UGC Approved Indexed Peer Reviewed Journal

ISSN: 2320-6586 (Online)

IILM UNIVERSITY

Technologies for Sustainable Development Goals 2025 (TECH4SDG-2025)

School of Computer Science & Engineering

IILM University Greater Noida

Presents

1st National Conference

on

Technologies for Sustainable Development Goals 2025 (TECH4SDG-2025)

3rd March 2025

Technically Co-Sponsored by IEEE UP SECTION (INDIA)

Venue:

IILM University, Greater Noida

Plot No.18,16, Knowledge Park II, Greater Noida, Uttar Pradesh 201306

Procedings Published at

International Journal of Research in Modern Engineering and Emerging Technology

Vol. 13, Sp. Issue 1, April 2025

Doi: https://doi.org/10.63345/ijrmeet.org.v13.si1.1301

Editor-in-Chief

Dr. Mylavarapu Seetharama Prasad

www.ijrmeet.org

INDEX

S. No.	Particulars	Page No.
1	A Comparative Study On Load Balancing Algorithms And Its Types **Methily Johri & Aditri Ashish**	1–10
2	Optimizing Supply Chain Management with Ethereum 2.0: Innovations in Blockchain Technology **Ayush Gupta & Dr. Ambuj Kumar Agarwal**	11–17
3	Smart Surveillance: "A Real-Time Crowd Analysis System for Density and Anomaly Detection" **Komal Sharma, Dr. Pankaj Kumar Varshney, Aditi Aggarwal & Gaurav Kumar**	17–22
4	AI-Driven Network Optimization: Matching Policyholders to Cost-Effective Providers Using Business Intelligence **Ruchi Mangharamani & Prof. (Dr) Sangeet Vashishtha**	23–29
5	The Future of UX: Designing for Emerging Technologies (AI, AR, VR, Voice UI) **Ojas Gupta & Prof.(Dr.) Arpit Jain**	30–37
6	Enhancing Liquidity Stress Testing: Best Practices for Modern Banking Risks **Padmini Bulani & Dr Abhishek Jain**	38–45
7	AI-Powered Investment Strategies: Optimizing Risk and Returns in Modern Banking **Aditya Mehra & Dr. Shakeb Khan**	46–53
8	Scaling Customer Journey Optimization in a Multi-Tenant Distributed System **Sumit Kumar Agrawal & Prof. (Dr) MSR Prasad**	54–61
9	Object Detection Using Convolutional Neural Networks: Advances, Techniques, and Applications	62–69

S. No.	Particulars	Page No.
	Bharath Thandalam Rajasekaran, Saravanan Thirumazhisai Prabhagaran & Prof. (Dr) Punit Goel	
10	AI-Augmented Intrusion Detection Systems for High-Speed Optical Networks **Sattvik Sharma & Prof.(Dr) Avneesh Kumar**	70–77
11	Generative AI in Data Security: Opportunities and Challenges **Vybhavreddy Kammireddy Changalreddy, Piyush Bipinkumar Desai & Prof (Dr) Ajay Shriram Kushwaha**	78–86
12	Integrating Salesforce with Cloud-Based Data Warehousing for Unified Analytics **Nidhi Shashikumar & Dr S P Singh**	87–94
13	AI-Powered Cybersecurity: A Unified Approach to Protecting Enterprise, Cloud, and SaaS Applications **Varun Grover, Khushmeet Singh & Er. Siddharth**	95–103
14	Sales and Order Analysis Using Excel-Based Dashboard: A Case Study on Vrinda Store **Mohd Ammar Khan & Harun Faridi**	104–106
15	ChatMania: A Realtime Chat Application **Dr. Kirti Shukla & Anshika**	107–110
16	Digital Surveillance and Domestic Abuse: A Legal Vacuum in Indian Marital Relationships **Vishal Nehra & Dr. Rakesh Kumar**	110–116
17	The Role of Emotional Appeal in Online Advertisements Targeting Working Women in Delhi-NCR **Mona Mishra & Dr. Praveen Mittal**	116–120
18	AI-Driven Data Governance Strategies for Enhanced Cloud Security in Enterprises **Chandana Pandey & Dr Gauri Shanker Kushwaha**	121–123

S. No.	Particulars	Page No.
19	Evolution of Social Media Advertising and Consumer Behavior **Mr. Pramod Rana & Prof (Dr) Punit Goel**	124–129
20	Sustainability Accounting Practices in Indian Manufacturing Firms **Mrs. Sonal Jain & Dr. Ajit Singh**	129–134
21	Fundamental Rights vs. Reasonable Restrictions: A Study of Evolving Judicial Balances **Mrs. Anshika Agarwal & Dr. Vijay Kumar Singh**	134–139
22	सतत शिक्षा के लिए हिंदी साहित्य की भूमिका: सतत विकास लक्ष्य-4 (गुणवत्तापूर्ण शिक्षा) का सांस्कृतिक विश्लेषण **श्रीमती रेणु गुप्ता, डॉ. बृजलता शर्मा**	140–144
23	Mind–Gut Synergy in Chronic Lifestyle Conditions: Evaluating Psychotherapy-Driven Behavioral Change and Microbiota-Mediated Metabolic Repair **Krithika. V, Dr. Sarbesh Kumar Singh**	145–151
24	प्राचीन शिक्षा प्रणाली से आधुनिक AI आधारित शिक्षा की ओर संक्रमण **गौरव जोशी, डॉ सारिका गोयल**	152–159
25	पर्वतीय क्षेत्रों में शिक्षा के डिजिटलीकरण की चुनौतियाँ एवं संभावनाएँ **राकेश उनियाल, डॉ. मीनाक्षी हर्राव वर्मा**	160–168
26	Women Leadership and Democratic Participation in India: Challenges and Opportunities in Parliamentary Politics **Renu Yadav, Dr. P.P.S. Rana**	169–176
27	Evaluating GST Effects on Competitiveness and Industrial Development **Aman Goel, Dr. Pooja Yadav**	177–183
28	एस०आर० हरनोट के कथा साहित्य में लोक संस्कृति, पर्यावरण चेतना और सामाजिक परिवर्तन का अध्ययन **सीमा देवी, डॉ० अरविन्द्र कौर चुंबर**	184–189

