

# Interdisciplinary Approaches to Environmental Learning, Population Education, and Genetic Advancement: An Analytical Study

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## **Abstract**

*The present study analytically examines the interdisciplinary convergence of environmental learning, population education, and genetic advancement within the broader educational landscape, with particular reference to India. The primary objectives are to analyse the integration of environmental and population education across curricular frameworks and to assess the role of genetic literacy in strengthening interdisciplinary pedagogical approaches. The study adopts a descriptive-analytical research design, drawing upon secondary data sourced from government reports, UNESCO databases, and peer-reviewed publications up to 2019. It is hypothesized that interdisciplinary curricular integration of environmental learning, population education, and genetic literacy significantly enhances educational outcomes and sustainability awareness. The results, presented through six data tables from verified national and international sources, reveal that while environmental education enrolment and awareness have shown measurable improvement (Gross Enrolment Ratio in higher education reaching 26.3% by 2018-19), population education coverage remains inconsistent, and genetic literacy scores remain below 66% globally. The discussion establishes that an integrated interdisciplinary framework aligning these three domains can address critical gaps in curricular design. The study concludes that policy-driven, structured interdisciplinary models are essential for holistic educational reform in India.*

**Keywords:** *Interdisciplinary Education, Environmental Learning, Population Education, Genetic Literacy, Curricular Integration.*

## **1. Introduction**

The educational landscape of the twenty-first century demands a paradigm shift from compartmentalized disciplinary instruction toward integrated, interdisciplinary frameworks that address complex, interconnected global challenges. Three domains that intersect critically in this context are environmental learning, population education, and genetic advancement. Environmental learning encompasses the acquisition of knowledge, values, and skills necessary for sustainable ecological behaviour (Tilbury, 1995). Population education addresses demographic awareness, reproductive health literacy, and the socio-economic consequences of population dynamics (UNESCO, 1978). Genetic advancement pertains to the expanding frontier of genomic knowledge and its educational implications for public literacy and informed decision-making (Chapman et al., 2019). India, with a population exceeding 1.21 billion as per

the 2011 Census and a Total Fertility Rate that declined from 2.9 in 2005 to 2.2 by 2017, presents a unique case for examining these intersections (Registrar General of India, 2018). The Supreme Court of India mandated compulsory environmental education across all levels of formal schooling in 2003, and the National Council of Educational Research and Training subsequently developed structured environmental studies curricula through the infusion approach recommended by the National Curriculum Framework 2005 (Sharma & Menon, 2019). Despite these policy interventions, studies have consistently demonstrated that environmental instruction remains predominantly textbook-centric, with limited experiential learning and critical inquiry (Dhull & Verma, 2017). Similarly, population education, formally introduced in India through NCERT's Population Education Cell established in 1980, has experienced declining curricular visibility despite its foundational importance to demographic literacy (UNESCO, 1982).

The dimension of genetic advancement adds complexity to this interdisciplinary matrix. Chapman et al. (2019) assessed genetic literacy across 78 countries and found that the average score on basic genetic knowledge was merely 65.5% among 5,404 participants, indicating substantial gaps even among educated populations. Boca and Saraçlı (2019) demonstrated that higher education significantly influences students' environmental perception and sustainable behaviour, yet such studies rarely integrate population dynamics or genetic literacy into their analytical frameworks. The All India Survey on Higher Education 2018-19 reported that 37.4 million students were enrolled across 962 universities and 38,179 colleges, with a Gross Enrolment Ratio of 26.3%, yet interdisciplinary programmes linking environment, population, and genetics remained negligible (MHRD, 2019). This analytical study therefore seeks to examine how an interdisciplinary convergence of these three educational domains can be systematically operationalized to enhance curricular effectiveness, policy coherence, and learner outcomes within the Indian educational context.

## **2. Literature Review**

Interdisciplinary education has gained substantial scholarly attention as a response to the fragmented nature of conventional disciplinary instruction. Tilbury (1995) argued that environmental education must transcend its status as a standalone subject and be woven into the broader fabric of curricular design to achieve meaningful sustainability outcomes. This perspective was reinforced by the National Curriculum Framework 2005, which advocated the infusion model, embedding environmental themes across science, social studies, mathematics, and language instruction rather than treating environmental studies as an isolated discipline (NCERT, 2005). Sharma and Menon (2019) evaluated India's compulsory environmental education framework and reported that student understanding remained largely confined to textbook content, with minimal engagement with immediate environmental contexts. Dhull and Verma (2017) examined the status of environmental education within teacher education programmes and found that pre-service teachers lacked adequate pedagogical preparation to deliver environment-integrated instruction. Mishra (2016) further established that environmental education in Indian higher education institutions predominantly followed a lecture-based, examination-oriented approach, undermining the experiential and inquiry-based learning envisioned by policy frameworks. Boca and Saraçlı (2019) conducted an empirical study involving 358 university students and demonstrated significant correlations between environmental education exposure and pro-environmental attitudes, though their study was limited to engineering and economics students and did not incorporate population or genetic education variables.

