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# REDEFINING EDUCATION
## INNOVATIONS AND EMERGING TRENDS IN THE 21ST CENTURY


EDITORS

Prof. Vibha Asthana
Dr. Hureen Wasifa Siddiqui
Dr. K. Sindhu Bhavani
Dr. M. Raju
Ms. Lubna Aly Khan



**GHULAM AHMED COLLEGE OF EDUCATION**
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Edited by

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*Prof. Vibha Asthana, Dr. Hureen Wasifa Siddiqui, Dr. K. Sindhu Bhavani, Dr. M. Raju, Ms. Lubna Aly Khan*

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**PROF. V. BALAKISTA REDDY**
**LL.M; M.Phil; Ph.D.(JNU)**
**CHAIRMAN**


## MESSAGE

It gives me immense pleasure to extend my warm greetings and best wishes to **Ghulam Ahmed College of Education for organizing a significant International Conference on International Conference on "Innovation & Emerging Trends in Education" on the 24th and 25th of April, 2026.**

In today's rapidly evolving world, education stands at the crossroads of tradition and transformation. The integration of innovative pedagogies, digital technologies, and interdisciplinary approaches has become essential to meet the needs of 21st-century learners.

I am so glad that the Conference is focussing on the Sustainable Development Goals (SDGs) as they provide a framework for teachers to cultivate global citizenship, foster critical thinking, and make learning relevant to real-world challenges like climate change and inequality. By integrating SDGs, teachers can empower students with skills for sustainability and prepare them for a changing future, fulfilling SDG 4 quality education.

I commend the organizers for their vision and efforts in bringing together such a distinguished gathering. I am confident that the deliberations and outcomes of this conference will contribute significantly to enriching educational practices and policies.

I extend my best wishes for the grand success of the conference and hope that it will inspire meaningful dialogue and collaboration among all participants.

Warm regards,

(Prof. V. Balakista Reddy)

**Prof. KUMAR MOLUGARAM**
Ph.D. (IIT Bombay)
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Date: 02.04.2026

## MESSAGE

It gives me great pleasure to learn that Ghulam Ahmed College of Education, Hyderabad, is organizing an International Conference on "Innovation & Emerging Trends in Education" on 24th and 25th April, 2026.

Hyderabad, known for its rich historical and cultural heritage, serves as the ideal setting for this prestigious event. I hope that the deliberations and exchanges during this conference will inspire new ideas, forge lasting connections, and lead to meaningful outcomes that contribute to the advancement of education globally.

In an era marked by rapid technological advancements and evolving societal expectations, education must continuously adapt to remain relevant and impactful. The theme of this conference aptly highlights the need to embrace innovation and explore emerging trends that can transform teaching-learning processes and educational systems.

Such international forums provide a vital platform for scholars, educators, and practitioners to engage in meaningful dialogue, exchange ideas, and present research that can contribute to the advancement of the field of education. I am confident that the deliberations will generate valuable insights and practical solutions to contemporary educational challenges.

I congratulate the organisers on their commendable initiative and extend my best wishes for the success of the conference. I am confident that the collective wisdom and expertise of all involved will lead to new insights that will benefit not only India but the world.

[Prof. KUMAR MOLUGARAM]

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# THEME 1

# FROM POLICY VISION TO INSTITUTIONAL PRACTICE: TEACHER EDUCATORS' AWARENESS AND CHALLENGES IN IMPLEMENTING THE NATIONAL EDUCATION POLICY 2020