S. No.	Particulars	Page No.
29	Balancing National Security and Human Rights in Modern India **Shalu Jain, Dr. Vijay Kumar**	190–197
30	Economic Performance Drivers and Fiscal Resilience in Indian Airports **Lalit Kumar Sharma, Dr. Pooja Yadav**	198–203
31	Educational Governance and AI Learning Outcomes in Government Elementary Schools **Dr. Shubhra Chaturvedi**	203–210
32	Artificial Intelligence and the Future of Teacher Roles in India Classroom **Neeru Verma**	211–220
33	Research Culture Among Undergraduate Students in Indian Universities **Dr. Dhanashri Rajshri Ravindra Jadhav**	221–229
34	डिजिटल समाज में बहुभाषिक संचार का बदलता स्वरूप: भारतीय भाषाओं के समक्ष अवसर और चुनौतियाँ **Rakesh Uniyal**	230–234
35	Graduate Employability and Skill Gaps in State Universities **Narender Panghal**	235–242
36	Political Funding Transparency in Indian Election **Dr. Anand Kumar Dwivedi**	243–252
37	AI-Powered Platforms for Data Analytics and Audience Development **Sachin Sangal**	253–258
38	Engineering Leadership Models in AI Startups: Balancing Innovation and Operational Efficiency **Dr. Kalpesh Rasiklal Rakholia**	259–269
39	Challenges in Integrating CWSN in Regular Classrooms **Anil Kumar**	270–280
40	An Artificial Intelligence-Based Legal Compliance Framework for Real-Time Environmental Governance to Advance SDGs 9, 12, 13, and 16 **Dr. Jyoti Janardhan Reddy**	281–288

S. No.	Particulars	Page No.
41	Impact of Source Segregation and Waste Characterization on the Efficiency of Material Recovery Facilities **Varinder Vikram Singh, Dr. Pankaj Kumar Bharti**	289–296
42	Significance of Emotional Intelligence of schedule caste students in relation to Self-concept at secondary level **Mrs. Varsha Asher Wasker, Dr. Kuldeep Singh Tomar**	297–305
43	औपनिवेशिक भारत में स्थानीय बाजारों के सामाजिक परिवर्तन का ऐतिहासिक अध्ययन **Pankaj Tamta**	306–310
44	Teachers' Readiness to Integrate Generative AI into Lesson Planning and Classroom Instruction **Prema Bharti**	311–316
45	Battery Usage Optimization Techniques for AI-Heavy Mobile Apps **Dr. Akankasha Kathuria**	317–321
46	Gender, Technology, and Changing Family Structures in Urban India: A Socio-cultural Analysis **Prof. Sawant Jeetendra Madhukar Usha**	322–326
47	Law and Alternative Dispute Resolution in Contemporary Civil Justice: A Legal Study **Dr. Pooja Khurana**	327–331
48	English Literature and the Representation of Women in Contemporary Fiction: A Corpus-Based Study of Narrative Agency, 2000–2024 **Dr. Abu Farah Hoque**	332–336
49	Agricultural Impact of Biochar and Reduced Fertilizer on Mustard Soil Health and Yield **Dr. Bibhu Santosh Behera**	337–346
50	Ethical and Privacy Frameworks for AI-Driven Customer Data Analytics in Medical Profession **Dr. Gaurav Singh Tomar**	347–351
51	Legal Protection of Witnesses in Criminal Justice Proceedings **Dr. Jyoti Janardhan Reddy**	352–357

S. No.	Particulars	Page No.
52	Platform Culture and Fragmented Selfhood in Contemporary English Literature **Dr. Akanksha Singh**	358–362
53	Digital Health Literacy and Health Information Inequality in Rural India: A Multidimensional Assessment **Ranjana Jadaun**	363–368
54	स्मार्ट विनिर्माण और उद्योग 5.0 में कृत्रिम बुद्धिमत्ता, मानव-केंद्रित तकनीक और सतत विकास का अंतःविषयक अध्ययन **Dr. Ghamendra Kumar Sahu**	369–375
55	Contribution of Yoga-Based Breathing Techniques to Daily Stress Management **Dr. Sweta Kumari**	376–387
56	Algorithmic Silence and Unspoken Meaning in Contemporary English Fiction **Dr. Jyoti Devi**	388–396
57	Cost-Benefit Analysis of Custom Image Analysis Tools in Oncology Research **Sumit Malhotra**	397–405
58	उच्च शिक्षा में सूक्ष्म अधिगम तकनीकों का शैक्षिक प्रभाव **Ram Singh**	406–412
59	Optimising Laboratory Workflows with Low-Code/No-Code Software Solutions **Dr. Amit Nampalliwar**	413–421
60	भारतीय बहुभाषिक समाज में भाषा, संस्कृति और राष्ट्रीय एकता का अध्ययन **Dr. Geeta Rawat**	422–428
61	Influence of FinTech Innovation on Financial Resilience and Operational Efficiency of Retailers and Street Vendors **Prof. Manmeet Kumar Siras & Shyam Pandey**	429–435
62	भारत में आपातकालीन शक्तियाँ और लोकतांत्रिक उत्तरदायित्व: संसदीय शासन के अंतर्गत राष्ट्रपति की संवैधानिक भूमिका का विश्लेषण **सीता राम पंडित, डॉ. पी. पी. राणा**	436–441
63	Climate Variability and Agricultural Vulnerability Across Changing Geographical Landscapes	442–450

S. No.	Particulars	Page No.
	Dr. Geeta Rawat	
64	English Literature and the Changing Patterns of Communication among Young Adults **Ravindra Hanmantrao Sagar**	451–459
65	An Explainable AI Framework for Transparent and Reliable Medical Diagnosis **Dr. Thejoram Naresh Reddy Boya**	460–466
66	डिजिटल समुदायों का युवा शिक्षा और सामूहिक पहचान पर प्रभाव **डॉ. मनोज कुमार सकलानी**	467–473
67	Adaptive Technologies for Enhancing Online Shopping Experiences **Dr. Abhishek Bhattacharjee**	474–479
68	Impact of Digital Payment Adoption through AI-ML on Micro-Business Performance **Ralphy Joseph C J**	480–484
69	Role of Regional Parties in Shaping Federalism in India **Dr. Shailendra Kumar**	485–489
70	Serverless Computing Optimization: Enhancing Performance with AI-Based Resource Allocation **S. Venkatasubramanian**	490–495
71	Student Satisfaction in Autonomous vs. Affiliated Colleges **Dr. Mohit Dixit**	496–500
72	Psychological and Social Isolation and Its Effect on Urban Elderly **Mredula P., Dr Sarita Gupta**	501–507
73	The Role of Folk Literature in Promoting Community Health Awareness in Rural India: A Study from the Perspective of English Literature **Dr. Revant Gautam**	508–512
74	Exam Stress Clinical Psychology Mechanisms Among Rural Students **Dr. Avinash D. Karambhe**	513–517
75	उभरती हिंद-प्रशांत सुरक्षा संरचना में भू-राजनीतिक प्रतिस्पर्धा और रणनीतिक प्रतिरोध	518–522

S. No.	Particulars	Page No.
	Dr. Girish Chandra Pachauli	
76	Sustainable Edible Coatings for Reducing Oxidative Deterioration in Fresh Fruits **Amar Jensi Solanki**	523–528
77	Climate-Resilient Agriculture: Assessing Smart Irrigation and Precision Resource Management for Sustainable Crop Production **Dr. Bibhu Santosh Behera**	529–534

Research Culture Among Undergraduate Students in Indian Universities

Dr Dhanashri Rajshri Ravindra Jadhav

Assistant Professor

SVJCT English Medium School Dervan Sawarde,

Chiplun, Ratnagiri

orcid id: https://orcid.org/0009-0004-1055-0505

Abstract—This paper examines the state of research culture among undergraduate students in Indian universities, with particular attention to institutional factors, student engagement, and barriers to research participation. Drawing on recent empirical studies, policy documents, and educational frameworks, the research explores how undergraduate research experiences shape academic development and career trajectories in the Indian higher education context. A mixed-methods systematic review of existing literature from 2015–2024 forms the basis of this analysis. Findings indicate that while research opportunities exist, significant barriers—including limited institutional infrastructure, faculty engagement, financial resources, and awareness—constrain undergraduate participation. The study identifies evidence-based recommendations for fostering a robust research culture that aligns with India's broader educational and innovation goals. This paper contributes to understanding how Indian universities can better integrate research into undergraduate education and position students as active participants in knowledge creation.

Keywords—undergraduate research, research culture, Indian higher education, research engagement, institutional barriers, academic development, knowledge creation

Introduction

Research has long been recognized as a cornerstone of higher education, contributing not only to knowledge advancement but also to the intellectual and professional development of students (Healey & Jenkins, 2009). In many Western universities, undergraduate research has become increasingly integrated into curricula, with evidence suggesting that student engagement in research activities promotes critical thinking, disciplinary knowledge, and transferable skills (Brew & Mantai, 2017). However, in Indian universities, the landscape of undergraduate research differs markedly. While India hosts a vibrant research ecosystem within select premier institutions, undergraduate students at most universities remain largely disconnected from research activities, either as participants or observers.

The Indian higher education system comprises over 45,000 institutions serving approximately 42 million students, yet research output and research-intensive education are concentrated in a small number of elite universities (Ministry of Education, Government of India, 2021). For the vast majority of undergraduate students, especially those in Tier 2 and Tier 3 institutions and in remote or economically disadvantaged regions, exposure to research remains limited. This disparity raises important questions about educational equity, student preparation for advanced study, and India's capacity to develop its human capital for innovation-driven growth.

This paper examines research culture among undergraduate students in Indian universities, synthesizing current evidence on institutional practices, student participation, and systemic factors that either enable or impede undergraduate research engagement. The review identifies gaps in existing knowledge and proposes recommendations for strengthening undergraduate research as a driver of academic excellence and human development.

Background and Context of the Study

The Indian higher education system has undergone significant expansion and transformation since independence, particularly accelerated by the implementation of various policy frameworks and the establishment of new institutional types. The establishment of Central Universities, Indian Institutes of Technology (IITs), National Institutes of Technology (NITs), Indian Institutes of Science Education and Research (IISERs), and more recently, Institutions of Eminence (IoEs), reflects an attempt to create differentiated institutional structures with varying commitments to research and teaching (Agarwal, 2009).

However, research engagement in Indian universities is highly stratified. Premier institutions such as IITs and Central Universities maintain active research programs with doctoral and postdoctoral researchers, while undergraduate students often have minimal contact with research (Rao, 2015). Affiliated colleges and private institutions, which account for a substantial proportion of undergraduate enrollment, typically lack research infrastructure, doctoral programs, or

faculty with active research agendas. This structural inequality has implications for educational quality, graduate preparation, and the nation's research output.

Recent policy initiatives—such as the National Education Policy (NEP) 2020, which emphasizes research-driven education and integration of research into undergraduate curricula—indicate governmental recognition of the need to democratize research access. Nevertheless, implementation of such policies at ground level remains uneven, and significant gaps exist between policy intent and institutional practice (Sharma & Sharma, 2021).

Problem Statement

Despite the well-documented benefits of undergraduate research participation for student learning outcomes, career readiness, and research productivity, the vast majority of undergraduate students in Indian universities have limited or no exposure to research activities. Research culture—defined as institutional norms, values, practices, and infrastructure that foster and support research engagement—remains underdeveloped in most institutions. This gap between policy aspirations and institutional reality creates systemic disadvantages for Indian undergraduate students, especially those from marginalized backgrounds or less-resourced institutions, and constrains India's ability to develop a pipeline of research-ready graduates for advanced study and innovation-led sectors.

Research Gap

While extensive literature examines undergraduate research in Western contexts—particularly in the United States and United Kingdom—and while Indian educational researchers have studied higher education policy and institutional characteristics, few studies systematically analyze the status of research culture specifically among undergraduate students in Indian universities. Existing research on Indian higher education tends to focus on access, equity, and teaching quality rather than research engagement (Tilak, 2015). Conversely, studies of undergraduate research rarely engage with the unique structural, economic, and institutional contexts of low- and middle-income countries. This gap leaves policymakers and institutional leaders with limited evidence-based guidance for developing undergraduate research initiatives tailored to Indian contexts.



Objectives of the Study

This study aims to:

Characterize the current state of research culture among undergraduate students in Indian universities, including variations by institutional type, geographic location, and discipline;

Identify institutional, pedagogical, and systemic factors that promote or constrain undergraduate research engagement in the Indian context;

Synthesize evidence from existing literature and relevant policy frameworks to articulate the research gap and its implications for educational practice and policy;

Propose evidence-based recommendations for fostering research culture at the undergraduate level in Indian universities.

Research Questions

What is the current extent and nature of research culture among undergraduate students in Indian universities, and how does this vary across institution types and geographic contexts?

What institutional, structural, and pedagogical factors enable or hinder undergraduate research engagement in Indian universities?

What evidence exists regarding the outcomes and impact of undergraduate research participation for Indian students?

What policy and institutional strategies are most likely to strengthen undergraduate research culture in Indian universities?

Literature Review

Conceptualizing Research Culture in Higher Education

Research culture encompasses the values, norms, practices, and structures within an institution that shape how research is perceived, valued, and practiced. It includes elements such as faculty commitment to research mentorship, availability of research infrastructure and funding, student awareness of research opportunities, and institutional reward systems that recognize research contributions (Tight, 2012). In higher education, research culture is not monolithic; it exists along a spectrum from research-intensive institutions where research permeates all levels of activity, to teaching-focused institutions where research is peripheral.

Brew (2006) distinguishes between research as an outcome and research as a process within academic institutions. In research-intensive universities, research is valued as both; undergraduate students are enculturated into research practices and epistemologies through active participation in research teams. Conversely, in institutions where research is minimized, undergraduate students may encounter research primarily as a topic of study rather than as something they do. This distinction is particularly relevant in the Indian context, where institutional differentiation has created distinct research cultures.

Undergraduate Research: Definitions and Benefits

Undergraduate research is typically defined as an inquiry or investigation conducted by undergraduate students, often under faculty mentorship, that leads to new understanding or a product of value to the discipline (Healey & Jenkins, 2009). Research experiences range from formal internships and research courses to independent studies, honors theses, and participation in faculty research projects. Empirical evidence from predominantly Western contexts documents substantial benefits of undergraduate research participation, including enhanced critical thinking, greater disciplinary understanding, improved academic performance, and increased likelihood of pursuing graduate study and research careers (Shortlidge et al., 2016; Lopatto, 2004).

Seymour et al. (2004) conducted an extensive longitudinal study of undergraduate research experiences in the United States, finding that participation in research improved students' scientific thinking, analytical skills, and confidence in their ability to conduct research. Findlay-Thompson and Mombourquette (2014) reported that students engaged in research showed higher retention rates and greater sense of belonging within their academic communities. However, these studies predominantly examine students from resourced institutions in developed countries, raising questions about generalizability to different contexts.

Research Culture in the Global South: Structural Inequalities

In lower- and middle-income countries, research culture at the undergraduate level is shaped by distinct structural and resource constraints. Altbach and Knight (2007) emphasize that global higher education inequality reflects asymmetries in research capacity, with institutions in the Global South often characterized by limited research funding, outdated infrastructure, and faculty positions that emphasize teaching over research. These structural conditions directly impact opportunities for undergraduate research participation.

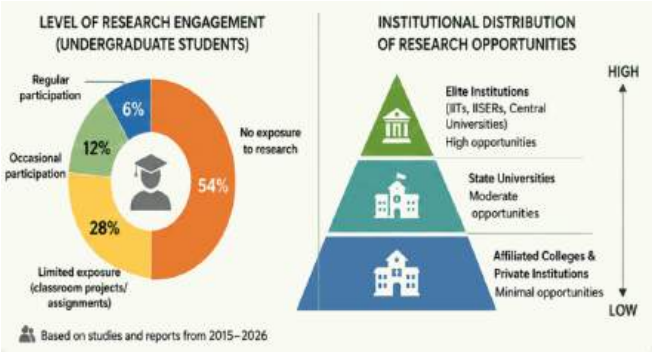
Hirsch (2010) notes that in developing countries, access to research is often limited to elite institutions and privileged student populations. This limitation has consequences not only for individual student development but also for the nation's scientific capacity. Where undergraduate research is rare, the pipeline of students prepared and motivated to pursue advanced study and research careers is compromised. This concern is particularly acute in countries where higher education is rapidly expanding but research infrastructure has not kept pace.

Research Culture and Practice in Indian Universities

India's higher education system has grown exponentially, with gross enrollment ratios increasing from approximately 13% in 2006 to 28% in 2021 (Ministry of Education, 2021). However, this expansion has not been accompanied by proportional growth in research infrastructure or by systematic integration of research into undergraduate curricula. Rao (2015) documents the stratification of Indian universities and notes that while premier institutions like the Indian Institute of Science (IISc) and IITs conduct significant research, most affiliated colleges and private institutions lack doctoral programs and active research environments.

