Student's perception towards Technology AssistedProject-Based Learning in enhancing Soft Skill Competencies in Chemistry

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Abstract
With the implementation of National Education policy, the primary aim of higher education was the development of 21st-century skills to prepare students for future. The traditional model of teaching did not provide opportunities for students to apply abstract knowledge in authentic contexts and therefore lacks the growth of skills in students. Project-Based Learning (PBL) is widely recognized as active, learner-centric and experiential learning. Technology integration in education has been widely approved for facilitating student learning, contributing to enhanced creativity, innovation, critical thinking, and higher-order cognitive skills. Technology Assisted Project-Based Learning model combining conceptual learning, application of chemistry concepts to real life, and evidence-driven project tasks is instructional design aims to bridge gaps between learning objectives, instructional processes, learning resources, assessment practices, and real-world applications, thereby fostering meaningful learning and the development of essential soft skill competencies. This study investigates the effectiveness of Technology Assisted Project-Based Learning model in Chemistryfor developing essential soft skills. The study was conducted on TY B.Sc. students of chemistry. Students were assigned to experimental and control groups. The experimental groups participated in technology-integrated projects on chemistry topic ***'Concept of Symmetry and Symmetry in Daily Life'.*** *The control group received conventional lecture-based instruction. This research is quantitative type. A feedback questionnaire was administrated for evaluating the effectiveness of this model. The Student's feedback were collected through questionnaire indicated a highly positive perception of TI-PBL in chemistry education with the mean scores for most statements ranged from 4.25 to 4.88 on a five-point Likert scale. However, the findings also highlighted challenges associated with instructional clarity, time management, and technology integration and learner self-motivation suggesting the need for careful planning and instructional support to ensure effective implementation of Technology Assisted PBL.*

Keywords: *Project-Based Learning, Technology integration, Chemistry learning, Soft Skill Competencies*

Introduction

The Primary focus of National Education policy in India regarding student development is to shift the educational focus from rote memorization to holistic, experiential and skill-based learning by fostering multidisciplinary student-centered approach [1]. Since chemistry is inherently an experimental and application-oriented discipline, students must continuously develop their conceptual understanding, practical competencies, and skills to effectively relate chemical principles to everyday life. Project-based learning (PBL) it is a student-centric, active learning strategy and most closely work on Bloom's ideal (1984) [2].This approach not only enhances students' conceptual understanding but also fosters essential interpersonal and 21st-century skills required in contemporary workplaces [3-4]. Additionally, Chemistry is closely related to real life. Students can take projects from real life issues such as environmental pollution control, soil, water, food, oil analysis as well as analysis of other product related to daily life. They can apply knowledge from multidisciplinary fields such as chemistry and biology etc. to find solution real world problem.During these project task, a teacher's role would shift from knowledge provider to guide, mentor and facilitators of learning [5-6].It also need careful planning and implementation and assessment of learning using diverse evaluation methods from teachers side.Earlier researcher reported project-based learning helped in the development of critical, creative, innovative, and collaborative thinking, enhancing problem-solving skills. [7-11].Project-based learning helps students to effectively exercise their thinking abilities as well as inter personal skills [12-16]. Project based learning when combined with technology brings tremendous transformation in education, promoting active learning with digital competency. It not only facilitates the learning but also enhances technological skills, student autonomy and promotes higher levels of learning motivation [17-19].

Combined study of project-based learning (PBL) and technology in chemistry education was not explored much regarding it's impact on the development of 21st century skills. Therefore, in the present study PBL combined with digital tools implemented in chemistry learning and the study

mainly focuses on the student's perception regarding the impact of this combined study especially in chemistry project. This studyfocuses on evaluating the effectiveness of Technology Assisted Project-Based Learning model in Chemistry where technology is used in every stage of project facilitating the learning and developing essential soft skills.

Methodology

This study employed to examine the student's perception regarding Technology-Assisted Project-Based Learning in enhancing soft skill competencies in chemistry. The study conductedon TY B.Sc students of the academic year 2025–2026. The participants were selected from similar academic backgrounds to ensure homogeneity and equally assigned to an experimental group (n = 40) exposed to Technology Assisted Project-Based Learning and a control group (n = 40) taught through conventional lecture-based instruction. The topicfor the study was selected from TY B.Sc. syllabus i.e. ***'Concept of Symmetry and Symmetry in Daily Life'***as it is closely related to daily life and has potential to conceptual understanding;promote inquiry, thinking skill, and project-based learning experiences.