**Mrs. Shaik Habeeba Sulthana [1]**

**Abstract:**

The National Education Policy 2020 represents a transformative framework aimed at restructuring India's education system, with a strong emphasis on improving the quality of teacher preparation and professional development. Within this reform agenda, teacher educators play a pivotal role in translating policy vision into effective institutional practices in teacher education programmes. The present study examines teacher educators' awareness of the provisions of the National Education Policy 2020 and explores the challenges they encounter while implementing its recommendations in teacher education institutions. The study adopts a descriptive research design to investigate the level of awareness, perceptions, and institutional constraints experienced by teacher educators in relation to the policy's objectives. Data were collected from teacher educators working in selected teacher education institutions through a structured questionnaire and supplemented with qualitative insights regarding implementation barriers. The findings indicate that while a majority of teacher educators demonstrate a moderate to high level of awareness of the policy's key provisions—such as multidisciplinary education, competency-based learning, and the emphasis on continuous professional development—several challenges hinder its effective implementation. These challenges include limited institutional preparedness, inadequate professional training, lack of infrastructural support, and insufficient clarity regarding curriculum restructuring aligned with the policy's vision. The study highlights the critical need for systematic capacity-building initiatives and institutional support mechanisms to empower teacher educators in operationalizing the policy's objectives. Strengthening professional development opportunities, enhancing policy orientation programmes, and fostering collaborative institutional environments may significantly contribute to bridging the gap between policy formulation and classroom practice. By examining teacher educators' awareness and the practical constraints they face, this study contributes to the ongoing discourse on educational reform and teacher preparation in India. The findings offer valuable implications for policymakers, teacher education institutions, and academic stakeholders seeking to ensure the effective implementation of the National Education Policy 2020 within the teacher education landscape.

***Key words*:** teacher educators, awareness, challenges, implementing, national education, policy 2020.

**Introduction:**

The National Education Policy 2020 represents a significant milestone in the reform of India's education system, aiming to transform the structure, pedagogy, and governance of education to meet the demands of the twenty-first century. The policy envisions a holistic, multidisciplinary, and learner-centered educational framework that promotes critical thinking, creativity, and inclusive learning. Among its various reforms, the policy assigns particular importance to teacher education, recognizing that the quality of teachers and teacher educators plays a decisive role in shaping the effectiveness of educational transformation.

Teacher educators occupy a strategic position in the successful implementation of educational policies. They are responsible for preparing future teachers, guiding pedagogical practices, and aligning teacher preparation programmes with evolving educational priorities. In this context, the National Education Policy 2020

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emphasizes the restructuring and strengthening of teacher education through initiatives such as multidisciplinary institutional frameworks, the introduction of the four-year integrated teacher education programme, competency-based curricula, and continuous professional development. These reforms place new expectations on teacher educators to reinterpret policy directives and translate them into meaningful institutional practices.

However, the transition from policy vision to institutional practice is often complex and influenced by multiple contextual factors. Effective implementation requires not only policy awareness but also adequate institutional support, professional preparedness, and infrastructural resources. Teacher educators must possess a clear understanding of the policy's objectives, principles, and pedagogical implications in order to integrate them into teacher education programmes. At the same time, challenges such as limited professional training, institutional constraints, and ambiguities in policy interpretation may affect the pace and quality of implementation. In light of these considerations, examining teacher educators' awareness of the National Education Policy 2020 and the challenges they encounter in implementing its provisions becomes essential. Understanding their perspectives can provide valuable insights into the practical realities of policy enactment within teacher education institutions. Therefore, the present study seeks to explore the extent of teacher educators' awareness of the policy and to identify the institutional and professional challenges that influence its effective implementation. The findings of the study are expected to contribute to the broader discourse on educational reform and to offer practical implications for strengthening teacher education in alignment with the goals of the National Education Policy 2020.

**Theoretical Basis:**

The present study is grounded in policy implementation theory and teacher professional development frameworks, which emphasize the role of educators in translating educational policies into institutional practice. The National Education Policy 2020 highlights teacher educators as key agents in facilitating educational reform and preparing future teachers to meet evolving pedagogical demands. According to policy implementation perspectives, the success of educational reforms largely depends on stakeholders' awareness, readiness, and institutional support systems. Therefore, understanding teacher educators' awareness and the challenges they encounter is essential for bridging the gap between policy formulation and effective practice within teacher education institutions.