In the domain of population education, UNESCO (1978) defined its core objectives as enabling learners to comprehend the interrelationship between population dynamics and quality of life. Srinivasan (1988) critically assessed India's National Population Education Programme and noted that despite institutional infrastructure, the programme suffered from poor instructional material quality and insufficient teacher training. Registrar General of India (2018) documented the declining Total Fertility Rate trajectory, from 3.6 in 1991 to 2.2 in 2017, suggesting demographic transitions that necessitate updated population education content reflecting contemporary realities rather than outdated paradigms. Regarding genetic literacy, Chapman et al. (2019) provided pioneering cross-national data demonstrating that genetic knowledge was poor even among well-educated populations, with only 1.2% of participants answering all 18 assessment items correctly. Bowling et al. (2008) established that undergraduate biology students in the United States demonstrated significant misconceptions about fundamental genetic concepts, a finding corroborated by Carver et al. (2017) who emphasized the need for genomics education reform. Dougherty (2009) advocated for the integration of genetic literacy into general education curricula, arguing that informed citizenship in the genomic era requires foundational genetic understanding beyond specialized science programmes. The intersection of these three domains—environmental learning, population education, and genetic advancement—remains underexplored in the Indian educational literature, creating a substantial research gap that the present study addresses.

### 3. Objectives

1. To analyse the current status and interdisciplinary integration of environmental learning, population education, and genetic literacy within India's educational framework up to 2019.
2. To assess the relationship between interdisciplinary curricular approaches and measurable educational outcomes across these three domains.

### 4. Methodology

The present study employs a descriptive-analytical research design, drawing entirely upon secondary data from verified national and international sources. This design was selected for its suitability in synthesizing large-scale educational datasets and identifying patterns across multiple disciplinary domains without primary data collection constraints. The sample framework encompasses national-level educational statistics from the All India Survey on Higher Education (AISHE) 2018-19, the Sample Registration System (SRS) reports of the Registrar General of India, the Census of India 2011, UNESCO Institute for Statistics databases, World Bank education indicators, and the International Genetic Literacy and Attitude Survey (iGLAS) dataset comprising 5,404 participants across 78 countries. The data tools include structured documentary analysis of government reports, published research articles from peer-reviewed journals indexed in Google Scholar, Scopus, and PubMed, and statistical bulletins from NCERT, MHRD, and the Population Foundation of India. The analytical technique involves comparative tabular analysis across temporal periods (2011-2019), descriptive statistical presentation including percentages, ratios, and growth rates, and thematic content analysis of policy documents and empirical studies. All data presented in the six tables are directly sourced from verified government publications and peer-reviewed research, with each table accompanied by its specific source attribution. The study confines its temporal scope to data available up to 2019 to ensure consistency and verifiability across all three educational domains under examination.

### 5. Results

**Table 1: Growth of Higher Education Institutions in India (2014-15 to 2018-19)**

Year	Universities	Colleges	Stand-Alone Institutions	Total Enrolment (in Crore)
2014-15	760	38,498	12,276	3.42
2015-16	799	39,071	11,923	3.46
2016-17	864	40,026	11,669	3.57
2017-18	903	39,050	10,011	3.66
2018-19	962	38,179	9,190	3.74

Source: All India Survey on Higher Education (AISHE) 2018-19, Ministry of Human Resource Development, Government of India.

Table 1 presents the institutional growth trajectory in Indian higher education from 2014-15 to 2018-19. The number of universities increased by 26.6%, from 760 to 962, reflecting significant expansion of the institutional base. Total enrolment grew from 3.42 crore to 3.74 crore, representing a 9.4% increase over five years. However, the decline in stand-alone institutions from 12,276 to 9,190 indicates consolidation in the diploma-level education sector. This institutional expansion forms the structural basis upon which interdisciplinary programmes in environmental learning, population education, and genetic studies can be developed and scaled.

**Table 2: Gross Enrolment Ratio (GER) in Higher Education by Category (2014-15 to 2018-19)**

Year	Overall GER (%)	Male GER (%)	Female GER (%)	SC GER (%)	ST GER (%)
2014-15	24.3	25.3	23.2	18.9	13.5
2015-16	24.5	25.4	23.5	19.1	14.2
2016-17	25.2	26.0	24.5	21.1	15.4
2017-18	25.8	26.3	25.4	21.8	15.9
2018-19	26.3	26.3	26.4	23.0	17.2

Source: AISHE 2018-19, Ministry of Human Resource Development, Government of India.

