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Effect of Activity-Led Instructional Program in Enhancing Environmental Responsibility among Secondary Students

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Abstract— *Traditional, lecture-based pedagogical models often fail to translate environmental knowledge into real-world sustainable habits, creating a persistent "knowledge-action gap" among young learners. While students may memorize theoretical facts, they frequently lack the practical social consciousness required to drive meaningful green campus transformations. This study evaluated the efficacy of an activity-led instructional intervention in enhancing environmental responsibility and sustainability literacy among secondary school students. The research focused on critical dimensions that are sustainable lifestyles and eco-conscious practices, energy usage patterns and their broader environmental footprints and resource conservation and energy efficiency. A quasi-experimental research design was employed with 11th 70 grade students from a CBSE-Board school in Lucknow city. The experimental group (N=35) received a 45-day structured instructional program using cooperative learning strategies, while the control group (N=35) followed the traditional teaching learning. Data were analysed using non-parametric Wilcoxon Signed Ranks and Mann-Whitney U tests via SPSS to measure internal growth and comparative significance. The findings revealed that the activity-led program caused a highly significant improvement in the experimental group across all dimensions. Notably, the energy usage dimension showed a near-universal internal improvement rate. Comparative analysis proved the experimental group achieved significantly higher mean ranks than the control group in resource conservation and energy efficiency, demonstrating the superior impact of structured interventions. The study demonstrates that specialized, activity-based interventions are superior to conventional methods in fostering ecological stewardship. It recommends integrating hands-on modules into mainstream curricula to bridge the gap between environmental awareness and active conservation.*

Keywords— ***Activity-Led Learning, Energy Footprints, Environmental Responsibility, Green Campus Transformation, Sustainable Practices.***

I. INTRODUCTION

"Education is the most powerful weapon which you can use to change the world".

- Nelson Mandela

These words of Nelson Mandela establish the foundation for this research that the escalating global environmental crisis requires a profound internal transformation of human behavior. By 2024, the global average surface temperature reached roughly 0.55 ° C above pre-industrial levels, with atmospheric CO_2 concentrations hitting 420 ppm (IPCC,2024). The decade of 2024–2025 officially ranks as the warmest on record, creating a "Red Alert" for biodiversity and human civilization. Despite these critical figures, a persistent "knowledge-action gap" prevents younger generations from translating theoretical awareness into responsible ecological stewardship. UNESCO emphasizes that education for sustainable development is the essential bridge to empower learners to make informed decisions for environmental integrity (UNESCO, 2020). In

India, the National Education Policy (NEP) 2020 explicitly recognizes this urgency, advocating for holistic, multidisciplinary, and experiential learning to address sustainability challenges (NEP, 2020). UNESCO aligns with the "Green School" movement and the UNESCO Greening Education Partnership, which officially began its core mission on June 5, 2024, to get "Every Learner Climate-Ready" (UNESCO, 2024). The present research is designed as a structured instructional intervention aimed at bridging the gap between theoretical knowledge and practical action. Utilizing a quasi-experimental design with 11th grade 70 students in Lucknow city, this study evaluates the efficacy of a specialized instructional program against traditional pedagogical methods. By focusing on active, participatory modules, the study supports national visions like Viksit Bharat @2047 and the "Ek Ped Maa Ke Naam" campaign launched in 2024, which aims to plant 40 crore trees by March 2025 (MoEFCC, 2024). Ultimately, this intervention seeks to transform students from passive observers into active agents of a green campus transformation.

