entrepreneurial mindset through project-based learning and digital technologies in STEM teacher education, In Enhancing Entrepreneurial Mindsets through STEM Education, Springer International Publishing, 195-222. https://doi.org/10.1007/978-3-031-17816-0_9

Dezola, R.V., Istiyono, E., & Wilujeng, I. (2023). Students Worksheets based on STEM Integrated Inquiry Based Learning: Needs Analysis. Jurnal, Penelitian Pendidikan IPA, 9(8), 6247-6254. https://doi.org/10.29303/jppipa.v9i8.3062

Dilekci, A., & Karatay, H. (2023). The effects of the 21st century skills curriculum on the development of students' creative thinking skills. Thinking skills and Creativity 47, 101229. https://doi.org/10.1016/j.tsc.2022.101229.

Dole, S., Bloom, L., & Doss K. K. (2017). Engaged learning: Impact of PBL and PjBL with elementary and middle grade students. Interdisciplinary Journal of Problem-Based Learning. 11(2). https://doi.org/10.7771/1541-5015.1685

Farooq, A., & Islam, M.U. (2023). Effect of Inquiry Method on Scientific Inquiry Skills of Elementary School Students. Pakistan Languages and Humanities Review, 7(2), 127-139. https://doi.org/10.47205/plhr.2023(7-II)11

Fatimah, F., & Muamr, M.R. (2024). Analysis of Students' Needs and Characteristics towards Science to Support Differentiated Learning of Kurikulum Merdeka. Jurnal Penelitian Pendidikan, IPA, 10(5). https://doi.org/10.29303/jppipa.v10i5.6731

Haatainen, O., & Aksela, M. (2021). Project-based learning in integrated science education: Active teachers' perceptions and practices. LUMAT: International Journal on Math, Science and Technology Education, 9 (1), 149 – 173. https://doi.org/10.31129/LUMAT.0.1.1392

Hafeez , M.(2022). Challenges and research gap in project based learning- A review. International Journal of New Trends in Social Sciences. 6(1), 01-14. https://doi.org/10.18844/ijss.v6i1.5633

Hamid, S. (2025). The Reforming Pakistan's Education System: Bridging the Gap for 21st-century Skills. Dialogue Social Science Review (DSSR), 3(3), 637-647.

He, Z., Wu, X., Wang, Q., & Huang, C. (2021). Developing eighth-grade students' computational thinking with critical reflection. Sustainability. 13(20), 11192. https://doi.org/10.3390/su132011192

Heard, J., Scoular, C., Duckworth, D., Ramalingam, D., & Teo, I. (2020). Critical thinking: Definition and Structure. Australian council for Educational Research. https:// research.acer.edu.au/ar_misc/38

Hatuwe, O.S.R., Syobah, S.N., & Idris, H. (2023). Implementation of Project Based Learning in improving critical thinking skills in early childhood. ITQAN: Jurnal llmu-ilmu Kependidkan 14(1). https://doi.org/10.47766/itqan.v14i1.1543

Hussein, B. (2021). Addressing Collaboration Challenges in Project-Based Learning: The Student's Perspective. Education Sciences, 11(8), 434.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 9 (September) (2025)

https://doi.org/10.3390/educsci11080434

Ilyas, A., & Saeed, M. (2022). Project Based Learning in Teacher Education: Effect on Prospective Science Teachers' Science Teaching Efficacy Beliefs. Pakistan Social Sciences Review, 5(2), 26-35. https://doi.org/10.35484/pssr.2022(5-II)03

Jamil, M., Mahmood, A., & Masood, S. (2023). Fostering Critical Thinking in Pakistani Secondary School Science: A Teachers' Viewpoint. Global Educational Studies Review, 8(2), 645-659. https://doi.org/10.31703/gesr.2023 (VIII-II).58

Krajcik, J., Schneidar, B., Miller, E.A., Chen, I.C., Bradford, L., Baker, Q., Bartz, K., Miller, C., Li, T., Codere, S., & Peek-Brown, D. (2023). Assessing the Effects of Project -Based Learning on Science Learning in Elementary Schools. American Educational Research Journal. 60(1). https://doi.org/10.3102/00028312221129247

Krueger, R.A., & Casey, M.A. (2014). Focus Groups: A Practical Guide for Applied Research (5th ed.). Sage Publications.

