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PROJECT-BASED LEARNING AS A CATALYST TO IMPROVE KNOWLEDGE OF GLOBAL WARMING

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ABSTRACT

This case study examined the impact of project-based learning (PBL)on the knowledge of Grade 7 students studying in the Central Board of Secondary Education (CBSE) school in Panchkula, Haryana, India. A quasi-experimental design, including pre-test and post-test, was employed with 27 students who completed a 10-item Likert-scale instrument before and after a PBL intervention. Descriptive statistics revealed a mean score increase from 42.63 (SD = 3.58) to 44.81 (SD = 3.68) out of a possible 50. A paired-samples t-test yielded a statistically significant result, $t(26) = 5.62$, $p < .001$, with a large effect size (Cohen's $d = 1.08$). These findings indicate that project-based learning significantly enhanced students' knowledge of global warming. Thus, highlighting the integration of project-based learning into academic curricula.

Keywords: Project-based learning, global warming, environmental education, climate education, knowledge acquisition

1. INTRODUCTION

Environmental literacy has emerged as a critical educational priority amid accelerating climate change. Global warming — driven primarily by anthropogenic greenhouse gas emissions — poses one of the most complex challenges of the 21st century [1]. Schools serve as key sites for cultivating ecological awareness among young learners, and the quality of instructional approaches directly shapes the depth of understanding students develop [2].

Project-based learning (PBL) is a student-centred pedagogical approach in which learners engage with authentic, real-world problems over an extended period, producing a tangible product or solution [3]. Research consistently demonstrates that PBL promotes deeper conceptual understanding, higher-order thinking, and increased motivation compared to traditional instruction [4] [5]. However, evidence specifically examining PBL's effectiveness for environmental science topics among early adolescent learners remains limited in the Indian school context.

This case study was conducted to fill this gap. The objective was to measure the impact of a PBL intervention on Grade 7 students' knowledge of global warming. The study tests the following hypotheses: There is no significant impact of project-based learning on Grade 7 students' knowledge of global warming.

2. METHODOLOGY

2.1 Research Design

A pre-test post-test case study design was adopted. This quasi-experimental single-group design enabled measurement of knowledge change within the same cohort before and after the intervention, making it suitable for classroom-based educational research [6].

2.2 Participants

The sample comprised 27 Grade 7 students studying in a CBSE school in Panchkula, Haryana, India. All participants were part of the PBL intervention on global warming and had no prior formal exposure to PBL-based environmental education.

2.3 Instrument

A 10-item Likert-scale questionnaire was developed to assess students' knowledge of and attitudes toward global warming. The items included in the questionnaire addressed the following concepts: the role of greenhouse gases, consequences of global warming, waste management, the 3Rs (reduce, reuse, recycle), the role of fossil fuels, afforestation, and the responsibilities of educators. Responses were scored on a 5-point scale: Strongly Agree (5), Agree (4), Neither Agree nor Disagree (3), Disagree (2), and Strongly Disagree (1), yielding a maximum possible total score of 50.

2.4 Intervention

Students participated in a structured PBL intervention on global warming. The project required learners to investigate environmental problems, collaborate in teams, gather evidence, and present solutions. The intervention was designed to connect abstract climate science concepts to students' lived experiences and community contexts.

2.5 Data Analysis

Quantitative data were analysed using descriptive statistics (means, standard deviations, frequency distributions) and inferential statistics (paired-samples t-test). Effect size was calculated using Cohen's d to assess the practical significance of the findings. All analyses were performed with a significance threshold of $\alpha = .05$.

3. RESULTS

3.1 Descriptive Statistics

Table 1 presents the descriptive statistics for pre-test and post-test total scores across all 27 students. (SD = Standard Deviation; scores out of a maximum of 50).

Table 1. Descriptive Statistics for Pre-Test and Post-Test Total Scores (N = 27).

Measure	N	Mean	SD	Min	Max
Pre-test	27	42.63	3.58	35	49
Post-test	27	44.81	3.68	39	50
Mean gain	—	+2.19	—	—	—

The mean total score increased from 42.63 (SD = 3.58) in the pre-test to 44.81 (SD = 3.68) in the post-test, representing a mean gain of 2.19 points. The minimum score rose from 35 to 39, and the maximum score increased from 49 to 50, indicating a consistent upward shift across the entire score distribution.

3.2 Per-Item Analysis

Table 2 presents the mean scores for each of the 10 questionnaire items, comparing pre-test and post-test performance. (M = Mean score on a 5-point Likert scale).