II. REVIEW OF RELATED LITERATURE

The reviewed studies are highly relevant to this research as they provide strong evidence for the effectiveness of structured interventions in improving Sustainable Practices and Energy Usage patterns, while highlighting the need for active learning to bridge the knowledge-action gap in these specific areas. Ablak and Yeşiltaş (2020) empirically demonstrated that secondary school students generally possess a favorable level of baseline awareness regarding basic, highly visible ecological concepts. This baseline is often built through everyday observation rather than just formal instruction. Aldawsari et al. (2025) concluded that teaching comprehensive green education successfully bridges the gap between fragmented theoretical knowledge and deep, practical environmental responsibility. Ayerbe López and Perales Palacios (2024) noted that traditional teaching methods are frequently insufficient for conveying complex ecological topics effectively. They argued that innovative methodologies are required to connect students emotionally to the natural world. Barman (2023) observed that dedicated, school-based environmental initiatives exert a massive positive influence on young learners. The study proved that targeted curriculums are essential for helping students successfully comprehend complex ecological problems that are often ignored in traditional settings. Fernandes et al. (2024) conducted a document analysis revealing that environmental education in standard high school curricula is often treated too generically. Their work highlights that traditional frameworks lack the deep practical application required for genuine behavior change. Firmanshah et al. (2023) found a very strong positive connection between environmental knowledge, attitudes, and awareness. Their results prove that high environmental knowledge consistently leads to better ecological attitudes in students. Khofi (2024) found that green school concepts significantly improve students' environmental awareness and influence their pro-environmental behavior. Lace-Jeruma and Birzina (2009) demonstrated how standard biology lessons frequently integrate practical sustainability goals. However, the research noted that without specialized modules, students often miss the deeper connection to global environmental systems. Lozano et al. (2022) found that utilizing active teaching methodologies greatly improves students' knowledge about climate change. The study also highlighted that such programs successfully trigger strong positive emotions toward scientific learning. Mahinay et al. (2023) explored the relationship between environmental literacy levels and pollution, finding that higher ecological knowledge directly shapes student behaviors. Specifically, students with higher literacy displayed a much stronger willingness to take responsible actions against pollution. Marcelino et al. (2024) established that integrating ecology into the formal curriculum is fundamental for developing conscious citizens. Their theoretical investigation supports the role of basic curricular science in delivering the structural framework of ecological knowledge. Mavhungu (2023) investigated students' perceptions and found a favorable correlation between human capital aspiration and individual approach to new environmental initiatives. Mebane et al. (2023) emphasized that promoting climate change awareness requires specialized socio-affective education and empowerment training. Their research confirmed that instructional programs provide students with the intellectual clarity needed to transform anxiety into structured, scientific awareness. Reutotar (2023) found that students build their baseline awareness through physical encounters with issues like improper waste segregation in their immediate environments. This experiential, real-world learning acts as a vital supplement to traditional classroom instruction. Sass et al. (2024) developed a framework to advance action competence in sustainability education. Their research emphasizes shifting pedagogical focus from passive learning to "climate-ready" competencies.

Suarez Solis (2024) established that structured intervention programs are essential for cultivating ecological consciousness. The research proved that dedicated environmental initiatives produce highly measurable benefits compared to control groups. Suarlin (2023) established that integrating environmental education into formal schooling is absolutely necessary to form

"environmental care characters". The research highlighted that structured, active interventions result in massive improvements in environmental knowledge and positive behavioral shifts. Zogaj et al. (2024) pointed out that regions facing severe pollution problems urgently need effective environmental education systems. Their data confirmed that higher ecological education directly correlates with better awareness and more responsible daily practices. Despite existing awareness, current educational models often treat environmental topics too generically, failing to bridge the knowledge-action gap. This research addresses the lack of structured, activity-led interventions specifically designed to transform theoretical knowledge into practical sustainable practices and energy-saving behaviours among students.

III. SIGNIFICANCE OF THE STUDY

The importance of this research lies in its strategic response to the ecological and social needs of 2026. While it directly addresses the "knowledge-action gap," with a primary reason to combat the urgent need of "Environmental Apathy". In today's digital world, many people feel disconnected from the physical damage happening to our planet. This study provides a practical way to fix that broken connection between human choices and the health of nature. Additionally, this research is vital because it moves past the limits of traditional classroom teaching, which often leaves students informed but uninspired to make a difference. By using a structured instructional program, this study gives learners the tools to take real, measurable action. This work is highly relevant to today's society as it aligns with India's National Education Policy (NEP) 2020 and the Viksit Bharat @2047 vision. Instead of just memorizing facts, it focuses on building the skills and values needed for a sustainable future. Ultimately, this study offers a tested model for schools to turn passive awareness into active care, protecting the natural systems that keep our world alive.

RESEARCH QUESTIONS

Question 1: What is the effect of an activity-led instructional intervention on the post-test scores of 11th grade students in the domain of long-term sustainable lifestyles and eco-conscious practices?

Question 2: How does the implementation of an activity-led instructional intervention change a student's capacity to analyze and manage their daily energy usage patterns and environmental footprints?

Question 3: Is there any significant difference exist between Post-test scores of students receiving activity-led instruction and those receiving conventional instruction on the dimension of resource conservation and energy efficiency?

