

Activity-Based Learning in Secondary Education: A Quasi-Experimental Study

Dr. Harsha Devi

Department of Education, Adarsh College of Education, H.P.

Abstract

Activity-Based Learning (ABL) posits that students learn best through active, hands-on engagement rather than passive reception. Despite its theoretical backing, empirical evidence comparing its efficacy directly against traditional lecture-based methods in secondary education requires continuous contextual validation. This study utilised a quasi-experimental, pre-test/post-test non-equivalent control group design to evaluate the impact of Activity-Based Learning Modules on academic achievement in science. A sample of 60 secondary students was divided into an experimental group (ABL Modules) and a control group (Traditional Lecture Method). Baseline equivalence was established using an independent samples t-test, while post-intervention differences were analysed using an Analysis of Covariance (ANCOVA), controlling for pre-test scores. Initial t-test results indicated no significant difference between groups at baseline. Following a four-week intervention, ANCOVA results demonstrated a statistically significant difference between the groups, with the Experimental group scoring significantly higher than the control group, $F(1,57) = 32.54, p < .001$. The findings suggest that ABL modules significantly enhance academic achievement compared to traditional pedagogies, providing actionable insights for curriculum designers and educators.

Keywords: Activity-Based Learning, Secondary Education, Academic Achievement.

1. Introduction

The pedagogical process has recently undergone a significant transition from passive, teacher-centric methods to student-centric approaches. In the context of science education, these approaches foster deeper cognitive engagement and the development of scientific attitude as traditional methods fail to adequately cultivate the critical thinking and performance outcomes required in modern academic environments. Science education specifically at the secondary-school level is expected to develop conceptual understanding, scientific reasoning, problem-solving, and the ability to apply knowledge in different contexts. Achieving these outcomes requires instructional experiences that allow learners to observe phenomena, examine critically and connect scientific concepts with everyday situations. When students participate meaningfully in these processes, science learning becomes an active process of constructing and applying knowledge rather than merely reproducing textbook information (Antonio & Prudente, 2024; Urdanivia Alarcon et al., 2023).

The traditional lecture method is useful and widely used because it enables teachers to present subject matter systematically within a limited period. It is useful for introducing concepts, explaining difficult ideas, and summarising content. The traditional methods are historically characterised by direct instruction and rote memorisation (Shloul et al., 2024; Wijnia et al., 2024). However, excessive dependence on

lectures may reduce students' opportunities to explore scientific phenomena, test their understanding, and apply concepts through practical experiences. Research across STEM and science education has increasingly supported the inclusion of active and inquiry-oriented learning experiences alongside teacher explanation (Ting et al., 2023; Uluçınar, 2023).

Activity-Based Learning addresses this concern by engaging students in purposeful activities such as experimentation, observation, problem-solving, discussion and reflection. Its effectiveness does not arise from physical activity alone. Meaningful activities require students to predict outcomes, record observations, interpret evidence, explain findings, and relate their experiences to scientific principles. Effective science instruction therefore requires an integration of hands-on participation and minds-on engagement (Oliveira & Bonito, 2023; Sanjito & Hyams-Ssekasi, 2025).

A structured activity-based module can provide continuity among classroom activities, teacher guidance, curricular content, and assessment. Activities may generate experience, while worksheets and supplementary material help students organise observations and consolidate conceptual understanding. The National Curriculum Framework for School Education 2023 similarly emphasises observation, experimentation, conceptual understanding, and the application of scientific knowledge (MHRD, 2020; NCERT, 2023). Teacher prompts, discussion, feedback, and formative assessment further connect the activity with its intended learning outcome. Recent evidence also indicates that inquiry-oriented instruction, practical work, and appropriately designed worksheets can support conceptual understanding and science-learning outcomes when they are integrated into a coherent instructional process (Mediana et al., 2025; Revano et al., 2026). These recommendations create a need for classroom-based evidence concerning the effectiveness of structured activity-based instruction.

