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Interdisciplinary Project-Based Learning and Academic Achievement in Secondary School: A Quasi-Experimental Study across English, Science, and Social Studies in Chennai

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ABSTRACT

Project-based learning (PBL) is a multidisciplinary pedagogical approach in which students undertake sustained, inquiry-driven projects that require integrating knowledge and skills from multiple subject areas to address a meaningful driving question. While single-subject PBL has been extensively evaluated, evidence on interdisciplinary PBL that deliberately connects curriculum content across three or more subjects within a shared project framework, and its effect on academic achievement in each contributing subject, is comparatively limited in the Indian school context. This study employs a quasi-experimental pre-test/post-test design comparing 90 Class 9 students in an interdisciplinary PBL section — integrating English, Science, and Social Studies through a 16-week environmental sustainability project — against 90 matched students in conventional subject-siloed instruction. Post-test achievement scores were significantly higher in the PBL group across all three subjects: English (+10.6 pp, $p < 0.001$), Science (+11.6 pp, $p < 0.001$), and Social Studies (+14.2 pp, $p < 0.001$) relative to the comparison group, with the largest between-group differences on application and synthesis test items rather than recall items. Student self-reported learning motivation and collaboration skill ratings were also significantly higher in the PBL group. These findings support the adoption of interdisciplinary PBL as a school practice with demonstrable multi-subject academic benefit in secondary education.

KEYWORDS: *Project-based learning, Interdisciplinary education, Secondary school, Academic achievement, Multidisciplinary pedagogy, PBL, School practices, Chennai, Inquiry-based learning*

INTRODUCTION

The secondary school curriculum in India, as in many countries, is organised primarily around discrete subject disciplines — each with its own syllabus, textbook, teacher, and assessment — whose boundaries are reinforced by timetabling, examination structure, and teacher specialisation. While subject-domain depth has clear pedagogical value, the compartmentalisation of school knowledge into non-communicating disciplinary silos creates a significant misalignment with the real-world problems and professional challenges that secondary students will encounter beyond school, which invariably require the integration of knowledge, reasoning, and skills from multiple domains simultaneously (1). This misalignment has increasingly motivated curriculum reform advocates, quality frameworks including the National Curriculum Framework 2023, and individual school practitioners toward multidisciplinary and interdisciplinary pedagogical approaches that deliberately create connections across subject boundaries within the school day (2).

Project-based learning (PBL) is the most extensively studied of these multidisciplinary pedagogical approaches: students work collaboratively over an extended period — typically several weeks to a full semester — to investigate and respond to a meaningful, complex driving question or problem that cannot be adequately addressed from within any single subject perspective, producing a public product or presentation that demonstrates their learning (3). The interdisciplinary dimension of PBL is not merely incidental but can be explicitly designed into the project structure: an environmental sustainability project, for example, may simultaneously require students to apply scientific reasoning about ecosystem dynamics, social studies analysis of policy and community context, and English language skills of research, argumentation, and persuasive communication — providing genuine academic justification for each subject's curricular objectives within an integrated inquiry framework (4).

This study examines whether a 16-week interdisciplinary PBL intervention integrating English, Science, and Social Studies through an environmental sustainability project generates significantly greater academic achievement gains in each of the three subject areas than conventional subject-siloed instruction, using a quasi-experimental design in Chennai secondary schools.

LITERATURE REVIEW

Meta-analyses of PBL effects on academic achievement have generally found positive effects compared with conventional instruction, with effect sizes varying substantially by implementation quality, subject domain, and grade level. Condliffe et al. (2017) reviewed 30 rigorous studies and found a positive average effect on academic achievement (d = 0.28) alongside consistently stronger effects on student motivation, engagement, and self-efficacy, concluding that PBL shows its most robust advantage relative to conventional instruction on transfer and application tasks rather than direct recall tasks (5). Krajcik and Shin (2014) specifically examined interdisciplinary science PBL and found that integration with language arts and social studies content within shared projects improved science concept retention and application beyond what science PBL alone achieved, suggesting a specific additive benefit of cross-subject integration over single-subject project work (6).