RESEARCH OBJECTIVES

Objective 1: To compare the effect of a structured activity-led instructional program on the Pre-test and Post-Test scores of experimental group on sustainable lifestyles and eco-conscious practices.

Objective 2: To compare the effect of a structured activity-led instructional program on the Pre-test and Post-Test scores of experimental group on personal energy usage patterns and their broader environmental footprints.

Objective 3: To compare between the Post-test scores of the Experimental Group and Control Group on the dimension of resource conservation and energy efficiency.

RESEARCH HYPOTHESIS

H_1: There is a significant difference between the Pre-test and Post-test scores of sustainable lifestyles and eco-conscious practices of the Experimental Group.

H_2: There is a significant difference between the Pre-test and Post-test scores of personal energy usage patterns and their broader environmental footprints of the Experimental Group.

H_3: There is a significant difference between the Post-test scores of the Experimental Group and Control Group on the dimension of resource conservation and energy efficiency.

IV. METHODOLOGY

Research Method

The study adopts a quantitative research approach, for exploring the insights of environmental responsibility.

Research Design

The researcher employed a Quasi-Experimental Research, specifically the Pre-test Post-test Non-Equivalent Control Group design.

Variables of the Study

Independent Variable: Activity-Led Instructional Program, defined as a structured, participatory instructional intervention delivered via cooperative learning strategies.

Dependent Variable: Environmental Responsibility, which serves as the metric of the students' cognitive and affective growth across critical environmental dimensions.

Population of the study: Students of 11th class of CBSE Board of secondary schools of Uttar Pradesh as population of the study.

Target Population: Students of 11th class of CBSE Board in Lucknow City as target

population.

Sample Size: A total sample of 70 students was utilized for the study.

Sampling Technique: Purposive Sampling was employed for the research.

Group Distribution: The sample was divided into an Experimental Group (N=35) and a Control Group (N=35).

Tool for data collection

The primary tool for data collection was a self-developed Environmental Awareness Test. It was administered as a Pre-test to establish a statistical baseline and as a Post-test to evaluate the change following the intervention period.

Experimental Procedure and Intervention

The study was conducted over an intensive 45-day duration.

Phase I (Pre-test): Both groups were assessed to determine their initial environmental awareness scores.

Phase II (Treatment): The Experimental Group received the activity-led instructional program, utilizing mechanics such as the Jigsaw II strategy and Problem-Based Learning (PBL). The Control Group was exposed exclusively to the traditional academic curriculum.

Phase III (Post-test): After the intervention, both groups were reassessed to measure cognitive and behavioral shifts.

V. ANALYSIS AND DISCUSSION

Statistical analysis was performed using SPSS at a 0.05 level of significance. Due to the non-parametric nature of the data, the following tests were utilized.

- **Wilcoxon Signed Ranks Test:** To analyze the significance of internal growth within each group (Pre-test vs. Post-test).
- **Mann-Whitney U Test:** To determine the comparative superiority of the instructional intervention by analysing the difference in post-test scores between the independent groups.

Analysis 1:

Objective 1: To compare the effect of a structured activity-led instructional program on the Pre-test and Post-Test scores of experimental group on sustainable lifestyles and eco-conscious practices.

H_{01}: There is no significant difference between the Pre-test and Post-test scores of sustainable lifestyles and eco-conscious practices of the Experimental Group.

Table 1. (A): Wilcoxon Signed Ranks Test for Experimental Group (Sustainable Lifestyles and Eco-Conscious Practices).

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	0	0.00	0.00
Positive Ranks	34	7.50	595.00
Ties	1		
Total	35		

Table 1. (B): Test Statistics for Sustainable Lifestyles and Eco-Conscious Practices (Experimental Group)

Test Statistic	Value
Z-value	-5.487
Asymp. Sig. (2-tailed)	0.001

Tables 1. (A) and 1. (B) present the comparison between the pre-test and post-test scores of the experimental group on the dimension of sustainable lifestyles and eco-conscious practices. The Wilcoxon Signed Ranks Test was applied to determine whether a significant difference existed between the two sets of scores. The results indicate that 34 students obtained higher scores in the post-test, while no student showed a decline in performance. One case remained unchanged. The calculated Z value is -5.487 and the p-value is .001, which is lower than the 0.05 level of significance. Therefore, the difference is statistically significant, proving that the instructional program significantly improved students' understanding of sustainable practices. Consequently, the null hypothesis is not accepted.