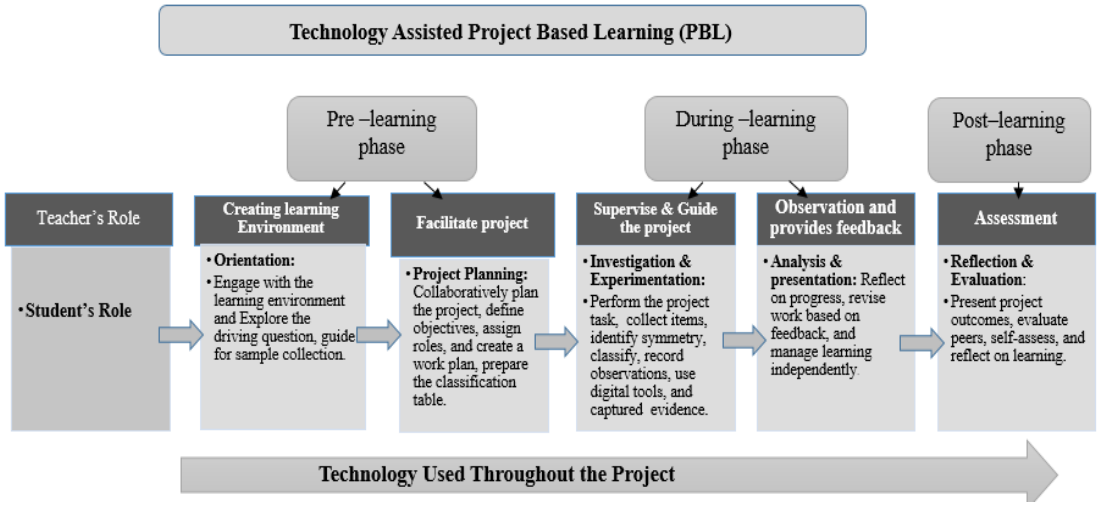


Fig. 1.Learning model showing complementary roles of teachers and students during three phases of Technology Assisted Project-Based Learning

Before the study starts, both the experimental and control groups were given introductory knowledge on the projecttopic *'Concept of Symmetry and Symmetry in Daily Life'*. After that students in the control group received traditional lectures and discussion. While the students in the experimental group explored the topic using digital tools, collected sample, items, identify symmetry, define it, classify and analyzed information and arranged data using different digital tools in addition to traditional learning.The PBL combined with technology for experimental group students happened in three main phases as pre-learning, during learning and post-learning. Here the teacher played the role of facilitator, guide and mentor, while students were actively engaged in investigation, experimentation, collaborative learning using different digital tools.Fig. 1 shows the flow of learning in different phases highlighting the role of teachers and students.

Data Analysis and Procedure:

In the present study, feedback questionnaires were administered at the end of the study. This paper mainly discussed the student's perception regarding Technology-Assisted PBL in chemistry for knowledge gain and development of soft skill competencies among the undergraduate chemistry students.Qualitative feedback responses were analyzed to determine the effectiveness of the Technology-Assisted PBL intervention based on improvements in conceptual understanding, data collection & analysis, technology use, and development of soft skill competencies among undergraduate chemistry students.

Students' Feedback on the Technology Assisted-PBL

At the end of the academic session 2025–2026, feedback were collected from the experimental group (EG)students who participated in the Technology-Assisted Project-Based Learning intervention on the chemistry project*'Concept of Symmetry and Symmetry in Daily Life'.* A structured questionnaire was administered through Google Forms to evaluate students' perceptions of this approach and to examine its impact on their engagement, motivation, conceptual understanding, practical learning, and development of soft skill competencies. Collecting students' feedback provided valuable insights into the effectiveness and acceptability of the instructional intervention from the learners' perspective.

The questionnaire consisted of 16 items covering both the positive and challenging aspects of the Technology Assisted PBL implementation, including learning engagement, collaboration, critical thinking, problem-solving, communication, digital literacy, self-directed learning, and the practical application of chemistry concepts in real-life contexts. Responses were recorded on a 5-point Likert scale, ranging from 1 (Strongly Disagree)to5 (Strongly Agree)**.** The response categories were interpreted as follows: Strongly Disagree (1.00–1.80), Disagree (1.81–2.60), Neutral (2.61–3.40), Agree (3.41–4.20), and Strongly Agree (4.21–5.00)**.** The collected responses were analyzed using descriptive statistics**,** including the mean and standard deviation(SD)**,** to determine students' overall perceptions of this approach and to draw conclusions regarding its effectiveness in enhancing chemistry learning and the development of essential 21st-century competencies.