1.1 Review of Literature

Research on active learning methodologies in science education highlights their transformative potential, underscoring the pivotal role they play in shaping students' academic achievements and attitudes towards scientific inquiry. Choudhary & Khushnood (2021) and Sy et al. (2022) highlighted the holistic benefits of activity-oriented learning, including skill development, engagement, and achievement across subjects and grade levels. Afyusisye and Gakuba (2022) found that chemistry practicals supported the academic performance of secondary-school students in Tanzania using a non-equivalent control-group design, reported that STEM problem-based learning improved secondary students' biology achievement and retention. Nwankwo et al. (2024) similarly found that students taught biology through hands-on activities achieved higher scores than those taught through problem-based learning. Together, these studies indicate that direct engagement with scientific tasks can support achievement, but they also suggest that the form in which active learning is implemented may influence its effectiveness. Sanjito and Hyams-Ssekasi (2025), in a meta-analysis of 16 quasi-experimental studies, reported a large overall effect of practical work on secondary-school learning outcomes. However, substantial variation across the included studies indicated that outcomes were influenced by teacher competence, resources, instructional design, and implementation quality.

Thus, the above studies suggest the importance of an activity-based teaching learning approach, which significantly influences students' attitudes towards science and their better academic performance. The literature indicates that active, practical, inquiry-based, and problem-based approaches can improve science learning. Furthermore, considerable variation across studies shows that instructional outcomes are sensitive to educational level, subject matter, teacher guidance, duration, resources, and classroom context.

1.2 Rationale of the Study

Despite growing evidence supporting active science instruction, comparatively limited directly verifiable research has examined a structured, curriculum-aligned ABL module for Grade secondary school science students. Much of the recent literature has focused on individual strategies such as inquiry-based learning, problem-based learning, practical work, or worksheets. Fewer studies have examined an integrated module combining classroom activities, worksheets, supplementary readings, teacher prompts, discussion, and formative assessment. Integrating all these in a structured module, the present study therefore compares the academic achievement of Grade IX students taught through a structured activity-based module with that of students taught the same science content through the traditional lecture method.

2. Objectives of the study

1. To compare the mean pre-test scores on academic achievement in science between the control and experimental groups.
2. To compare the mean post-test scores on Academic Achievement in science between the Control and experimental groups.

3. Hypotheses

H01: There is no significant difference in mean pre-test scores on Academic Achievement in Science between the Control and Experimental group.

H02: There is no significant difference in mean post-test scores on Academic Achievement in Science between the Control and Experimental group.

4. Methodology

4.1 Research Design

This study employed a quasi-experimental, pre-test/post-test non-equivalent control group design. The intact classroom sections of the school were used for the study. The ANCOVA was selected as the primary analytical tool to statistically control for any pre-existing differences in prior knowledge of the subject.

4.2 Sample

The sample comprised 60 students of IX class from a CBSE-affiliated secondary school located in Shimla, Himachal Pradesh. Two intact sections were purposefully selected and assigned to the experimental group ($n = 30$) and the control group ($n = 30$). The homogeneity of groups was established in terms of age range (14–15 years) and intelligence level as measured by the Non-Verbal Group Intelligence Test (NVGIT) by Imtisingba Ao.

4.3 Tool Used

Academic achievement was measured using a researcher-developed, expert-validated Science Achievement Test (SAT). The SAT consisted of 40 multiple-choice questions assessing higher-order thinking skills. The tool demonstrated high internal consistency, yielding a Kuder-Richardson reliability coefficient of 0.73.

4.4 Procedure

- Pre-test Phase: Both groups were administered the SAT to find out pre-test scores.
- Intervention Phase (four weeks):

Experimental Group: Received instruction via Activity-Based Learning modules, incorporating interactive activity-based classroom teachings, peer-led group discussions, related reading material and assignment worksheets.

Control Group: Received instruction via traditional chalk-and-talk lectures, textbook reading, and standard worksheets.

- Post-test Phase: Both groups were re-administered the SAT to obtain post-test scores.

5. Analysis

The data were analysed using SPSS. Assumptions of normality, homogeneity of variances, and homogeneity of regression slopes were verified before running the primary analyses.

5.1 Pre-Intervention analysis

An independent samples t-test was conducted on the pre-test scores to determine if the two groups were academically equivalent before the intervention.