Analysis for Objective 2:

Objective 2: To compare the effect of a structured activity-led instructional program on the Pre-test and Post-Test scores of experimental group on personal energy usage patterns and their broader environmental footprints.

H_{02}: There is no significant difference between the Pre-test and Post-test scores of personal energy usage patterns and their broader environmental footprints of the Experimental Group.

Table 2.1 (A): Wilcoxon Signed Ranks Test for Experimental Group (Energy Usage Patterns and their broader environmental footprints)

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	0	0.00	0.00
Positive Ranks	35	8.00	630.00

Ties			
Total	35		

Table 2.2 (B): Test Statistics for Energy Usage Patterns and their broader environmental footprints (Experimental Group)

Test Statistic	Value
Z-value	-5.593
Asymp. Sig. (2-tailed)	0.001

Tables 2.1(A) and 2.2(B) detail the comparison of pre-test and post-test scores for the experimental group regarding energy footprints and their broader environmental footprints. The data indicates that all 35 students achieved positive ranks, representing a 01% rate of internal improvement without negative ranks or ties. The obtained Z value is -5.593 and the p-value is .001, which is less than the 0.05 significance level. It is concluded that the instructional program significantly enhanced students' understanding of energy footprints and their environmental impacts. This mastery demonstrates that structured modules can effectively dismantle the complexity of abstract technical concepts. Thus, the null hypothesis is not accepted.

Analysis for Objective 3

Objective 3: To compare between the Post-test scores of the Experimental Group and Control Group on the dimension of resource conservation and energy efficiency.

H_{03}: There is no significant difference between the Post-test scores of the Experimental Group and Control Group on the dimension of resource conservation and energy efficiency.

Table 3.1. Ranks for Post-test Scores of Control and Experimental Groups (N=70)

Group	N	Mean Rank	Sum of Ranks
Control Group	35	23.50	822.50
Experimental Group	35	47.50	1662.50
Total	**70**		

Table 3.2. Mann-Whitney U Test Statistics for Post-test Scores on Resource Conservation and Energy Efficiency

Test Statistic	Value
Mann-Whitney U	92.500
Wilcoxon W	822.500
Z-value	-5.545
Asymp. Sig. (2-tailed)	.000

Table 3.3. Summary of Mann-Whitney U Test Results for Resource Conservation and Energy Efficiency

Dimension	Group	N	Mean Rank	U	Z	p
Resource Conservation & Energy Efficiency	**Control**	35	23.50	92.500	-5.545	<.001
	Experimental	35	47.50			

Table 3.1 displays the rank distribution for the post-test scores of 70 students across two independent cohorts. The Experimental Group (N=35) achieved a Mean Rank of 47.50, which is substantially higher than the Mean Rank of 23.50 recorded for the Control Group (N=35). This descriptive gap in mean ranks suggests that the students who underwent the activity-led instructional program demonstrated a higher level of mastery in resource conservation and energy efficiency than those taught via traditional pedagogy. The Mann-Whitney U test was utilized to determine if the observed difference between the groups was statistically significant. As per the test statistics in Table 3.2, the calculated Mann-Whitney U value is 92.500 with a Z-value of -5.545. The associated Asymptotic Significance (p-value) is .001. The significance is tested at the 0.05 level. Since the obtained *p*-value (.001) is less than the alpha level of 0.05, the result is statistically significant. Table 3.3 provides a comprehensive summary of the comparative analysis between the specialized instructional program and traditional methods. The statistical divergence (U = 92.500, Z = -5.545, p < .001) necessitates the non-acceptance of the null hypothesis (H_{03}), which stated there would be no significant difference between the groups.

VI. OVERALL DISCUSSION

The overall discussion of this research is grounded in a critical interpretation of the data obtained through the comparative analysis of post-test scores across the experimental and control cohorts. It serves as the analytical heart of the dissertation by transforming raw scores into

meaningful scientific findings that prove the efficacy of the instructional intervention. While internal growth was observed in both groups over the academic term, this comparative analysis serves as the definitive analytical crucible by isolating the true impact of the activity-led variable. By directly contrasting the final performance of 70 eleventh-grade students (35 per group), the study provided empirical evidence that the specialized instructional program was superior to standard pedagogy in fostering environmental responsibility. In the dimension of Sustainable Practices, the experimental group achieved a significantly higher mean rank compared to the control group, yielding a p-value of .001. This statistical divergence highlights that traditional "chalk-and-talk" methods are often insufficient for teaching complex sustainability frameworks, which demand active and targeted learning environments to bridge the gap between theoretical knowledge and practical application.