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Table 2. Item-Wise Pre-Test and Post-Test Mean Scores.

Item	Statement	Pre M	Post M	Gain
Q1	Students are the changemakers for the community.	4.63	4.63	0.00
Q2	The emission of greenhouse gases leads to global warming.	4.26	4.44	+0.19
Q3	Global warming leads to climate change.	4.26	4.63	+0.37
Q4	Plastic decomposition leads to global warming.	4.04	4.41	+0.37
Q5	The 3Rs (reducing, recycling & reusing) could reduce global warming	4.22	4.63	+0.41
Q6	By educating children, the issue of global warming could be solved.	4.30	4.41	+0.11
Q7	By separating wet and dry waste, global warming could be reduced	4.11	4.48	+0.37
Q8	By reducing the usage of fossil fuels, global warming could be reduced.	4.15	4.22	+0.07
Q9	By planting more trees, global warming could be reduced.	4.33	4.52	+0.19
Q10	By minimising water wastage, global warming could be reduced.	4.33	4.44	+0.11

Item Q1 (students as changemakers) showed no change (M = 4.63 at both time points), suggesting this belief was already firmly held before the intervention. The largest gains were observed in Q5 (3Rs; +0.41), Q3 (global warming leads to climate change; +0.37), Q4 (plastic decomposition; +0.37), and Q7 (waste separation; +0.37). The smallest gains were recorded for Q8 (fossil fuels; +0.07) and Q6 (educating children; +0.11).

3.3 Likert Response Distribution

Table 3 summarises the shift in Likert response frequencies across all items, aggregated for the full cohort.

Table 3. Aggregated Likert Response Frequencies.

Response category	Pre-test (n)	Post-test (n)	Change	% change
Strongly Agree (5)	109	143	+34	+31.2%
Agree (4)	154	119	−35	−22.7%
Neither Agree nor Disagree (3)	37	8	−29	−78.4%
Disagree / Strongly Disagree	0	0	—	—

The most notable distributional shift was the 78.4% reduction in neutral responses (from 37 to 8), indicating that the PBL intervention resolved conceptual uncertainty across the cohort. Concurrently, Strongly Agree responses increased by 31.2%, while the proportion of Agree responses declined as students moved toward stronger conviction.

3.4 Inferential Statistics

To test the null hypothesis, a paired-samples t-test was conducted on the pre-test and post-test total scores. Table 4 presents the results. Two-tailed paired-samples t-test; df = degrees of freedom; Cohen's d interpreted as small < 0.2, medium ≥ 0.5, large ≥ 0.8 [7].

Table 4 Paired-Samples t-Test Results (Pre-Test vs. Post-Test).

Comparison	Mean diff.	SD diff.	t	Df	P	Cohen's d
Post-test vs. Pre-test	2.19	2.02	5.62	26	< .001	1.08

The paired-samples t-test revealed a statistically significant increase in total scores from pre-test (M = 42.63, SD = 3.58) to post-test (M = 44.81, SD = 3.68), t (26) = 5.62, p < .001. The effect size was large (Cohen's d = 1.08), indicating that the PBL intervention produced not only a statistically significant but also a practically meaningful improvement in students' global warming knowledge. Based on these findings, the null hypothesis — there is no significant impact of project-based learning on students' knowledge of global warming — is rejected.

4. DISCUSSION

4.1 Interpretation of Key Findings

The results of this study provide compelling evidence that project-based learning meaningfully enhanced Grade 7 students' knowledge of global warming. The statistically significant improvement (t(26) = 5.62, p < .001) and large effect size (Cohen's d = 1.08) are consistent with the broader PBL literature, which reports medium-to-large effects on subject matter knowledge in science education [4] [8].

The 78.4% reduction in neutral Likert responses is particularly significant. Before the intervention, 37 responses across the 10 items were rated as neither agree nor disagree, indicating uncertainty or insufficient understanding. By the post-test, this number fell to 8. This is in line with the argument that PBL facilitates the construction of structured knowledge frameworks, enabling learners to move beyond surface-level familiarity toward more definitive conceptual positions [9].

4.2 Item-Level Discussion

Item Q5 (3Rs: reduce, reuse, recycle) showed the largest gain (+0.41), likely because the PBL project involved hands-on activities around waste management — a theme directly observable and actionable in students' immediate environments. This aligns with the seminal framework, which argues that PBL is most effective when learning tasks are embedded in authentic, contextually meaningful problems [10].

