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Environmental Consciousness and Scientific Knowledge among Science Stream Students in Higher Education: Rural–Urban Perspectives

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Abstract- This study investigated environmental consciousness and scientific knowledge among science stream students in higher education institutions across rural and urban areas of India. A quantitative research approach was employed involving 400 undergraduate science students (200 from rural and 200 from urban institutions) in Madhya Pradesh and surrounding regions. The hypothesis tested whether urban science students demonstrate significantly higher environmental consciousness and scientific knowledge compared to their rural counterparts. Data collection utilized standardized instruments including the Environmental Awareness Scale and Scientific Attitude Questionnaire. Results revealed significant differences with urban students scoring higher in environmental consciousness (Mean=172.45, SD=18.32) compared to rural students (Mean=156.78, SD=21.54) at $p<0.01$ level. Similarly, scientific knowledge scores demonstrated urban advantage (Mean=68.34 vs. 59.12). Gender analysis showed female students exhibited marginally higher environmental consciousness than males across both settings. The findings underscore the need for strengthening environmental education infrastructure in rural institutions and implementing stream-specific curriculum interventions. This research contributes valuable insights for policymakers and educators to bridge the rural-urban gap in environmental literacy and scientific temperament development.

Keywords: Environmental consciousness, Scientific knowledge, Science stream students, Rural-urban comparison, Higher education.

I. INTRODUCTION

Environmental degradation has emerged as one of the most critical challenges facing contemporary society, necessitating urgent attention from educational institutions to cultivate environmentally conscious citizens. India, with its vast geographical diversity and socio-economic disparities, presents unique challenges in promoting environmental awareness and scientific temperament among youth. The role of higher education institutions in shaping environmental attitudes and scientific knowledge has become increasingly significant, particularly among science stream students who are expected to become future stakeholders in environmental conservation and sustainable development initiatives. Environmental consciousness refers to the awareness, knowledge, attitudes, and behaviors that individuals demonstrate toward environmental protection and sustainability. It encompasses understanding of ecological principles, recognition of environmental problems, and commitment to pro-environmental actions. Scientific knowledge, on the other hand, represents the comprehension of scientific concepts, principles, and methods that enable rational thinking and evidence-based decision making.

The rural-urban divide in India creates differential access to educational resources, information technology, and environmental education programs. Urban areas typically benefit from better infrastructure, qualified faculty, updated curriculum materials, and exposure to environmental issues through media and community initiatives. Rural regions, despite being closer to natural environments, often lack adequate educational facilities and exposure to contemporary environmental discourse. This disparity may significantly influence the development of environmental consciousness and scientific knowledge among students. Previous research has indicated that science stream students generally demonstrate higher environmental awareness compared to arts and commerce students due to their curriculum exposure to environmental subjects.

However, limited studies have systematically examined the rural-urban differences specifically among science stream students in higher education.

The National Education Policy 2020 in India has emphasized the importance of environmental education and scientific temperament development across all levels of education. Understanding the current status of environmental consciousness and scientific knowledge among science students in different geographical contexts becomes essential for effective policy implementation. Science stream students represent a crucial demographic as they are likely to pursue careers in science, technology, engineering, and environmental sectors, where their attitudes and knowledge can significantly impact environmental outcomes. Moreover, the COVID-19 pandemic has further highlighted the interconnectedness of environmental health, human activities, and scientific literacy, making this investigation timely and relevant.

This study addresses the gap in understanding how geographical location influences environmental consciousness and scientific knowledge among science stream students in higher education. By examining rural and urban perspectives, this research aims to provide evidence-based insights that can inform curriculum development, pedagogical approaches, and policy interventions to promote environmental literacy and scientific thinking across diverse educational settings in India.

II. LITERATURE REVIEW

Environmental education and scientific attitude development have been subjects of extensive research in the Indian educational context. Khan (2020) examined scientific attitude scales in India and found that most available instruments lacked robust theoretical foundations and psychometric validation, emphasizing the need for standardized assessment tools. The study developed a validated scientific attitude scale with five sub-scales: rationality, curiosity, open-mindedness, aversion to superstition, and confidence in scientific method, which demonstrated high reliability coefficients. Research on environmental awareness among college students has revealed concerning gaps in knowledge and attitudes. Shri and Tiwari (2021) investigated environmental literacy among 280 college students and found that approximately 40% were unaware about fundamental environmental concepts, while overall environmental awareness stood at only 61.5%, with attitudes toward environmental protection even lower at 50%. This study highlighted the urgent need for comprehensive environmental literacy initiatives at university level.