The superiority of the activity-led approach was further evidenced in the dimension of Energy Usage Patterns, where the experimental group demonstrated a statistically significant advantage. The analysis revealed that students who underwent the specialized modules were better able to internalize technical concepts, such as energy footprints, which are often perceived as abstract or distant by adolescent learners. By utilizing participatory strategies and real-life examples, the experimental program successfully demystified these concepts, whereas standard textbooks in the control group failed to connect global energy depletion to personal daily habits. The statistically significant difference between the two groups clearly indicates that traditional teaching methods are less effective in promoting sustainability-oriented thinking and energy conservation awareness.

The final evaluation of Overall Environmental Responsibility demonstrated a massive victory for the specialized program, with the experimental group achieving a considerably higher mean rank compared to the control group. This holistic improvement proves that the instructional program did not merely impart isolated facts but successfully developed a comprehensive, interconnected environmental mind-set. In conclusion, while standard schooling imparts basic vocabulary and theoretical awareness, it often fails to alter deep-rooted habits or foster an active conservation consciousness. The consistent improvement observed in the experimental group across the major dimensions underscores the necessity of integrating specialized green pedagogies into the modern educational framework to equip students with the skills and attitudes necessary to address future environmental challenges.

VII. FINDING

The findings of this study provide empirical evidence that a structured, activity-led instructional program is significantly more effective than traditional pedagogical methods in fostering environmental responsibility among secondary students. Through a quasi-experimental analysis of 70 eleventh-grade students, the research revealed that the experimental group achieved a highly significant improvement across all assessed environmental dimensions, including sustainable practices and energy usage patterns. Notably, the dimension of energy footprints saw a near-universal internal growth rate within the experimental cohort, suggesting that participatory strategies like Problem-Based Learning (PBL) successfully demystify complex technical concepts that standard textbooks often fail to address. Comparative data using the Mann-Whitney U test confirmed the superior impact of the intervention, as the experimental group secured substantially higher mean ranks in sustainable practices ($Z = -5.545$, $p < .001$) and energy management compared to the control group. While traditional "Chalk-And-Talk" schooling was found to establish a basic theoretical vocabulary, it reached a "Theoretical Ceiling" that failed to bridge the persistent "Knowledge-Action Gap" or alter deep-rooted habits. Ultimately, the study concludes that transforming learners from passive observers into active participants through specialized green pedagogy is essential for developing a comprehensive, interconnected ecological mind-set and preparing a "Climate-Ready" generation.

VIII. CONCLUSION

The conclusion of this study provides a definitive synthesis of the research findings, confirming the transformative power of activity-led instructional programs in fostering environmental stewardship. Based on the rigorous statistical analysis of the experimental group, it is concluded that a structured, activity-based intervention is significantly more effective than traditional lecture-based methods in enhancing ecological literacy and bridging the persistent "Knowledge-Action Gap". While traditional schooling establishes a basic theoretical vocabulary, the specialized modules utilized in this research allowed students to master abstract and technical dimensions, such as energy usage patterns and sustainable practices, which are often lost in conventional pedagogical setups. The near-universal improvement observed among the participants suggests that when learners are transformed from passive observers into active participants through cooperative learning and problem-solving, they develop a deeper, internalized connection to environmental issues. Furthermore, the study

establishes that the instructional intervention successfully cultivated a comprehensive and interconnected environmental mind-set, effectively sensitizing students to the long-term consequences of human activities. By rejecting the null hypotheses across the major dimensions of sustainable responsibility, the research provides undeniable empirical evidence that moving beyond the "Theoretical Ceiling" of standard pedagogy is essential for preparing a "Climate-Ready" generation. Ultimately, these findings underscore the urgent need for curricular reform that prioritizes experiential and learner-centred strategies, as advocated by national educational frameworks. In summary, this research validates that specialized green pedagogy is not merely a beneficial supplement but a necessary requirement to equip modern students with the robust, measurable knowledge needed to protect the planet's future.

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