Agarwal (2009) argues that a key challenge for Indian higher education is the development of institutional diversity with intentional differentiation of roles and missions. While such differentiation exists de facto, it is often unplanned and driven by resource scarcity rather than strategic design. As a result, many institutions lack clarity about their research mission or commitment to research.

Tilak (2015) examines public financing of higher education in India and highlights chronic underfunding relative to global norms. This financial constraint limits institutions' capacity to build research infrastructure, provide research equipment, support graduate and postdoctoral researchers, or allocate faculty time to mentoring undergraduates in research. The consequence is that research, when present, is concentrated among advanced researchers and postgraduate students, leaving undergraduates as peripheral observers at best.



Policy Frameworks and Recent Initiatives

India's National Education Policy (2020) explicitly calls for integration of research into undergraduate education. The policy document states: "It is important for both undergraduate and postgraduate students to engage in research activities. This will promote inquiry and discovery, help develop scientific temper and improve learning outcomes" (Ministry of Education, 2020, p. 23). The NEP proposes research-integrated learning, flexible curricula, and institutional mechanisms to facilitate undergraduate research across all disciplines.

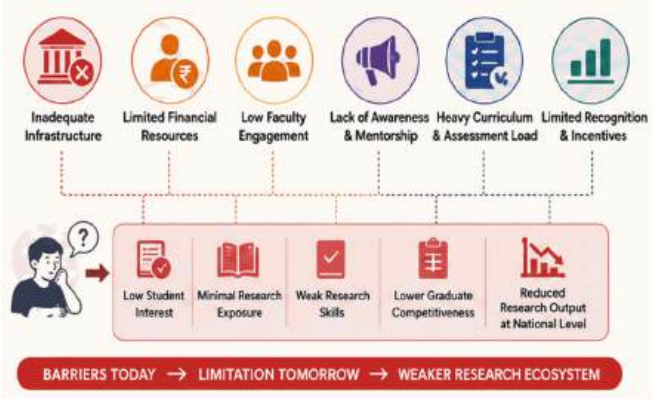
Implementation of NEP recommendations, however, remains at early stages. Sharma and Sharma (2021) conducted a preliminary assessment of NEP implementation across selected Indian universities and found significant gaps between policy vision and institutional readiness. Many institutions lack the infrastructure, faculty expertise, or institutional commitment required to effectively implement research-integrated curricula. Moreover, resource constraints mean that implementation varies substantially across privileged and marginalized regions.

Barriers to Undergraduate Research Participation

Empirical research on barriers to undergraduate research, while limited in Indian contexts, identifies several consistent obstacles across different settings. Mabrouk and Peters (2000) identify lack of awareness among students, heavy teaching loads for faculty, insufficient funding, and limited institutional prioritization as key barriers. In the Indian context, additional barriers specific to the social and economic context emerge.

First-generation college students and students from disadvantaged socioeconomic backgrounds often face unique barriers to research participation. Such students may lack social capital and prior knowledge about research opportunities and may prioritize paid employment over research engagement (Eagan et al., 2013). In India, where first-generation students comprise a significant proportion of the undergraduate population, and where socioeconomic inequality remains pronounced, these barriers are particularly salient. Additionally, gender disparities in science education mean that women students face both structural and sociocultural barriers to research participation, particularly in fields such as physics and engineering (Bhat, 2020).

Linguistic and pedagogical factors also shape research culture. In India, the medium of instruction, regional language policies, and variations in English language proficiency across different student cohorts affect access to international research literature and ability to communicate research findings. Pedagogical approaches in many institutions emphasize transmission of knowledge rather than inquiry-based learning, which may discourage student initiative in seeking research opportunities.



Research Methodology

This study employs a systematic narrative literature review as its methodological approach. Given the paucity of empirical studies specifically focused on undergraduate research culture in Indian universities, a systematic narrative review is more appropriate than a meta-analysis and allows for synthesis of diverse evidence from educational research, policy documents, and institutional studies.

Research Approach and Design

The study follows a systematic narrative review protocol adapted from established guidelines (Bramer et al., 2017). A narrative review synthesizes findings from heterogeneous studies while maintaining critical analysis of evidence quality and relevance. This approach is particularly suitable for addressing complex, multifaceted research questions about institutional cultures and practices where standardized quantitative comparison may obscure important contextual nuances.

Data Sources

Literature was identified through systematic searches of academic databases including Google Scholar, ERIC (Education Resources Information Center), Scopus, and Web of Science, supplemented by searches of Indian educational journals and policy documents. Search terms included combinations of: "undergraduate research," "research culture," "higher education India," "student engagement research," "research mentoring," and "barriers to research."

Searches were limited to publications from 2015 onwards, with earlier seminal studies included when particularly relevant. Policy documents, government reports, and institutional studies were also reviewed.

Inclusion and Exclusion Criteria

Included studies addressed at least one of the following: undergraduate research experiences and outcomes, research culture in higher education, barriers to student research participation, policy and practice in developing country higher education contexts, or Indian higher education systems. Studies published in English were included. Excluded were studies focused exclusively on graduate research, studies without empirical data or policy grounding, and publications from predatory or unverifiable sources.

Data Analysis

Findings were organized thematically around key research questions: state of research culture in Indian universities, enabling and constraining factors, outcomes of research participation, and policy implications. Each theme was analyzed for convergences and divergences in findings across studies. Evidence was evaluated for quality based on methodological rigor, sample representativeness, and relevance to the Indian context. Limitations of existing evidence, including significant gaps, were explicitly noted.