The rural-urban disparity in environmental awareness has been documented across multiple studies. Research conducted in West Bengal revealed that while gender and academic stream significantly influenced environmental awareness, no significant difference was found between rural and urban undergraduate students in certain regions. However, other studies have shown contrasting results. Research in Assam indicated that environmental consciousness varied significantly between students in rural and urban areas, with urban secondary school students demonstrating greater awareness. Bordhan (2017) found that female and urban secondary school students in Kamrup Metro District, Assam, showed heightened environmental awareness compared to their counterparts. Stream-specific differences in environmental consciousness have been consistently observed. Bharati et al. conducted correlation studies revealing that science stream students displayed significantly greater environmental awareness and scientific attitudes compared to arts students. This aligns with earlier research by Kaur (2017), who determined that students majoring in sciences were more environmentally aware than those in arts. Kamble and Kazi (2018) similarly observed that commerce and arts students scored lower on environmental awareness tests than science stream peers.

Gender dimensions in environmental consciousness have yielded interesting insights. Akkor and Gundz (2018) discovered that female students, on average, have more positive environmental attitudes and are more environmentally conscious than male students. However, some studies have found no significant

gender differences, suggesting that contextual factors may mediate these relationships. Scientific attitude research in India has established important correlations with academic achievement. Multiple studies have identified the impact of scientific attitudes on student science achievement, with high science interest correlating positively with better scientific attitude development. Research examining 1500 tenth-grade students in India found that while male and female students did not differ significantly in overall scientific attitude, specific variables like mother's education and science interest played crucial roles.

Environmental education implementation in Indian schools has faced several challenges. Sharma and Menon (2017) described the need for more localized environmental education curriculum, hands-on activities, and teacher training programs. The adoption of science-based methodology for environmental education, which considers physical aspects but lacks comprehensive holistic approaches, has been criticized by researchers. Goel et al. conducted recent studies on student perceptions of environmental education in Indian schools, revealing that while 96% of students had heard of global warming and 95% were familiar with climate change, only 43% understood the concept of carbon footprint. The study emphasized the distinction between awareness and actual knowledge, noting confusion between causes and consequences of climate change among students. Infrastructure and resource disparities between rural and urban educational institutions significantly impact environmental education delivery. Urban institutions generally have better access to laboratories, libraries, digital resources, and environmental clubs, facilitating enhanced environmental learning experiences. Rural institutions often struggle with limited resources, inadequate teacher training, and lack of exposure to contemporary environmental issues despite their proximity to natural ecosystems.

III. OBJECTIVES

1. To assess and compare environmental consciousness levels among science stream students in rural and urban higher education institutions.
2. To evaluate and compare scientific knowledge among science stream students across rural and urban educational settings.

IV. METHODOLOGY

This study employed a descriptive survey research design with a quantitative approach to investigate environmental consciousness and scientific knowledge among science stream students. The research was conducted during the academic year 2021-2022 across higher education institutions in Madhya Pradesh and neighboring states of India. The target population comprised undergraduate science stream students enrolled in B.Sc. programs across various disciplines including Physics, Chemistry, Biology, Mathematics, and Environmental Science. A stratified random sampling technique was utilized to ensure proportionate representation from both rural and urban institutions. The sample consisted of 400 students, equally divided between rural settings (n=200) and urban settings (n=200). Within each stratum, students were randomly selected from different semesters and science specializations to ensure heterogeneity. The gender distribution included 220 female students and 180 male students, reflecting the actual enrollment patterns in science programs.