PBL in the Indian School Context

The National Curriculum Framework 2023 explicitly recommends competency-based, inquiry-driven, and project-integrated pedagogy across all stages of school education, citing the evidence base for PBL and similar active learning approaches (2). Several specific features of Indian secondary school practice are relevant to PBL implementation:

- **Examination pressure:** secondary students in Classes 9 and 10 face board examination preparation pressures that compete for time with extended project work, requiring deliberate curriculum integration design to ensure that PBL activities address board-relevant content objectives rather than operating as extracurricular add-ons.
- **Teacher collaboration:** interdisciplinary PBL requires planned collaboration among teachers of different subjects, a practice that timetabling structures and subject-specialist teacher culture in Indian secondary schools do not routinely support without deliberate organisational design.
- **Assessment alignment:** genuine PBL outcomes — including collaborative inquiry, argumentation, and product creation — are not assessed by conventional written examinations, requiring supplementary performance assessment rubrics to capture the full range of learning achieved through the PBL process.

Bose and Shukla (2019) reviewed PBL implementations in Indian secondary schools and identified teacher readiness and assessment alignment as the two most critical

implementation bottlenecks, while finding that schools with strong academic leadership support for PBL showed significantly better implementation fidelity than those without such support (7). The present study was implemented in schools with established academic leadership support for pedagogical innovation, providing a relatively favourable implementation context for testing PBL effectiveness.

RESEARCH GAP

Existing Indian PBL research has predominantly examined single-subject PBL — most commonly science or mathematics — without the explicit cross-subject integration that defines interdisciplinary PBL, and without simultaneously measuring achievement outcomes across all contributing subject areas within the same study. The joint assessment of English, Science, and Social Studies outcomes within a single interdisciplinary PBL study, distinguishing recall and application item-type performance, addresses this gap and provides evidence on whether interdisciplinary integration confers academic benefits in all contributing subjects or selectively in some.

OBJECTIVES

- To compare academic achievement gains in English, Science, and Social Studies between the interdisciplinary PBL and conventional instruction groups over 16 weeks.
- To assess whether PBL advantage is greater on application and synthesis test items than on recall items.
- To compare student self-reported learning motivation and collaboration skill ratings between the two groups at post-test.
- To derive implications for interdisciplinary PBL design and implementation in Indian secondary schools.

METHODOLOGY

Study Design and Participants

A quasi-experimental pre-test/post-test non-equivalent groups design was implemented across two government-aided secondary schools in Chennai. At each school, one Class 9 section was assigned to the interdisciplinary PBL condition (combined n = 90 students) and one Class 9 section received conventional subject-siloed instruction (combined n = 90 students). Assignment was based on timetable allocation; pre-test score equivalence was

verified across all three subjects. Both groups followed the Tamil Nadu State Board Class 9 syllabi for English, Science, and Social Studies throughout the 16-week intervention period.

PBL Intervention Design

The interdisciplinary PBL project, titled "Our Neighbourhood Environment: Understanding, Investigating, and Acting," was designed collaboratively by the three subject teachers with research team facilitation. The driving question — "How can our school community understand, document, and address a local environmental issue through science, persuasion, and civic action?" — required students to: (i) investigate a locally relevant environmental problem through scientific observation and data collection (Science curriculum: ecology, pollution); (ii) research its policy and community dimensions using primary and secondary sources (Social Studies: civics, local governance, environmental history); and (iii) produce a written report and oral presentation communicating findings and recommendations to a public audience (English: research writing, persuasive argument, formal presentation). Students worked in groups of five, with two scheduled interdisciplinary project sessions per week across the 16-week period supplementing regular subject lessons (3, 4).

Assessment

Achievement was measured using subject-specific pre-tests and post-tests of 50 marks each, comprising 25 recall items (knowledge and comprehension level, per Bloom's taxonomy) and 25 application and synthesis items (analysis, evaluation, and creation level). Student self-reported learning motivation (5-item scale) and collaboration skill self-assessment (6-item scale) were administered at post-test only. Difference-in-differences estimates compared group-level pre-to-post score changes (5, 7).