**Significance of the study:**

The study is significant as it examines teacher educators' awareness and the challenges they face in implementing the National Education Policy 2020 within teacher education institutions. By identifying gaps between policy vision and institutional practice, the study provides insights that may support policymakers, teacher education institutions, and academic stakeholders in strengthening professional development, institutional preparedness, and effective implementation of educational reforms.

**Operational definitions of the concepts used:**

**Teacher Educators:** In this study, teacher educators refer to faculty members working in teacher education institutions who are responsible for preparing pre-service and in-service teachers through teaching, training, and mentoring activities.

**Awareness:** Awareness refers to the level of knowledge and understanding possessed by teacher educators regarding the objectives, provisions, and reforms proposed in the National Education Policy 2020.

**Challenges:** Challenges denote the institutional, professional, and infrastructural difficulties encountered by teacher educators while implementing the provisions of the National Education Policy 2020 in teacher education programmes.

**Implementation**: Implementation refers to the process of translating the recommendations and reforms of the National Education Policy 2020 into practical actions within teacher education institutions, including curriculum changes, pedagogical practices, and professional development initiatives.

**National Education Policy 2020:** The National Education Policy 2020 refers to the comprehensive education reform framework introduced by the Government of India in 2020 to transform the country's education system. It emphasizes holistic and multidisciplinary education, quality teacher preparation, competency-based learning, and the integration of technology in education. In the context of this study, it refers to the policy guidelines and reforms related to teacher education that influence the roles, responsibilities, and professional practices of teacher educators.

## STATEMENT OF THE PROBLEM:

The National Education Policy 2020 proposes significant reforms aimed at transforming teacher education in India. However, the successful realization of these reforms largely depends on the awareness, preparedness, and institutional practices of teacher educators. In many cases, gaps may exist between the policy's vision and its practical implementation within teacher education institutions. Therefore, the present study seeks to examine teacher educators' awareness and the challenges they face in implementing the provisions of the National Education Policy 2020.

### Limitations of the Study:

- The study was limited to teacher educators working in selected teacher education institutions.
- The study relied primarily on self-reported responses collected through a questionnaire.
- The research focused only on awareness and perceived challenges related to the implementation of NEP 2020.
- The study considered only selected demographic variables (selected districts of Andhra Pradesh).

### Objectives of The Study:

**A. Awareness:**

1: To assess the level of awareness among Teacher Educators about NEP 2020 and to classify them.

2: To assess and compare Teacher Educators' awareness about NEP 2020 across the following dimensions: (i) Curriculum, (ii) Skills, Professional Development, and Teaching Techniques, (iii) Technology and Infrastructure, (iv) Quality Education, (v) Overall Impact of the Policy

3: To assess and compare the extent of Teacher Educators' awareness about NEP 2020 with reference to selected demographic variables: i) Gender, ii) Age, iii) Qualification, iv) Experience, v) Type of institution, vi) Subject taught.

**B. Perceived Challenges:**

4: To examine the overall perceived challenges of Teacher Educators towards implementation of NEP 2020.

5: To compare perceived challenges of NEP 2020 across five key dimensions: (i) Curriculum, (ii) Skills/Professional Development and Teaching Techniques, (iii) Technology and Infrastructure, (iv) Quality Education, (v) Overall Impact of the Policy.

6: To assess and compare the perceived challenges in implementing NEP 2020 with respect to selected demographic variables: i) Gender, ii) Age, iii) Qualification, iv) Experience, v) Type of institution, vi) Subject taught.

7: To assess and compare the correlation between teacher educators' awareness and perceived challenges of NEP 2020.

**Research Hypotheses of the Study:**

**A. Awareness:**

$H_{01}$: There is no significant difference in the level of awareness among teacher educators regarding the provisions of the National Education Policy 2020.