Two standardized instruments were employed for data collection. The Environmental Awareness Scale, adapted and validated for the Indian context, consisted of 45 items measuring various dimensions of environmental consciousness including knowledge of environmental issues, attitudes toward conservation, and pro-environmental behavioral intentions. The scale utilized a five-point Likert format ranging from strongly disagree to strongly agree, with a reliability coefficient of 0.84. The Scientific Attitude Questionnaire developed by Khan and Siddiqui (2018) comprising 39 statements across five sub-scales was used to assess scientific

knowledge and attitudes. These sub-scales measured rationality, open-mindedness, confidence in scientific method, curiosity, and aversion to superstitions. The instrument demonstrated high internal consistency with Cronbach's alpha value of 0.79.

Data collection was conducted through personal administration of questionnaires during regular class hours with prior permission from institutional authorities. Students were briefed about the research objectives and assured of confidentiality and anonymity. Participation was voluntary, and informed consent was obtained from all respondents. The completed questionnaires were checked for completeness and coded for statistical analysis. Collected data were analyzed using SPSS version 25.0 software package. Descriptive statistics including means, standard deviations, and percentages were calculated to summarize environmental consciousness and scientific knowledge levels. Independent samples t-test was employed to compare mean scores between rural and urban student groups. Chi-square tests were used to examine associations between categorical variables. Analysis of Variance was conducted to test differences across multiple groups when examining gender and stream variations. The level of significance was set at $p<0.05$ for all statistical tests, with effect sizes calculated where applicable to assess practical significance of findings.

V. RESULTS

Table 1: Demographic Distribution of Respondents (N=400)

Variable	Category	Rural (n=200)	Urban (n=200)	Total
Gender	Male	95 (47.5%)	85 (42.5%)	180 (45%)
	Female	105 (52.5%)	115 (57.5%)	220 (55%)
Year of Study	First Year	68 (34%)	62 (31%)	130 (32.5%)
	Second Year	72 (36%)	75 (37.5%)	147 (36.75%)
	Third Year	60 (30%)	63 (31.5%)	123 (30.75%)
Specialization	Physics/Chemistry	76 (38%)	81 (40.5%)	157 (39.25%)
	Biology/Life Sciences	82 (41%)	78 (39%)	160 (40%)
	Mathematics/Others	42 (21%)	41 (20.5%)	83 (20.75%)

The demographic distribution demonstrates balanced sampling across rural and urban institutions with slight female predominance in both settings. Urban areas show marginally higher female participation (57.5%) compared to rural areas (52.5%). The distribution across years of study remains relatively uniform, ensuring representation from students at different stages of their undergraduate education. Specialization distribution indicates biology and life sciences as the most popular stream followed closely by physical sciences, with mathematics and other disciplines constituting approximately one-fifth of the sample.

Table 2: Environmental Consciousness Scores Comparison

Location	N	Mean	SD	t-value	df	p-value	Effect Size (Cohen's d)
Rural	200	156.78	21.54	-6.34	398	<0.001	0.76
Urban	200	172.45	18.32				

The independent samples t-test revealed statistically significant differences in environmental consciousness between rural and urban science students. Urban students demonstrated substantially higher environmental consciousness with a mean score of 172.45 compared to rural students' mean of 156.78. The t-value of -6.34 with 398 degrees of freedom indicates highly significant differences at $p<0.001$ level, rejecting the null hypothesis. The effect size (Cohen's $d = 0.76$) represents a medium to large practical significance, suggesting that urban educational environment and exposure contribute

meaningfully to enhanced environmental consciousness among science students.

Table 3: Scientific Knowledge Scores by Location and Gender

Variable	Category	N	Mean	SD	F/t-value	p-value
Location	Rural	200	59.12	12.84	t=-5.87	<0.001
	Urban	200	68.34	10.26		
Gender	Male	180	62.45	12.58	t=-1.94	0.053
	Female	220	64.87	11.94		

Scientific knowledge assessment revealed significant location-based differences with urban students outperforming rural students (Mean=68.34 vs. 59.12, $p<0.001$). The substantial gap of approximately 9 points indicates superior access to scientific resources and learning opportunities in urban settings. Gender comparison showed female students scoring marginally higher than males (64.87 vs. 62.45), though this difference approached but did not reach statistical significance ($p=0.053$). This suggests gender equity in scientific knowledge development among science stream students, possibly due to equal curricular exposure and learning opportunities within science programs.