Item Q3 (global warming leads to climate change) and Q4 (plastic decomposition and global warming) also showed substantial gains (+0.37 each). These conceptual relationships —

linking cause and effect across environmental systems — are precisely the type of complex, multi-variable understanding that PBL promotes through sustained inquiry and collaborative sense-making [4].

In contrast, Q8 (reducing fossil fuel use) showed the smallest gain (+0.07). This may reflect the more abstract and systemic nature of energy systems, which are less amenable to direct student investigation within the project's scope. These findings are in accordance with the fact that PBL projects must be carefully scaffolded to address concepts that lie beyond students' direct experience [11].

Item Q1 (students as changemakers) recorded no change, maintaining a pre-test mean of 4.63. This suggests that students already held strong beliefs about the role of children in driving environmental change.

4.3 Individual Student Gains

Analysis of individual score trajectories revealed that 24 out of 27 students (88.9%) improved their scores following the PBL intervention. The remaining 3 students maintained their pre-test scores, with no student recording a decline. This pattern of broad, uniformly positive gains — without regression — is noteworthy and contrasts with some studies that report heterogeneous outcomes for lower-achieving students under PBL conditions [12]. The absence of any score decline may reflect the collaborative and inclusive structure of the PBL activities, which provided multiple access points for learners of varying ability levels.

4.4 Implications

These findings suggest that PBL can serve as an effective alternative or complement to conventional didactic instruction for teaching complex environmental topics to school students. The large effect size is particularly encouraging given the relatively brief duration of a single PBL cycle, suggesting that even short-term, well-designed project experiences can produce meaningful learning gains.

Further, the result emphasises the value of connecting curriculum content to students' local and experiential contexts. Concepts such as waste separation, water conservation, and tree planting are embedded in the daily community life of students. PBL implementation enhances students’ understanding of complex environmental issues related to real-life situations.

Third, the study contributes to a growing evidence base for PBL in the Indian school context, where environmental literacy remains a pressing national educational goal [13]. The findings suggest that policy-level support for teacher training in PBL facilitation, alongside curricular integration of project-based approaches to environmental science, is well-warranted.

4.5 Limitations

The current study presents certain limitations. The single-group pre-test post-test design, without a control group, limits causal inference; it is not possible to rule out alternative explanations for score improvement, such as maturation, test-retest effects, or historical events that may have increased students' environmental awareness during the study period. The sample size of 27 students from a single school restricts the generalizability of findings. Future research should employ experimental or quasi-experimental designs with larger, more diverse samples, and should also incorporate qualitative data — such as student reflections, project artefacts, and classroom observations — to provide a richer account of the learning processes that PBL affords.

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5. CONCLUSION

This case study examined whether a project-based learning intervention significantly impacted Grade 7 students' knowledge of global warming. The findings clearly indicate that PBL significantly impacted students' knowledge about global warming. The statistically significant paired t-test result ($t(26) = 5.62$, $p < .001$) combined with a large effect size (Cohen's $d = 1.08$) led to the rejection of the null hypothesis. The near-elimination of neutral responses and the consistent, individual-level gains across 88.9% of students further reinforce the practical significance of these findings. Therefore, PBL represents a potential pedagogical strategy for teaching global warming and climate-related issues. The study recommends its integration into school academic curricula and teacher professional development programs.

REFERENCES

1. Intergovernmental Panel on Climate Change. (2023). AR6 synthesis report: Climate change 2023. IPCC. https://www.ipcc.ch/report/ar6/syr/
2. Stevenson, R. B., Brody, M., Dillon, J., & Wals, A. E. J. (Eds.). (2013). International handbook of research on environmental education. Routledge.
3. Thomas, J. W. (2000). A review of research on project-based learning. Autodesk Foundation. http://www.bobpearlman.org/BestPractices/PBL_Research.pdf
4. Krajcik, J. S., & Shin, N. (2014). Project-based learning. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (2nd ed., pp. 275–297). Cambridge University Press.
5. Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733
6. Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.
7. Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates
8. Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. Interdisciplinary Journal of Problem-Based Learning, 3(1), 44–58. https://doi.org/10.7771/1541-5015.1046
9. Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3
10. Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. Educational Psychologist, 26(3–4), 369–398. https://doi.org/10.1080/00461520.1991.9653139
11. Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. Journal of the Learning Sciences, 8(3–4), 391–450. https://doi.org/10.1080/10508406.1999.9672075

12. Ravitz, J. (2010). Beyond changing culture in small high schools: Reform models and changing instruction with project-based learning. *Peabody Journal of Education*, *85*(3), 290-312.[13] Ministry of Education, Government of India. (2020). National Education Policy 2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf