

Impact of Experiential Learning on Physics Achievement among Class 10 Students

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Abstract— This study investigates the effect of experiential learning activities on the academic achievement of Class 10 students in Physics. A quasi-experimental pre-test/post-test control group design was employed with 66 students divided into an experimental group ($n = 33$) and a control group ($n = 33$). The experimental group participated in a structured six-month experiential learning programme that included laboratory experiments, model-making, projects, storytelling, graphic novels, cartoons, and problem-solving tasks aligned with curriculum objectives. The control group was instructed through traditional lecture-based methods.

Results showed that while the control group demonstrated negligible improvement, the experimental group achieved a statistically significant increase in post-test scores ($M = 22.39$) compared to the control group ($M = 18.76$). The effect size (Cohen's $d = 1.08$) indicated a very large educational impact. Gain achievement scores further supported the superiority of experiential learning in enhancing Physics understanding.

The findings confirm experiential learning as an effective pedagogical tool in science education. The study supports the National Education Policy (2020), which emphasizes activity-based and inquiry-driven approaches to foster deeper learning and critical thinking among secondary school students

Keywords: Experiential Learning, Kolb's Learning Cycle, Academic Achievement, Physics Education, CBSE, Inquiry-based Learning.

I. INTRODUCTION

The 21st century demands education that goes beyond rote memorization to foster critical thinking, problem-solving, and scientific reasoning. In science education, and particularly in Physics, the need for pedagogical reform is pressing. Physics is frequently perceived by students as abstract, difficult, and disconnected from everyday experiences, leading to low motivation, shallow understanding, and poor achievement.

Educational thinkers have long emphasized the importance of learning through experience. John Dewey (1938) argued that education must be rooted in learners' lived experiences, while David Kolb (1984) formalized this idea in his experiential learning cycle, which comprises four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Together, these frameworks highlight that knowledge is best acquired when learners actively construct meaning from their interactions with the world.

In India, the National Curriculum Framework (2005) and the National Education Policy (2020) advocate a shift toward experiential and activity-based pedagogies. These policies recognize that true improvement in science achievement requires connecting abstract theory with practical experience. However, despite policy support, empirical evidence on experiential learning in Indian secondary Physics classrooms remains limited.

The present study addresses this gap by evaluating the

effect of a structured experiential learning programme on the academic achievement of Class 10 CBSE students in Physics.

Aim of the Study

To determine the effect of a structured experiential learning programme on the academic achievement of Class 10 CBSE students in Physics, as compared to traditional lecture-based instruction.

Objectives of the Study

1. To design and implement an experiential learning programme in Physics for Class 10 CBSE students.
2. To compare post-test Physics achievement of students taught through experiential learning with those taught through traditional methods.
3. To examine pre-post improvements in Physics achievement within the experimental group.
4. To compare gain achievement scores between the experimental and control groups.
5. To estimate the effect size (Cohen's d) of experiential learning on Physics achievement.

Hypotheses of the Study

H₀₁: The implementation of an experiential learning programme does not significantly improve Physics achievement of Class 10 CBSE students.

H₀₂: There is no significant difference in post-test mean Physics achievement between the experimental group and the control group.

H₀₃: There is no significant difference between pre-test and

post-test mean Physics achievement within the experimental group.

H₀₄: There is no significant difference in gain scores between the experimental group and the control group.

H₀₅: The effect size of experiential learning on Physics achievement is not educationally meaningful (Cohen's $d \leq 0.20$).

II. LITERATURE REVIEW:

Traditional teacher-centred instruction has often been criticized for limiting students' conceptual understanding and discouraging real-world application of knowledge (Millar & Osborne, 1998). Dewey's principles of continuity and interaction emphasize the significance of experiences in shaping meaningful learning. Kolb's experiential learning cycle further systematized this process, showing that effective learning involves active engagement, reflection, and application.

International studies consistently demonstrate the benefits of experiential pedagogy. Aagsalok (2019) and Shivani (2020) found that secondary students taught Physics through experiential methods significantly outperformed peers in traditional classrooms. In Chemistry, Alkan (2016) reported that experiential approaches enhanced both academic achievement and scientific process skills. Hofstein and Lunetta (2004) showed similar benefits in Biology, particularly in comprehension and long-term retention.

Meta-analyses strengthen this evidence base. Burch (2019), reviewing 89 studies, concluded that experiential learning interventions produced achievement gains nearly half a standard deviation higher than conventional methods. Importantly, these effects were robust across contexts and subjects.

In India, empirical evidence remains sparse. Raina (2019) documented improved achievement when science instruction was activity-based, while NEP 2020 strongly endorses experiential pedagogies to improve measurable outcomes. However, subject-specific evidence in secondary Physics classrooms remains limited, which justifies the present study.

III. METHODOLOGY

Research Design

The study employed a quasi-experimental pre-test/post-test control group design to evaluate the impact of experiential learning on Physics achievement.