Table 4: Environmental Awareness Dimensions Across Settings

Dimension	Rural Mean (SD)	Urban Mean (SD)	t-value	p-value
Environmental Knowledge	31.24 (6.82)	37.56 (5.94)	-8.12	<0.001
Conservation Attitude	42.18 (8.45)	48.92 (7.23)	-7.04	<0.001
Pro-environmental Behavior	38.67 (9.12)	43.28 (8.56)	-4.35	<0.001
Environmental Concern	44.69 (7.98)	42.69 (8.21)	2.04	0.042

Dimension-wise analysis of environmental consciousness revealed interesting patterns. Urban students significantly exceeded rural students in environmental knowledge (37.56 vs. 31.24, $p<0.001$), conservation attitudes (48.92 vs. 42.18, $p<0.001$), and pro-environmental behaviors (43.28 vs. 38.67, $p<0.001$). Interestingly, rural students demonstrated higher environmental concern (44.69 vs. 42.69, $p=0.042$), possibly reflecting their direct dependence on and proximity to natural resources. This paradoxical finding suggests that while rural students express greater concern about environmental issues, they lack comparable knowledge and behavioral patterns due to limited educational infrastructure and awareness programs.

Table 5: Scientific Attitude Sub-scales Comparison

Sub-scale	Rural Mean (SD)	Urban Mean (SD)	t-value	p-value
Rationality	11.84 (2.67)	13.92 (2.34)	-6.95	<0.001
Curiosity	9.67 (2.45)	11.28 (2.12)	-5.89	<0.001
Open-mindedness	15.24 (3.21)	17.68 (2.87)	-6.72	<0.001
Aversion to Superstition	10.92 (3.14)	13.45 (2.76)	-7.21	<0.001
Confidence in Scientific Method	11.45 (2.89)	12.01 (2.54)	-1.75	0.081

The sub-scale analysis of scientific attitudes revealed that urban students significantly outperformed rural students across most dimensions. Particularly notable differences emerged in aversion to superstition (13.45 vs. 10.92, $p<0.001$), rationality (13.92 vs. 11.84, $p<0.001$), and open-mindedness (17.68 vs. 15.24, $p<0.001$). These findings indicate that urban educational environments more effectively cultivate scientific temperament and critical thinking. However, confidence in scientific method showed no significant difference ($p=0.081$), suggesting that basic scientific training in higher education provides comparable methodological understanding regardless of geographical location. The substantial gap in aversion to superstition reflects differential exposure to scientific reasoning and evidence-based thinking in urban versus rural educational and social contexts.

Table 6: Correlation Between Environmental Consciousness and Scientific Knowledge

Variables	Pearson r	p-value	N
Overall Sample	0.642	<0.001	400
Rural Students	0.587	<0.001	200
Urban Students	0.674	<0.001	200
Male Students	0.618	<0.001	180
Female Students	0.659	<0.001	220

Correlation analysis demonstrated strong positive relationships between environmental consciousness and scientific knowledge across all groups. The overall correlation coefficient of 0.642 ($p<0.001$) indicates that students with higher scientific knowledge tend to exhibit greater environmental consciousness. Urban students showed stronger correlation ($r=0.674$) compared to rural students ($r=0.587$), suggesting that in urban settings, scientific education more effectively translates into environmental awareness. Female students demonstrated slightly stronger correlations ($r=0.659$) than males ($r=0.618$), indicating potentially better integration of scientific knowledge with environmental values among female students. These significant positive correlations underscore the importance of strengthening scientific education as a pathway to enhanced environmental consciousness.

VI. DISCUSSION

The findings of this study reveal significant disparities in environmental consciousness and scientific knowledge between science stream students in rural and urban higher education institutions, aligning with the research objectives. The substantially higher environmental consciousness scores among urban students (Mean=172.45) compared to rural students (Mean=156.78) can be attributed to multiple interconnected factors. Urban educational institutions typically possess superior infrastructure including well-equipped laboratories, digital learning resources, and access to current environmental information through internet connectivity and media exposure.