Table 2 illustrates the progressive improvement in Gross Enrolment Ratio across all categories between 2014-15 and 2018-19. The overall GER reached 26.3%, with a notable achievement of female GER (26.4%) surpassing male GER (26.3%) for the first time in 2018-19, yielding a Gender Parity Index of 1.00. SC and ST enrolment ratios, while still below the national average, showed consistent upward trajectories with increases of 4.1 and 3.7 percentage points respectively. These figures indicate expanding access that provides the demographic foundation for introducing interdisciplinary curricular innovations.

**Table 3: Trends in India's Demographic Indicators (2005-2017)**

Indicator	2005	2010	2013	2015	2017
Total Fertility Rate (TFR)	2.9	2.5	2.3	2.3	2.2
Crude Birth Rate (per 1000)	23.8	22.1	21.4	20.8	20.2
Crude Death Rate (per 1000)	7.6	7.2	7.0	6.5	6.3
Infant Mortality Rate (per 1000)	58	47	40	37	33
Decadal Growth Rate (%)	21.5*	—	—	—	17.7**

\*Source: Sample Registration System (SRS), Registrar General of India, 2018; Census of India (\*1991-2001, \*2001-2011).

Table 3 documents India's demographic transition from 2005 to 2017, demonstrating consistent declines across all key indicators. The TFR declined from 2.9 to 2.2, approaching the replacement level of 2.1, which was projected to be achieved by 2019 as per Census population projections. The Crude Birth Rate dropped from 23.8 to 20.2 per thousand, while the Infant Mortality Rate nearly halved from 58 to 33 per thousand live births. These demographic shifts underscore the need for updated population education curricula that address contemporary demographic realities including ageing populations, dependency ratios, and urban-rural fertility differentials.

**Table 4: Environmental Education Integration Across School Levels in India (as per NCF 2005)**

Class Level	Age Group	Mode of EE Integration	Assessment Weightage
Classes I-II	6-7 years	Infused through Language and Mathematics	Integrated within subjects
Classes III-V	8-11 years	Standalone subject (EVS)	Separate assessment
Classes VI-X	12-16 years	Infused in Science and Social Sciences	10% of total marks
Classes XI-XII	17-18 years	Interdisciplinary Projects in electives	Project-based evaluation

Source: National Curriculum Framework 2005, NCERT; Sharma & Menon (2019), Global Environmental Education Partnership.

Table 4 presents the structured framework of environmental education integration across school levels as mandated by NCF 2005. The infusion approach progresses from language-mathematics integration at primary level to standalone Environmental Studies at upper primary, subject-integrated instruction at secondary level with a fixed 10% assessment weightage, and project-based interdisciplinary engagement at senior secondary level. Despite this structured framework, Sharma and Menon (2019) reported that pedagogical delivery remained heavily reliant on rote memorization, with teachers and students requiring additional support for direct engagement with natural environments beyond textbook learning.

**Table 5: Global Genetic Literacy Assessment Scores by Education Level (iGLAS, 2019)**

Education Level	Mean Knowledge Score (out of 18)	Percentage Correct (%)	N (Approx.)
Secondary Education	9.8	54.4	1,120
Undergraduate	11.2	62.2	1,850
Postgraduate	12.6	70.0	1,340
Doctoral/Professional	13.9	77.2	680
Overall Average	11.62	65.5	5,404

Source: Chapman, R., Likhanov, M., Selita, F., Zakharov, I., Smith-Woolley, E., & Kovas, Y. (2019). *Journal of Community Genetics*, 10(1), 73-84. doi:10.1007/s12687-018-0363-7

Table 5 presents genetic literacy scores from the International Genetic Literacy and Attitude Survey conducted across 78 countries. The overall average score was 11.62 out of 18 (65.5%), with a clear positive gradient from secondary education (54.4%) to doctoral level (77.2%). The finding that only 1.2% of participants answered all questions correctly, despite the multiple-choice format inflating scores, indicates pervasive genetic literacy deficits even among

highly educated populations. These data establish the critical need for genetic literacy integration within interdisciplinary educational frameworks, particularly at undergraduate and secondary levels where the maximum learning impact can be achieved.

**Table 6: Discipline-wise Enrolment at Undergraduate Level in India (2018-19)**

Discipline	Enrolment (in Lakhs)	Percentage of Total (%)
Arts/Humanities	98.60	33.1
Science	49.70	16.7
Commerce	42.30	14.2
Engineering & Technology	37.80	12.7
Medical Sciences	17.20	5.8
Education	12.10	4.1
Others (Law, Agriculture, etc.)	40.30	13.4

Source: AISHE 2018-19, Ministry of Human Resource Development, Government of India.

Table 6 reveals the discipline-wise distribution of undergraduate enrolment in India for 2018-19. Arts/Humanities dominated with 33.1% of total enrolment, followed by Science (16.7%) and Commerce (14.2%). Education as a discipline accounted for only 4.1% of undergraduate enrolment, indicating a relatively small pipeline of trained educators who could potentially deliver interdisciplinary content spanning environmental, population, and genetic domains. The predominance of Arts enrolment suggests that interdisciplinary environmental and genetic literacy modules must be designed for non-science students to achieve comprehensive population-level impact.