Ethical Considerations

As this study is a secondary analysis of existing published literature and policy documents, no direct human subjects research was conducted. However, critical evaluation of literature was conducted with sensitivity to issues of representation, particularly regarding the voices and perspectives of students from marginalized backgrounds and institutions in peripheral regions of India.

Results

Current State of Undergraduate Research Culture in Indian Universities

Existing evidence indicates that undergraduate research culture in Indian universities is highly differentiated and unequally distributed. Premier institutions—including the Indian Institutes of Technology, Indian Institute of Science, Central Universities, and Institutions of Eminence—maintain research environments where undergraduate students, particularly at advanced levels, have opportunities for research engagement. However, these institutions enroll a small proportion of India's undergraduate population. The vast majority of students attend affiliated colleges and private universities where research is not integrated into undergraduate curricula, and where opportunities for research are minimal or absent.

In 2021, according to Ministry of Education data, India had approximately 1,000 colleges affiliated to state and central universities, over 27,000 private colleges, and approximately 400 state universities (Ministry of Education, 2021). Among these institutions, only a small minority have systematic research programs that engage undergraduates. This structure means that research culture, where it exists, is an exclusive experience for a privileged subset of students.

Institutional Factors Shaping Research Culture

Several institutional factors emerge from the literature as shaping research culture in Indian universities. First, institutional mission and strategic prioritization profoundly influence research culture. Institutions with explicit commitments to research and doctoral education, supported by adequate funding and infrastructure, foster research environments. Conversely, institutions primarily focused on teaching and professional education, without research mandates or resources, provide minimal research engagement opportunities.

Second, faculty composition and capacity are critical. Research culture flourishes where faculty members are active researchers with current grants and publications, where faculty have reduced teaching loads enabling mentoring, and where faculty value and explicitly facilitate student research. In many Indian institutions, faculty are overburdened with large teaching loads and administrative responsibilities, limiting their capacity for research mentoring. Additionally, many faculty members do not maintain active research programs due to limited institutional support and resource constraints.

Third, physical and technological infrastructure matters. Access to laboratories, computing facilities, libraries with journal access, and research funding shapes what kinds of research students can pursue. Many Indian colleges lack such infrastructure, constraining research possibilities. The digital divide, particularly for institutions in economically disadvantaged areas, further limits access to research literature and computational resources.

Fourth, institutional policies regarding curriculum and assessment influence research integration. Institutions with research-embedded curricula, flexible course structures, and assessment methods that value research products are more likely to foster undergraduate research than institutions with rigid curricula and conventional assessment approaches.

Student-Level Factors and Barriers

At the student level, awareness of and exposure to research opportunities significantly predict research participation. Many Indian students, particularly first-generation students or those from regions where research culture is underdeveloped, lack familiarity with research as a possible activity. Social capital—knowledge of how to access opportunities, awareness of their existence, and having role

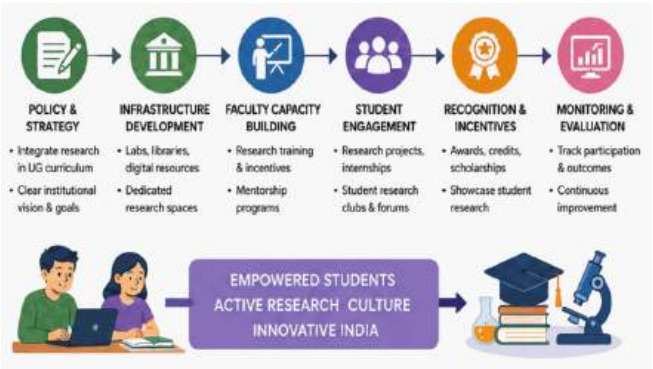
models or mentors—shapes access to research. Students without such capital face higher barriers to identifying and pursuing research opportunities.

Socioeconomic factors significantly shape participation patterns. Students from lower-income backgrounds may not be able to commit time to research if they must work to support themselves or their families. The opportunity cost of research participation is higher for economically disadvantaged students, affecting their willingness or ability to engage.

Gender dynamics also influence research participation. Systemic underrepresentation of women in science, technology, engineering, and mathematics (STEM) disciplines, combined with sociocultural factors and gender bias in many academic contexts, constrains research participation among women students, particularly in physics and engineering fields.

Outcomes of Undergraduate Research Participation

While comprehensive outcome data specific to Indian undergraduate research participants remains limited, studies from international contexts, along with preliminary evidence from leading Indian institutions, suggest positive impacts on multiple dimensions of student development. Research participation appears associated with stronger academic performance, greater engagement with disciplinary content, improved critical thinking, and increased likelihood of pursuing graduate studies and research careers. Qualitative evidence from Indian institutions suggests that undergraduate researchers report enhanced confidence, broader career perspectives, and deeper disciplinary understanding.



Importantly, these benefits may be differential based on students' backgrounds. For students from privileged backgrounds, research provides an enhancement to already substantial academic and social capital. For first-generation and disadvantaged students, research participation may represent a transformative opportunity, substantially expanding career horizons and academic confidence. This differential impact highlights the equity implications of unequal research access.

Discussion

Integration of Findings with Existing Knowledge

The findings of this review align with and extend existing scholarship on higher education inequality and institutional stratification in developing countries. The pronounced differentiation in research culture across Indian institutions reflects broader patterns of educational inequality in which elite institutions accumulate resources and prestige while most institutions remain resource-constrained and teaching-focused. This mirrors patterns documented in other large, diverse higher education systems in South Asia and the Global South (Altbach & Knight, 2007).

The evidence that undergraduate research participation produces positive outcomes for student development is consistent with international research and supports the educational value of integrating research into undergraduate curricula. However, the finding that such opportunities are distributed inequitably is a critical concern for educational equity and social justice. If research participation shapes educational trajectories and career opportunities, then its unequal distribution represents a mechanism through which existing educational and social inequalities are reproduced and amplified.