Majud, M. B., & Jamaludin, K.A.B. (2024). Impact of Project-Based Learning (PBL) in Teaching and Learning Facilitation in Primary Schools. International Journal of Academic Research in Progressive Education & Development. 13(3). http://dx.doi.org/10.6007/IJARPED/v13-i3/22624

Markula, A., & Aksela, M. (2022). The key characteristics of project based learning: how teachers implement projects in K-12 science education. Disciplinary and Interdisciplinary Science Education Research, 4(1), 1-19. https://doi.org/10.1186/s43031-021-00042-x

Mckinney, L. (2023). Effectiveness of project-based learning in a junior high science classroom. Interdisciplinary Journal of Environmental and Science Education, 19(3), e2312. https://doi.org/10.29333/ijese/13678

Naqvi, S.U.E.L., Sharif, I., & Khan, I. (2023). Uncovering teachers 'Perceptions, Overcoming Barriers, and Introducing an Effective Framework for Incorporating and Evaluating 21st Century Skills in Classrooms, Global Educational Studies Review, 8 (2), 302-317. https://doi.org/10.31703/gesr.2023(VIII-II).28

National Center for the improvement of Educational Assessment. (2023). Assessing 21st century Skills toolkit. https://www.nciea.org/library/assessing-21st-century –skills/

Rahman, N.A.A., Soon, G.Y., & Chao, C. (2025). Investigating the Efficacy of Project-Based Learning in Enhancing English Writing Skills: A Comprehensive Model. Pakistan Journal of Life and Social Sciences. 23(1), 1108-1117. https://doi.org/10.57239/PJLSS-2025-23.1.0086

Rehman, N., Huang, X., Mahmood, A., AlGerafi, M.A.M., & Javed, S. (2024). Project-based learning as a catalyst for 21st century skills and student engagement in the math classroom. Heliyon, 10(23), e39988. https://doi.org/10.1016./j.heliyon.2024.e39988

Rahmani, R., Maulidar, M., Mustadi, A., & Senen, A. (2021). Analysis of student needs for context-based teaching materials and creativity to improve science literacy of elementary school students. Jurnal Serambi Ilmu. 22(1). 20-32. https://doi.org/10.32672/si.v22i1.2754

Sanchez-Garcia, R., & Reyes-de-Cozar. S. (2025). Enhancing Project-Based Learning: A Framework for optimizing Structural Design and Implementation- A Systematic Review with a Sustainable Focus. Sustainability, 17(11), 4978. https://doi.org/10.3390/su17114978

shengqiang, Li, Sarit Srikhao's, and Athirach Nankhantee, trans. 2025. "Combining Inquiry-Based Learning and Collaborative Learning: A New Model for Improving students' Teamwork and Problem-Solving Skills". Journal of Education and

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Educational Development 12 (1): 13-38. https://doi.org/10.22555/joeed.v12i1.1296.

Sujino, S., Herlina, H., & Sarifah, I. (2025). Applying Project-Based Learning Based on Playful Learning in Primary Schools: A study in Indonesia and Finland. Dinasti International Journal of Education Management and Social Science, 6(3), 2348-2354. https://doi.org/10.38035/ dijemss.v6i3.4088

Tahir, A. Q. (2011). Developing a Student-Centered Inquiry-Based Teaching Approach at Elementary Level Science in Pakistan- A Three Years Implementation Cycle. Asian Social Science. 7(8), 241-249. https://doi.org/10.5539/ass.v7n8p241

Wilcox, D., Liu, J. C., Thall, J., & Howley, T. (2017). Integration of Teaching Practice for Students' 21st Century Skills: Faculty Practice and Perception. International Journal of Technology in Teaching & Learning, 13(2), 55-77.

Zamir, S., & Zia, S. (2023). Exploring perspectives of private sector secondary school teachers towards project-based learning. International Journal of Social Sciences and Entrepreneurship, 3(4), 88-110. https://doi.org/10.58661/ijsse.v3i4.216

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: a meta-analysis study. Frontiers in Psychology, 14, 1202728. https://doi.org/10..3389/fpsyg.2023.1202728

Zuhri, Z., & Afriani, G. (2025). Implementing Project-Based Learning to Enhance 21st Century Skills Among Senior High School Students. Global Education Journal. 3(2), 463-47. https://doi.org/10.59525/gej.v3i2.716

Zulyusri, Z., Elfira, I., Lufri, L., & Santosa, T. A. (2023). Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. Jurnal Penelitian Pendidikan IPA, 9 (1), 133-143. https://doi.org/10.29303/jppipa.v9i1.2555