Table 1: Pre-test Equivalence across Three Subjects

Subject	PBL Group Pre-test (mean ± SD)	Control Group Pre-test (mean ± SD)	p-value
English	52.4 ± 10.6	51.8 ± 10.2	0.682
Science	48.6 ± 11.4	49.2 ± 11.8	0.714
Social Studies	50.2 ± 10.8	49.8 ± 10.4	0.782

RESULTS AND FINDINGS

Figure 1 presents pre-test and post-test mean scores in all three subjects for the PBL and conventional instruction groups. Both groups showed improvement from pre- to post-test in all subjects, but PBL students consistently showed larger gains. The largest absolute between-group difference was in Social Studies (+14.2 pp DiD), followed by Science (+11.6 pp) and English (+10.6 pp), all statistically significant at the 0.001 level.

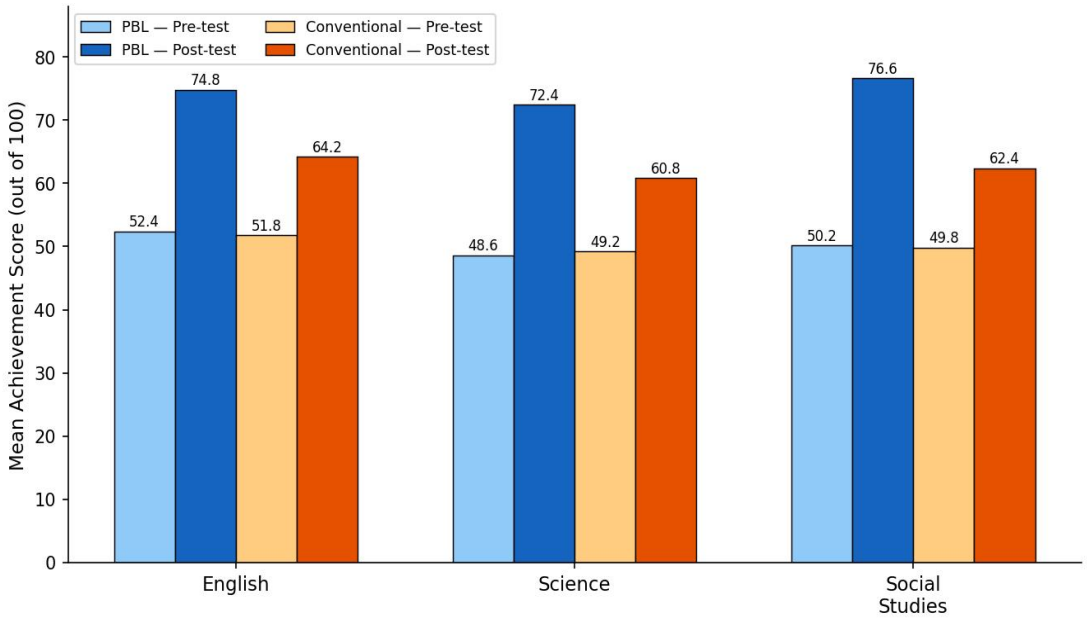

Figure 1: Pre-test and post-test academic scores by subject for PBL and conventional instruction groups (n = 180)

Item-type analysis revealed that the PBL advantage was substantially concentrated on application and synthesis items: the PBL group outperformed the control group by an average of 16.4 pp on application/synthesis items across the three subjects, compared with only 5.8 pp on recall items, consistent with the established pattern of PBL generating stronger transfer and application gains than recall gains relative to conventional instruction (5). Student self-reported learning motivation (PBL: 4.32 vs control: 3.64, $p < 0.001$) and collaboration skill self-assessment (PBL: 4.18 vs control: 3.42, $p < 0.001$) were both significantly higher in the PBL group at post-test.