Table 1
Summary of t-test for Pre-test Academic Achievement Scores

Group	N	Mean Scores	S.D.	df	t-value
Control Group	30	9.43	1.8	58	0.50
Experimental Group	30	9.6	1.7		

It is evident from Table 1, there was no statistically significant difference in pre-test scores between the experimental group and the control group, $t(58) = 0.50$, which is non-significant at a 0.05 level of significance. This confirms the groups had equivalent baseline knowledge, supporting null hypothesis H01.

5.2 Post-Intervention Analysis

To test H02, a one-way ANCOVA was conducted to determine a statistically significant difference between the Experiment and traditional group on post-test scores, controlling for pre-test scores.

Table 2
Summary of ANCOVA for Post-test Academic Achievement Scores

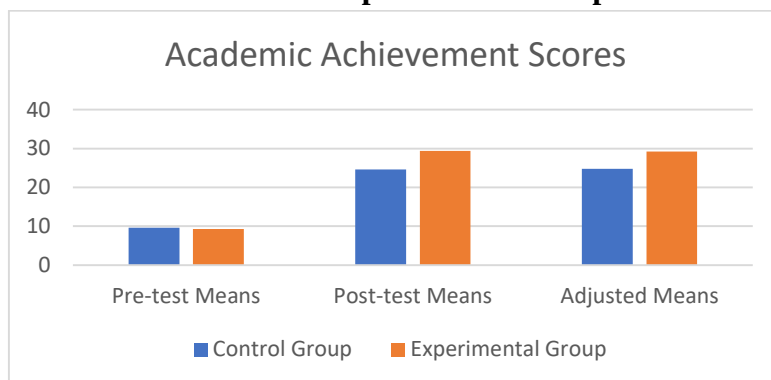
Components of variability	df	SSy.x	MSSy.x	F-Ratio
Between samples or treatments	1	289.4	289.4	32.54
Within samples or error	57	506.9	8.894	
Total	59			

Adjusted Means: Experimental Group = 29.2; Control Group = 24.8.

After adjusting for pre-test scores, there was a significant main effect of the instructional method on post-test academic achievement, $F(1, 57) = 32.54$, which is significant at 0.01 level of significance. The experimental group exposed to Activity Oriented Learning Modules demonstrated a significantly higher adjusted mean score ($M_{adj} = 29.2$) compared to the control group ($M_{adj} = 24.8$). Therefore, H02 is

rejected. Mean scores of Pre-test, Post-test and Adjusted Means on Academic Achievement of Control and Experimental Groups are given in Figure 1 below:

Figure 1: Mean score values of Control and Experimental Group on Academic Achievement at.



The findings of the study show that teaching Science through Activity Oriented Learning Modules has proven to be more effective in enhancing the Academic Achievement of IX class students as compared to the teaching through the traditional lecture method.

6. Conclusion

This study provides robust empirical evidence supporting the integration of Activity-Based Learning in secondary education. The data confirmed that ABL yields significantly higher academic achievement than traditional lecture-based instruction. This aligns with Constructivist theories, suggesting that when students actively take part in their learning, collaborate with peers, and solve localised problems, they transition from passive information consumers to active knowledge creators.

7. Limitations and Future research

While the findings are compelling, the study's localised sample within specific private schools limits broad generalisation. Additionally, the intervention lasted only four weeks. Future research should encompass longitudinal studies across diverse socioeconomic demographics and public school settings to verify the long-term retention of concepts learned through ABL.

8. Implications for Educators

For educators and curriculum developers, these findings underscore the necessity of moving away from purely didactic teaching models. Integrating structured, objective-driven activities into standard lesson plans. It is a validated strategy to enhance student academic outcomes and foster a more dynamic, effective classroom ecosystem.

References

1. Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics*, 66(1), 64-74.
2. Thompson, Jerome & Soyibo, Kola. (2002). Effects of Lecture, Teacher Demonstrations, Discussion and Practical Work on 10th Graders' Attitudes to Chemistry and Understanding of Electrolysis. *Research in Science & Technological Education*. 20. 25-37. Doi: 10.1080/02635140220130902.