Responses regarding TI-PBL in chemistry	**No. of Participating Students (n=40)**		**Percent**	**Mean**	**SD**
	Yes	No			
Does Technology-Assisted PBL is an effective strategy for understanding and retaining the chemistry concepts.	40		100		
Does Technology-Assisted PBL is an effective strategy in chemistry for the acquisition of soft skills?	40		100		
Does this model allow students to integrate technology effectively throughout the project?	36	4	90	10	
Does it provide opportunity to All students to interact and develop skills?	35	5	87.5	12.5	
Have you studied any topic before this through Technology-Assisted PBL?	27	13	67.5	32.5	
It helps student to review and reinforce their understanding of chemistry concepts				4.675	0.5256
It promotes ease of learning of complex concept supporting student learning achievements.				4.7	0.6076
It promotes active learning with critical thinking, and solve problems				4.725	0.64
It improves skills necessary to exercise student's creativity and innovation.				4.75	0.6304
Group activities aligned with the Technology-Assisted PBL provide opportunity for improving cooperation and collaboration ability				4.425	0.7157
It helps students to develop knowledge, skills, and attitudes.				4.7	0.5639
It supports student's holistic development				4.675	0.6558
It increases students' skill in managing learning resources				4.55	0.6775
Use of technology in PBL facilitates the learning and promotes digital literacy.				4.625	0.4903
It increases student's autonomy, confidence and learning motivation				4.55	0.7143

This model encourages students to learn independently and participate actively throughout the project.				4.65	0.483
Activities involved in this study will develop fluency, flexibility, originality, and elaboration components in the students				4.25	0.8697
Compared to traditional lecture method, this model have more meaningful and longtime effect of learning.				4.65	0.6222
It helps in improving the students' academic grades.				4.475	0.5057
It need time management and careful planning from both teacher and students side.				4.875	0.4043
Some students may not feel comfortable while working in group.				4.425	0.8439

Results And Discussion

The student's responses indicated a highly positive perception of Technology-Assisted Project-Based Learning in chemistry. The mean scores for most statements range from 4.25 to 4.88 on a five-point Likert scale, demonstrating that students generally agreed or strongly agreed with the positive statements regarding this approach. Such high mean values suggest that students perceived this approach as an effective instructional approach for enhancing conceptual understanding, promoting active participation, improving academic achievement, and developing essential soft skill competencies.A few statements showed comparatively lower mean scores, such as M = 4.25 (SD = 0.8697) and M = 4.30 (SD = 0.8286). Although these values still represent agreement, the relatively higher standard deviations indicate greater variability in students' opinions. This variation may reflect differences in students' experiences with group work, time management, or the challenges associated with implementing project-based learning.The Yes/No responses further support these findings. All students (100%) agreed that Technology Assisted PBL is an effective strategy for understanding and retaining chemistry concepts and for developing soft skill competencies. A large majority also agreed that this approach effectively combined technology (90%), provides opportunities for interaction and skill development (87.5%), and had positive learning outcomes. However, only 67.5% of students reported having previous experience with this approach, indicating that for many students this approach was relatively new, yet they still evaluated it very positively.

Overall, the high mean scores coupled with low standard deviation values demonstrate that students held a strong and consistent positive perception of Technology-Assisted Project-Based Learning. These findings suggest it as an effective pedagogical approach for chemistry education, fostering conceptual understanding, collaboration, digital literacy, creativity, critical thinking, and learner engagement while supporting the development of important soft skill competencies.

Conclusion

Students' feedback indicated that Technology Assisted -PBL enhanced collaboration, social participation, critical thinking, and student engagement. However, challenges related to instructional clarity, time management, technology use, learner focus, and facilitation skills were identified, highlighting areas for effective implementation.By focusing on the fundamental goals of student development and the development of 21st-century skills the TechnologyAssisted-PBL model provides strong empirical evidence of its effectiveness in enhancing students' core competencies through student's positive responses. The findings demonstrate that combining technology with project-based learning significantly promotes conceptual understanding, practical application, and the development of essential skills. Overall this approach fosters meaningful learning while promoting the acquisition of essential soft skill competencies.