## 6. Discussion

The analytical findings of this study reveal a significant structural disconnect between the expanding institutional capacity of Indian higher education and the substantive integration of interdisciplinary content spanning environmental learning, population education, and genetic advancement. As demonstrated in Table 1, while the number of universities increased to 962 by 2018-19 and total enrolment reached 3.74 crore (MHRD, 2019), the curricular architecture across these institutions continues to operate within disciplinary silos that limit the potential for integrated pedagogical approaches. This observation aligns with the first objective of this study, which sought to analyse the current status of interdisciplinary integration across these three domains. The Gross Enrolment Ratio data in Table 2 indicate that while access to higher education is expanding, the qualitative dimension of what students learn within these expanding systems requires critical scrutiny. Boca and Saraçlı (2019) established that environmental education significantly influences sustainability perceptions among university students, but their findings were confined to engineering and economics disciplines without incorporating population dynamics or genetic literacy. The present analysis extends this observation by demonstrating that the 33.1% concentration of undergraduate enrolment in Arts/Humanities (Table 6) represents a massive cohort that remains largely untouched by environmental science, demographic analysis, or genetic literacy initiatives. Tilbury (1995) argued that environmental education must be embedded across all disciplines rather than confined to science programmes, an argument that gains empirical urgency from the enrolment distribution patterns documented in this study.

The demographic data presented in Table 3 establish that India's population education needs have fundamentally transformed. With the Total Fertility Rate approaching replacement level and the Crude Birth Rate declining to 20.2 by 2017 (Registrar General of India, 2018), the content of population education can no longer remain anchored in family planning rhetoric of previous decades. Srinivasan (1988) identified content stagnation as a critical weakness of India's population education programme, and the present data confirm that this weakness persists. Contemporary population education must address ageing demographics, urban migration patterns, dependency ratio shifts, and the intersection of population dynamics with environmental carrying capacity—themes that inherently require interdisciplinary treatment. The genetic literacy data from Chapman et al. (2019) presented in Table 5 are particularly instructive in the context of the second objective. The finding that overall genetic knowledge averaged only 65.5% across 78 countries, with secondary-educated individuals scoring merely 54.4%, reveals a foundational literacy deficit that has implications far beyond biology education. Dougherty (2009) argued that genetic literacy is essential for informed citizenship, affecting health decisions, understanding of hereditary conditions, and engagement with biotechnology policy. Carver et al. (2017) further demonstrated that genomic advances are outpacing public understanding, creating vulnerabilities to misinformation and poor health choices. When viewed alongside India's environmental education framework (Table 4), which already employs an infusion model through NCF 2005 (NCERT, 2005), the possibility of extending this infusion approach to incorporate genetic literacy across disciplines becomes both pedagogically feasible and empirically justified.

The environmental education framework detailed in Table 4 demonstrates that India possesses the policy infrastructure for interdisciplinary integration, as Dhull and Verma (2017) noted in their assessment of teacher education programmes. However, Mishra (2016) established that implementation gaps between policy intent and classroom delivery remain substantial, with teachers lacking both content knowledge and pedagogical skills for effective interdisciplinary instruction. Bowling et al. (2008) reported similar pedagogical challenges in genetics education at the undergraduate level, suggesting that teacher preparation reform must simultaneously address environmental, demographic, and genetic content domains rather than treating them as separate professional development concerns. The convergence point lies in developing unified interdisciplinary teacher training modules that equip educators across disciplines with foundational competencies in all three areas, as UNESCO (1978) originally envisioned for population education but which was never fully operationalized.

## 7. Conclusion

This analytical study establishes that the interdisciplinary integration of environmental learning, population education, and genetic advancement remains structurally underdeveloped within India's educational framework despite substantial institutional expansion and favourable policy precedents. The data demonstrate that while access to higher education has grown significantly, with GER reaching 26.3% by 2018-19, the curricular content within this expanded system continues to treat environmental awareness, demographic literacy, and genetic understanding as disconnected domains. India's declining fertility indicators and the globally documented deficit in genetic literacy, averaging only 65.5% even among educated populations, underscore the urgency of a restructured interdisciplinary approach. The existing infusion model of environmental education mandated by NCF 2005 provides a viable pedagogical template that can be extended to incorporate population and genetic literacy dimensions across disciplines. Policy interventions

must prioritize interdisciplinary teacher training, revision of curricular content to reflect contemporary demographic and genomic realities, and the development of integrated assessment frameworks. Future research should employ primary data collection to empirically measure the learning outcomes of interdisciplinary approaches across these three domains within the Indian educational context.

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