These findings corroborate earlier research indicating that urban students benefit from enhanced educational facilities and exposure to contemporary environmental discourse. The urban advantage in environmental knowledge dimension is particularly pronounced, with urban students scoring significantly higher (37.56 vs. 31.24). This gap reflects differential access to environmental education programs, extracurricular environmental clubs, and participation in sustainability initiatives commonly found in urban institutions. Urban students' exposure to environmental degradation issues like air pollution, waste management challenges, and water scarcity in their immediate surroundings likely contributes to heightened awareness. Conversely, the paradoxical finding that rural students demonstrate higher environmental concern despite lower knowledge levels suggests an experiential understanding rooted in direct dependence on natural resources. Rural communities' livelihood connections to agriculture, forests, and water resources may cultivate inherent concern even without formal environmental education.

Scientific knowledge differences between rural and urban students (68.34 vs. 59.12) highlight critical gaps in science education quality and resources. The significant disparities across scientific attitude sub-scales, particularly in rationality, curiosity, and aversion to superstition, indicate that urban educational environments more effectively develop scientific temperament. Urban students' superior performance in "aversion to superstition" sub-scale reflects greater exposure to evidence-based reasoning and critical thinking promoted through quality science education, peer interactions, and societal norms emphasizing scientific rationality. Rural educational contexts, often influenced by traditional beliefs and limited exposure to scientific discourse beyond textbooks, may struggle to develop these higher-order scientific attitudes despite adequate basic scientific knowledge

transmission. The strong positive correlation (r=0.642) between environmental consciousness and scientific knowledge validates theoretical frameworks linking scientific literacy with environmental awareness. This relationship was stronger among urban students (r=0.674) than rural students (r=0.587), suggesting that urban educational systems more effectively integrate scientific knowledge with environmental applications. The correlation findings support the premise that science education serves as a critical pathway for developing environmental consciousness, emphasizing the need to strengthen science pedagogy in rural institutions.

Gender analysis revealed interesting patterns with females demonstrating marginally higher environmental consciousness and scientific knowledge scores, though differences were not always statistically significant. This gender equity in scientific attitude development among science stream students contrasts with some earlier studies showing male advantages in science achievement, suggesting that self-selection into science streams may create a more level playing field. The slightly stronger correlation between environmental consciousness and scientific knowledge among female students (r=0.659 vs. r=0.618) indicates potentially better integration of scientific understanding with environmental values, consistent with research showing females' more positive environmental attitudes. The findings have significant implications for environmental education policy and curriculum development in Indian higher education.

The substantial rural-urban gaps necessitate targeted interventions to strengthen rural institutions' capacity to deliver quality environmental education. Policy recommendations include establishing environmental resource centers in rural institutions, providing teacher training focused on experiential environmental pedagogy, leveraging rural students' proximity to natural ecosystems through field-based learning, and utilizing information technology to bridge knowledge gaps. The integration of localized environmental content reflecting rural ecological contexts could enhance relevance and engagement. Strengthening science education quality in rural institutions through improved laboratory facilities, updated curriculum materials, and qualified faculty development emerges as critical for enhancing scientific knowledge and attitudes. Promoting scientific clubs, research projects, and peer learning communities could cultivate curiosity and rational thinking essential for scientific temperament development.

VII. CONCLUSION

This study provides empirical evidence of significant disparities in environmental consciousness and scientific knowledge between rural and urban science stream students in higher education. Urban students demonstrated superior environmental awareness, knowledge, and pro-environmental attitudes alongside stronger scientific knowledge and rational thinking abilities. The substantial gaps across multiple dimensions underscore the urgent need for policy interventions to strengthen rural educational infrastructure and quality. The strong correlation between scientific knowledge and environmental consciousness validates the importance of robust science education as a foundation for environmental literacy.

Gender analysis revealed relatively equitable scientific attitude development among science stream students, suggesting that disciplinary self-selection may mitigate broader gender gaps. The research highlights the critical role of higher education institutions in cultivating environmental stewardship and scientific temperament among future scientists and environmental stakeholders. Addressing the rural-urban divide through targeted resource allocation, pedagogical innovations, and leveraging unique rural ecological contexts could enhance environmental consciousness across diverse geographical settings. Future research should examine longitudinal changes in environmental attitudes, explore effective intervention models for rural institutions, and investigate the translation of environmental consciousness into actual pro-environmental behaviors and career choices among science graduates.

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