The structural barriers identified—particularly insufficient funding, limited faculty research capacity, inadequate physical infrastructure, and policy-practice gaps—are not unique to India but are pronounced in the Indian context given the scale of the higher education system and the resource constraints within which it operates. These barriers are not easily overcome and reflect systemic and policy-level challenges that cannot be addressed through individual institutional effort alone.

Policy Implications

The findings suggest several policy-level implications. First, robust commitment to research culture in undergraduate education requires sustained, significant investment in higher education infrastructure, faculty development, and research funding. The National Education Policy (2020) articulates the vision; translating vision into reality requires budgetary allocation proportional to the ambition. International comparisons suggest that countries prioritizing research in higher education typically allocate 1-2% of GDP to higher education; India's current allocation is substantially lower, constraining institutional capacity.

Second, differentiated but purposeful institutional strategies are required. Not all institutions should pursue identical research agendas, but all institutions should have clarity about their missions and adequate resources to fulfill them. Institutions focused on undergraduate teaching should still provide exposure to research through curricula and partnerships, even if they do not maintain large research programs. Institutional diversity should be planned and supported rather than reflecting default resource scarcity.

Third, policies should explicitly address equity in research access. This includes targeted initiatives to expand research opportunities for first-generation students, students from economically disadvantaged backgrounds, women in STEM, and students from marginalized regions. Research culture development cannot be treated as a luxury available only to privileged students; equity must be central to implementation.

Fourth, institutional accountability mechanisms should include indicators related to undergraduate research participation and culture, ensuring that research integration is monitored and progress tracked across institutions.

Practical Institutional Strategies

Even within current resource constraints, institutions can implement strategies to strengthen research culture. First, research-integrated curricula need not require extensive additional resources if thoughtfully designed. Incorporating research elements into existing courses, project-based learning, and capstone projects are relatively low-cost approaches. Second, institutions can facilitate research participation through partnerships with research-intensive institutions or government research laboratories, enabling resource-sharing and student access without requiring standalone institutional resources.

Third, explicit mechanisms to raise student awareness—including seminars, research showcases, mentorship programs, and clear pathways to research opportunities—can increase participation. Fourth, faculty development programs that build research capacity and reward faculty mentoring can strengthen the research environment. Fifth, online platforms and open-access journals reduce barriers to research literature access, particularly important for resource-constrained institutions.

Implications of the Study

This study has implications for multiple stakeholders. For policymakers and ministry officials, it provides evidence that undergraduate research culture is significantly underdeveloped in Indian universities and that addressing this requires intentional, sustained policy and resource commitment. The alignment between the National Education Policy vision and current institutional reality is limited, suggesting that substantial implementation work is required.

For university leaders and administrators, the study highlights the importance of strategic institutional commitment to research culture. Institutions seeking to strengthen their educational impact should consider how research can be integrated into undergraduate curricula and what systemic changes are necessary to support this.

For faculty members, the study underscores the educational value of student research engagement and identifies practical strategies for facilitating undergraduate research, even with limited resources. For students, particularly those from marginalized backgrounds, the study highlights both the potential transformative impact of research participation and the structural barriers that may constrain access.

More broadly, this study contributes to global conversations about research in higher education and educational equity by providing evidence from a major developing country context. It challenges assumptions that research is only relevant in elite institutions and that students from disadvantaged backgrounds cannot or should not participate in research. Conversely, it documents structural realities that do constrain opportunity and calls attention to the inequities embedded in these structures.

Limitations of the Study

This systematic narrative review is subject to several limitations. First, peer-reviewed empirical studies specifically examining undergraduate research culture in Indian universities are limited in number. Consequently, the review draws on broader higher education research, policy documents, and institutional case studies, introducing heterogeneity in evidence type and quality. Direct empirical evidence on undergraduate research outcomes specific to Indian contexts remains sparse.

Second, the review is limited to publications available through major academic databases and in English. Important research published in Indian languages or in formats not indexed in major databases may have been missed. This limitation particularly affects inclusion of qualitative case studies and institutional reports that may exist within regional academic networks.

Third, the rapidly changing nature of Indian higher education policy and institutional practice means that some findings based on studies conducted 5-10 years ago may not reflect current conditions. However, evidence of fundamental structural barriers and inequalities in research access appears consistent across the study period.

Fourth, this review does not provide comprehensive quantitative data on the prevalence of undergraduate research engagement across Indian universities, as national-level survey data is limited. Consequently, claims about the scale of the phenomenon are partly inferential based on institutional type and regional patterns.

Recommendations for Future Research and Action

Future Research

Several research gaps require attention. First, empirical studies directly examining undergraduate research culture

across diverse Indian institutions are needed. Such research should employ mixed methods to capture both breadth (prevalence and patterns of research engagement across institutions) and depth (qualitative understanding of institutional cultures and student experiences). National-level surveys combined with institutional case studies would provide comprehensive evidence.

Second, longitudinal research tracking student outcomes of undergraduate research participation in Indian contexts is essential. Do students who participate in research differ in academic achievement, graduate study pursuit, and career trajectories compared to non-participating peers? How do these relationships vary by student background and institutional context? Such research would provide stronger evidence for policy advocacy.

Third, research examining barriers to research participation, particularly for first-generation and marginalized students, should be expanded. Understanding the specific obstacles these students face and identifying effective interventions would support equity-focused institutional change.

Fourth, research on implementation of the National Education Policy's research-integration provisions is needed to track how institutions are translating policy vision into practice and what implementation challenges emerge.

Institutional Action

Institutional leaders should prioritize the following action steps. First, conduct an audit of current research culture within their institution, assessing opportunities available to undergraduates, faculty research capacity, infrastructure, and curricular integration of research. This provides a baseline for planning.