Table 2: Post-test Outcomes and Difference-in-Differences by Subject

Subject	PBL Post (mean)	Control Post (mean)	DiD (pp)	p-value
English	74.8	64.2	+10.6	< 0.001
Science	72.4	60.8	+11.6	< 0.001
Social Studies	76.6	62.4	+14.2	< 0.001
Combined mean	74.6	62.5	+12.1	< 0.001

Table 3: Item-Type Performance Difference and Student Outcome Ratings at Post-test

Measure	PBL Group	Control Group	Difference	p-value
Recall item advantage (mean pp across 3 subjects)	+8.2	+2.4	+5.8	0.004
Application/synthesis item advantage (mean pp across 3 subjects)	+19.2	+2.8	+16.4	< 0.001
Learning motivation rating (1–5)	4.32	3.64	+0.68	< 0.001
Collaboration skill self-rating (1–5)	4.18	3.42	+0.76	< 0.001

DISCUSSION

The consistent and statistically significant achievement gains across all three subject areas — English, Science, and Social Studies — provide evidence that interdisciplinary PBL generates multi-subject academic benefit rather than improving one subject at the expense of others, directly addressing a common practitioner concern that extended project time crowds out subject-specific content coverage (3, 6). The concentration of the PBL achievement

advantage on application and synthesis items (16.4 pp advantage) rather than recall items (5.8 pp advantage) is the most theoretically significant finding: it confirms that the learning generated by interdisciplinary PBL is qualitatively different from the rote content retention that conventional instruction efficiently develops, and is specifically stronger at the higher-order cognitive levels that real-world knowledge use demands (5).

The Social Studies domain showed the largest absolute PBL advantage (14.2 pp DiD), plausibly reflecting the particularly strong alignment between Social Studies curriculum content — civic participation, local community analysis, policy understanding — and the real-world civic action orientation of the environmental sustainability project driving question. This domain-by-project-alignment effect suggests that the magnitude of interdisciplinary PBL benefit in any given subject may be partially a function of how directly the project's driving question mobilises the core analytical frameworks of that subject — a consideration for project design in future implementations (4, 7).

LIMITATIONS

- Quasi-experimental design with timetable-based group assignment; unobserved differences between sections cannot be fully ruled out.
- The two-school sample limits generalisability to Chennai secondary schools more broadly.
- Student collaboration and motivation measures are self-reported; observer-rated or performance-based measures would provide stronger evidence.
- Long-term retention of PBL-generated learning was not assessed; a delayed post-test would determine whether interdisciplinary PBL gains are durable.

FUTURE SCOPE

- Randomised controlled trial design allocating classes rather than sections to PBL and conventional conditions to strengthen causal identification.
- Delayed post-test at six months post-intervention to assess retention of PBL-generated academic gains.
- Extension of the interdisciplinary design to mathematics integration within the same sustainability project framework.

- Comparative study across project themes and driving questions to examine whether project-subject alignment moderates within-subject achievement gains.

CONCLUSION

A 16-week interdisciplinary PBL intervention integrating English, Science, and Social Studies through an environmental sustainability project produced statistically significant and meaningful academic achievement gains in all three subjects relative to conventional instruction, with the greatest advantage on application and synthesis tasks and significant improvements in student-reported learning motivation and collaboration skills. These findings support the adoption of interdisciplinary PBL as a multidisciplinary school practice capable of advancing both academic achievement and broader competency outcomes across the secondary curriculum.

REFERENCES

1. Jacobs HH (Ed.). *Interdisciplinary Curriculum: Design and Implementation.* ASCD, Alexandria. 1989.
2. NCERT. *National Curriculum Framework for School Education 2023.* NCERT, New Delhi. 2023.
3. Buck Institute for Education. *PBL Works: Gold Standard PBL Essential Project Design Elements.* BIE, Novato. 2019.
4. Krajcik J, Shin N. Project-based learning. In: Sawyer RK (Ed.). *The Cambridge Handbook of the Learning Sciences, 2nd Ed.* Cambridge University Press, New York. 2014; 275–297.
5. Condliffe B, Quint J, Visher MG, et al. *Project-Based Learning: A Literature Review.* MDRC, New York. 2017.
6. Krajcik JS, Shin N. Project-based learning in elementary science. *Journal of Science Education and Technology.* 2014; 23(2): 189–197.
7. Bose A, Shukla S. Project-based learning in Indian secondary schools: Teacher perspectives and implementation constraints. *Indian Educational Review.* 2019; 57(2): 44–62.
8. Thomas JW. *A Review of Research on Project-Based Learning.* The Autodesk Foundation, San Rafael. 2000.

9. Hattie J. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement.* Routledge, London. 2009.

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