Sample

The participants comprised 66 Class 10 students from a CBSE-affiliated school in Delhi. They were randomly assigned into two groups:

- **Experimental group (n = 33):** taught using a structured experiential learning programme.
- **Control group (n = 33):** taught using conventional lecture-demonstration methods.

Both groups were equivalent in terms of prior academic performance, age, and gender distribution.

Intervention: Experiential Learning Programme

The experimental group was instructed using an experiential programme designed around Kolb's learning cycle:

- **Concrete Experience:** first experience of the students in class involving hands-on experiments, lectures and demonstrations.
- **Reflective Observation:** guided reflections and discussions based on observations.
- **Abstract Conceptualization:** linking experiences to relevant Physics concepts included in the CBSE syllabus.
- **Active Experimentation:** problem-solving tasks, projects, and model-building, assignments, to apply the concepts in real life or new situations and problems.

The programme spanned six months and covered the full Class 10 Physics curriculum.

Instruments

- **Physics Achievement Test:** A 30-mark test constructed by the researcher and validated by subject experts. It included objective questions.
- **Lesson Plans:** Separate structured lesson plans for the experimental and control groups ensured consistency.
- **Observation Notes:** Classroom observations and teacher reflections monitored fidelity of implementation.

Data Collection and Analysis

Pre-tests were administered to both groups prior to the intervention. After six months of instruction, the test was administered as a post-test.

Data were analysed using:

- **Descriptive statistics** (mean, standard deviation, gain scores).
- **Independent-samples t-tests** to compare mean scores between groups.
- **Paired-samples t-tests** to assess within-group improvements.
- **Effect size (Cohen's d)** to measure the magnitude of differences.
- Normality of data was confirmed using Kolmogorov–Smirnov and Shapiro–Wilk tests.

IV. RESULTS

Descriptive Statistics: The marks obtained of the two groups and other details are as indicated in the table

Table 1

	Test Phase	Mean	SD
Control	Pre-test	18.06	6.42
Control	Post-test	18.76	5.47
Experimental	Pre-test	17.85	4.01
Experimental	Post-test	22.39	4.39

Hypothesis Testing:

H₀₁: The experiential programme does not improve Physics achievement.

- The experimental group's post-test mean (22.39) was higher than its pre-test mean (17.85). A paired-samples t-test confirmed this difference as significant $t = 4.41$, $p < 0.001$.

• **Result:** H₀₁ rejected.

H₀₂: No difference exists between experimental and control post-test means.

- Independent-samples t-test showed the experimental group ($M = 22.39$) significantly outperformed the control group ($M = 18.76$), $t = -2.97$, $p < 0.005$.

• **Result:** H₀₂ rejected.

H₀₃: No difference exists within the experimental group between pre-test and post-test.

- Experimental group improved significantly ($M = 17.85 \rightarrow M = 22.39$, $p < 0.001$).

• **Result:** H₀₃ rejected.

H₀₄: No difference exists in gain scores between experimental and control groups.

- Gain scores: Experimental = +4.54, Control = +0.70. Independent-samples t-test confirmed the difference as significant.

• **Result:** H₀₄ rejected.

H₀₅: Effect size is not meaningful (Cohen's $d \leq 0.20$).

- Cohen's $d = 1.08$, which indicates a very large effect.

• **Result:** H₀₅ rejected.

V. DISCUSSION

The rejection of all null hypotheses indicates that experiential learning led to significantly higher achievement in Physics compared to traditional methods. The results strongly demonstrate that experiential learning significantly improves Physics achievement among Class 10 students. The experimental group's substantial post-test gains and large effect size confirm the educational significance of the intervention.

These findings are consistent with prior international studies (Agsalog, 2019; Shivani, 2020; Burch, 2019) and support Dewey's and Kolb's theoretical frameworks. This study contributes subject-specific empirical evidence from India, where research on experiential Physics instruction remains limited.

Implications:

For Teachers: Experiential methods should be integrated into Physics classrooms through experiments, projects, and inquiry-based tasks.

For Schools: Infrastructure and resources, including low-cost activity materials, should be strengthened to support experiential pedagogy.

For Policymakers: NEP 2020 reforms can be advanced by embedding experiential learning into teacher training and

curriculum frameworks.

Limitations:

- The study involved a relatively small sample from a single school.
- The intervention period was limited to six months.
- Teacher fidelity and resource constraints may influence replicability.

Recommendations for Future Research:

- Extend to larger, more diverse samples across regions.
- Employ longitudinal designs to study retention effects.
- Apply experiential models across other science subjects.
- Explore digital integration and innovative assessment methods.

VI. CONCLUSION

The study provides robust evidence that experiential learning significantly enhances Physics achievement at the secondary school level. All null hypotheses, except for the control group's pre-post comparison, were rejected. The intervention not only produced statistically significant results but also demonstrated a very large educational impact.

By bridging theory and practice, experiential learning makes Physics more engaging, meaningful, and effective. The findings underscore the potential of experiential pedagogy to transform science education in India in alignment with national policy directions.

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