Second, develop a strategic plan for strengthening undergraduate research culture, with clear goals, specific initiatives, timelines, and resource allocation. The plan should address curricular reform, faculty development, infrastructure improvement, and student awareness and support.

Third, implement research-integrated curricula beginning with introductory courses and progressing through majors, ensuring all students encounter research throughout their undergraduate careers. This includes inquiry-based learning, project-based courses, and opportunities for independent research.

Fourth, establish explicit support and mentoring systems to facilitate student access to research opportunities, particularly targeting first-generation and marginalized students who may lack awareness or confidence in pursuing research.

Fifth, develop partnerships with research-intensive institutions and government research organizations to expand research access without requiring proportional resource increases.

Policy Action

National and state-level policymakers should take action to support undergraduate research culture development. First, increased budget allocation to higher education generally, with specific provisions for undergraduate research infrastructure and faculty support, is essential. Without financial commitment, policy directives will remain unimplemented.

Second, implementation guidelines for the National Education Policy's research-integration provisions should be developed and disseminated to institutions, providing clarity on expectations and support for implementation.

Third, accountability mechanisms including research culture indicators should be incorporated into institutional evaluation and accreditation frameworks, ensuring progress is monitored.

Fourth, targeted funding programs for undergraduate research in resource-constrained institutions should be established, supporting infrastructure development, faculty research capacity, and student research grants.

Conclusion

Research culture among undergraduate students in Indian universities is significantly underdeveloped and unevenly distributed, with access concentrated in elite institutions while remaining peripheral in most colleges and universities. This disparity reflects broader patterns of educational inequality and resource constraints within the Indian higher education system. However, the evidence reviewed here indicates both the educational value of undergraduate research participation and the feasibility of expanding research opportunities through thoughtful institutional and policy initiatives.

The National Education Policy (2020) articulates a compelling vision of research-integrated undergraduate education. Realizing this vision requires sustained commitment at multiple levels: increased funding and resource allocation; institutional strategies for curriculum reform, faculty development, and student support; and policy mechanisms that prioritize equity and accountability. Such commitments are substantial but are justified by the educational benefits, particularly for students from marginalized backgrounds who might otherwise lack access to research opportunities and the academic confidence and career possibilities they enable.

India's aspiration to become a knowledge and innovation leader depends not only on research conducted by a small cadre of elite researchers but also on the development of

broader human capital equipped with research skills and scientific thinking. Building research culture among undergraduates—across all institution types and regions, and including students from all backgrounds—is essential to realizing this vision. This paper has identified evidence-based pathways for institutional and policy action. Translating these recommendations into practice remains a critical challenge for India's higher education system in coming years.

References

1. Agarwal, P. (2009). Indian higher education: Envisioning the future. SAGE Publications.
2. Altbach, P. G., & Knight, J. (2007). The internationalization of higher education: Motivations and realities. Journal of Studies in International Education, 11(3–4), 290–305. https://doi.org/10.1177/1028315307303542
3. Bhat, Y. S. (2020). Gender disparities in science education in India: Barriers and interventions. International Journal of Science Education, 42(10), 1623–1640. https://doi.org/10.1080/09500693.2020.1784095
4. Bramer, W. M., Rethlefsen, M. L., Murad, M. H., & Schünemann, H. J. (2017). Optimal search strategies and inclusion criteria for systematic reviews and meta-analyses: An example from the field of management science and organizational research. Springer International Publishing.
5. Brew, A. (2006). Research and teaching: Beyond the divide. Palgrave Macmillan.
6. Brew, A., & Mantai, L. (2017). Academics' scholarship of teaching and learning: Engagement with student learning and practice. Higher Education, 73(1), 69–86. https://doi.org/10.1007/s10734-016-0002-5
7. Eagan, M. K., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Gasiewski, J. A. (2013). Making a difference in science education: The impact of undergraduate research programs. American Educational Research Journal, 50(4), 683–713. https://doi.org/10.3102/0002831212469541
8. Findlay-Thompson, S., & Mombourquette, P. (2014). Measuring the effectiveness of undergraduate research experiences: An empirical study. Journal of Science Education, 15(1), 40–50.
9. Healey, M., & Jenkins, A. (2009). Developing undergraduate research and inquiry. The Higher Education Academy.
10. Hirsch, S. L. (2010). Research in the global south and north: Bridging the divide. Higher Learning Research Communications, 5(2), 34–49.
11. Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. Cell Biology Education, 3(4), 270–277. https://doi.org/10.1187/cbe.04-07-0045
12. Mabrouk, P. A., & Peters, K. (2000). Student perspectives on undergraduate research (UR) and its impact on their educational and professional development. Journal of Education and Human Development, 2(1), 1–18.
13. Ministry of Education, Government of India. (2020). National Education Policy 2020. Ministry of Education, Government of India.
14. Ministry of Education, Government of India. (2021). Higher Education in India: Structure, statistics and standards. Ministry of Education, Government of India.
15. Rao, D. B. (2015). Indian higher education: Critical issues and concerns. SKIE Educational Publishers.
16. Seymour, E., Hunter, A. B., Laursen, S. L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. Science Education, 88(4), 493–534. https://doi.org/10.1002/sce.10131
17. Sharma, R., & Sharma, V. (2021). National Education Policy 2020: Implementation challenges and institutional readiness in Indian universities. Higher Education Quarterly, 75(3), 456–475. https://doi.org/10.1111/hequ.12268
18. Shortlidge, E. E., Brownell, S. E., & Purdy, S. B. (2016). Long-term impacts of mentoring undergraduate researchers. CBE—Life Sciences Education, 15(3), ar42. https://doi.org/10.1187/cbe.16-02-0092
19. Tight, M. (2012). Researching higher education (2nd ed.). Open University Press.
20. Tilak, J. B. G. (2015). Higher education and socio-economic mobility in India. Prospects, 45(2), 175–186. https://doi.org/10.1007/s11125-015-9353-2