3. Oliver-Hoyo, M. (2004). Effects of an Active Learning Environment: Teaching Innovations at a Research I Institution. *Journal of Chemical Education*.
4. Albadi, A. (2019). The Impact of Activity Based Learning on Students' Achievement. A study Among 12 Grade Science and Environment Student in a public School in Oman (Doctoral dissertation, The British University in Dubai (BUiD)).
5. Armbruster, P., Patel, M., Johnson, E., & Weiss, M. (2009). Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. *CBE—Life Sciences Education*, 8(3), 203-213.
6. Aydede, M. N. (2010). The Effect of Active Learning Based Activities on Students' learning Levels in Primary School Sixth Grade Science Course. *Education Sciences*, 5(4), 2245-2253.
7. Cotner, S. (2008). A Delicate Balance: Integrating Active Learning into a Large Lecture Course. *Cell Biology Education*, 7, 361–367.
8. Choudhary, F., & Khushnood, S. (2021). Effectiveness of Activity Based Learning in General Science at Elementary Level. *JEHR Journal of Education And Humanities Research*, University of Balochistan, 11(1), 55-64.
9. Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the national academy of sciences*, 111(23), 8410-8415.
10. Khan, M., Muhammad, N., Ahmed, M., Saeed, F., & Khan, S. A. (2012). Impact of activity-based teaching on students' academic achievements in physics at secondary level. *Academic Research International*, 3(1), 146.
11. Sy, R., Nimor, C., Etcuban, J., & Argate, R. (2022). Activity-Based Strategy in Teaching Earth Science among Junior High School Students in Philippines. *Asian Review of Social Sciences*. 2249-6319,11(2),1-7. DOI: <https://doi.org/10.51983/arss-2022.11.2.3139>
12. Afyusisye, A., & Gakuba, E. (2022). The effect of the chemistry practicals on the academic performance of Ward Secondary School students in Momba District in Tanzania. *Journal of Mathematics and Science Teacher*, 2(2), em019. <https://doi.org/10.29333/mathsciteacher/12397>
13. Antonio, R. P., & Prudente, M. S. (2024). Effects of inquiry-based approaches on students' higher-order thinking skills in science: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology*, 12(1), 251–281. <https://doi.org/10.46328/ijemst.3216>
14. Nwankwo, A. L., Ugwu, T. U., Ukala, G., & Benson, O. O. (2024). The effect of hands-on activity and problem-based learning on achievement of biology students in Enugu State. *Inornatus: Biology Education Journal*, 4(1), 46–56. <https://doi.org/10.30862/inornatus.v4i1.574>
15. Oliveira, H., & Bonito, J. (2023). Practical work in science education: A systematic literature review. *Frontiers in Education*, 8, 1151641. <https://doi.org/10.3389/feduc.2023.1151641>
16. Revano, M. J. N., Tanda, J. A., & Walles, F. A. (2026). Effectiveness of worksheets in science students' learning outcomes: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology*, 14(2), 603–624. <https://doi.org/10.46328/ijemst.5408>
17. Sanjito, B. P., & Hyams-Ssekasi, D. (2025). The impact of science practical work on secondary school students' learning outcomes: A meta-analysis. *Journal of Research in Science, Mathematics and Technology Education*, 8(3), 7–24. <https://doi.org/10.31756/jrsmte.832>
18. Ting, F. S. T., Shroff, R. H., Lam, W. H., Garcia, R. C. C., Chan, C. L., Tsang, W. K., & Ezeamuzie, N. O. (2023). A meta-analysis of studies on the effects of active learning on Asian students'

- performance in STEM subjects. *The Asia-Pacific Education Researcher*, 32(3), 379–400. <https://doi.org/10.1007/s40299-022-00661-6>
19. Uluçınar, U. (2023). The effect of problem-based learning in science education on academic achievement: A meta-analytical study. *Science Education International*, 34(2), 72–85. <https://doi.org/10.33828/sei.v34.i2.1>
20. Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023). Science and inquiry-based teaching and learning: A systematic review. *Frontiers in Education*, 8, 1170487. <https://doi.org/10.3389/feduc.2023.1170487>