References

1. Geisinger, K. F.:21st century skills: What are they and how do we assess them? Appl. Measure. Educ. 29, 245–249(2016)
2. Syahril, Purwantono, Wulansari, R. E., Nabawi, R. A., Safitri, D., &Kiong, T. T. :The Effectiveness of Project-Based Learning On 4Cs Skills of Vocational Students in Higher Education. *Journal of Technical Education and Training*, *14*(3), 29–37, (2022)
3. Chistyakov A.A., et al.: Exploring characteristics and effectiveness of project-based learning for science and STEAM education, Eurasia J. Math. Sci. Technol. Educ. 19 (5) (2023)
4. Almazroui K.M.: Project-based learning for 21st-century skills: an Overview and case study of moral education in the UAE, Soc. Stud. 114 (3) 125–136, (2023)
5. Major, C.H. Assessing problem-based learning: A review and analysis of faculty-developed PBL course portfolios. J. Excell. Coll. Teach. **2000**, 11, 113–131.
6. Conway, J.F.; Little, P.J. Adopting PBL as the preferred institutional approach to teaching and learning: Considerations andchallenges. J. Excell. Coll. Teach. **2000**, 11, 11–26.
7. Sumarni, W., &Kadarwati, S.: Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *JurnalPendidikan IPA Indonesia*, *9*(1), 11–21, (2020),
8. Syahril, Purwantono, Wulansari, R. E., Nabawi, R. A., Safitri, D., &Kiong, T. T. (2022). The Effectiveness of Project-Based Learning On 4Cs Skills of Vocational Students in Higher Education. *Journal of Technical Education and Training*, *14*(3), 29–37.
9. Tang, T., Vezzani, V., & Eriksson, V.: Developing critical thinking, collective creativity skills and problem solving through playful design jams. *Thinking Skills and Creativity*, *37*, 100696, (2020), Doi:10.1016/j.tsc.2020.100696
10. Prastiyan R., Purwaningsih E., Handayanto S.K.: Developing students' critical thinking skills through STEM-PjBL integrated with TPACK in static fluid topics, AIP Conf. Proc. 2569 (1), 050009, (2023), https://doi.org/10.1063/5.0117324.
11. Ambiyar, A., &Afifah, N.: The Effect of Project Based Learning Towards Student Achievement in Electrical Machines and Energy Conversion Subject. *Journal of Physics: Conference Series*, *1387*(1), (2019), Doi:10.1088/1742-6596/1387/1/012087
12. Hmelo-Silver, C.E.: The design of scaffolding in problem-based and inquiry learning. J. Learn. Sci., 16, 271–302, (2007)
13. Tian P., et al.: Integrating micro project-based learning to improve conceptual understanding and crucial learning skills in chemistry, J. Baltic Sci. Educ. 22 (1) (2023)
14. Cakici, Y. and Turkmen, N.: An investigation of the effect of project-based learning approach on childrens' achievement and attitude in science, *The Online Journal of Science andTechnology*, Vol.3, Issue 2, 9-17, (2013)
15. Rio, T Gomez-del, and J. Rodriguez.: Design and Assessment of a Project-Based Learning in a Laboratory for Integrating Knowledge and Improving Engineering Design Skills." *Education for Chemical Engineers* 40: 17–28, (2022), https://doi.org/10.1016/j.ece.2022.04.002.
16. Samala, A. D., Dewi, I. P., &Mursyida, L.: "E-Lab Sheet Project" 4Cs-Based Supplementary Media for Flexible Learning: Is it Well Implemented? *International Journal of Online and Biomedical Engineering (IJOE)*, *19*(1), 4–20, (2023),
17. Goradia T.: Role of Educational Technologies Utilizing the TPACK Framework and 21st Century Pedagogies: Academics' Perspectives, in IAFOR Journal of Education, 3rd ed, vol. 6, pp. 43–61, (2018). in press.
18. Greenstein L.: Assessing 21st Century Skills: A Guide to Evaluating Mastery and Authentic Learning," California: Corwin, 2012. in press.
19. Cohen, L., Manion, L., Morrison, K.: Research methods in education. Routledge,, New York (2017)