$H_{02}$: There is no significant difference in teacher educators' awareness of NEP 2020 across the dimensions of (i) Curriculum, (ii) Skills, Professional Development and Teaching Techniques, (iii) Technology and Infrastructure, (iv) Quality Education, and (v) Overall Impact of the Policy.

$H_{03}$: There is no significant difference in teacher educators' awareness of NEP 2020 with respect to demographic variables such as (i) Gender, (ii) Age, (iii) Qualification, (iv) Experience, (v) Type of institution, and (vi) Subject taught.

**B. Perceived Challenges:**

$H_{04}$: There is no significant difference in the overall perceived challenges of teacher educators towards the implementation of NEP 2020.

$H_{05}$: There is no significant difference in the perceived challenges of NEP 2020 across the dimensions of (i) Curriculum, (ii) Skills/Professional Development and Teaching Techniques, (iii) Technology and Infrastructure, (iv) Quality Education, and (v) Overall Impact of the Policy.

$H_{06}$: There is no significant difference in the perceived challenges in implementing NEP 2020 with respect to demographic variables such as (i) Gender, (ii) Age, (iii) Qualification, (iv) Experience, (v) Type of institution, and (vi) Subject taught.

$H_{07}$: There is no significant relationship between teacher educators' awareness and their perceived challenges regarding the implementation of NEP 2020.

**Literature Review**

The following review synthesizes the studies, focusing on the awareness and perceived challenges of implementing the National Education Policy (NEP) 2020 among teacher educators. These studies provide a foundation for understanding the policy's impact, the gaps in awareness, and the barriers to implementation across different educational contexts.

**Singh and Kaur (2022)** found that awareness of NEP 2020 among teacher educators varies significantly, with many expressing limited understanding of its core principles and practical applications. This lack of awareness can hinder effective policy implementation and compromise the quality of teacher education.

**Kumar and Rajan (2022)** identified digital infrastructure as a critical challenge, especially in rural and semi-urban teacher education institutions. Limited access to technology and internet connectivity constrains the adoption of digital tools and online resources, which are crucial for NEP's emphasis on blended and e-learning.

**Banerjee and Chatterjee (2022)** emphasize the importance of cultural sensitivity and awareness training, arguing that teacher educators must be equipped to address the educational needs of students from varied socioeconomic backgrounds. They advocate for integrating social justice and equity principles into teacher training curricula to foster inclusive practices.

**Bhatia (2021)** advocates for a systematic approach to teacher professional development aligned with NEP 2020's goals. The study suggests that regular workshops, certification programs, and peer mentoring can be instrumental in building educators' capacity to implement NEP reforms effectively.

Scholars have identified several challenges in implementing NEP 2020 in teacher education, including limited professional development, inadequate infrastructure, and insufficient training in multidisciplinary approaches. There are also uncertainties regarding curriculum restructuring within institutions. Research emphasizes the need for institutional readiness and continuous capacity-building to help teacher educators effectively implement policy directives. Overall, while NEP 2020 offers a progressive vision, its success depends on enhancing policy awareness, professional competencies, and institutional support systems

**Methodology**

**Population of The Study:**

The population for this study is the Teacher Educators in Andhra Pradesh (selected districts). This group consisted of faculty members working in teacher training institutions B.Ed./M.Ed. colleges) across both government and private colleges.

**Sample for The Study:**

The sample of 184 Teacher Educators randomly drawn from colleges and Universities of Teacher Education.

**Sampling Method:**

Simple random sampling technique used by the investigator while selecting a sample of 184.

**Tool Used for The Study:**

The study involved quantitative data collection method:

Document Analysis: Relevant policy documents, educational materials, and reports were analysed to provide context and background information.

**Variables:**

**Independent Variable:** Implementation of the National Education Policy 2020.

**Dependent Variables:** Teacher Educators' Awareness, Challenges in Institutional Practice

**Questionnaire:** Structured questionnaire administered to a representative sample of teacher educators across Andhra Pradesh. This survey gathered quantitative data on challenges, perceptions, and needs related to NEP 2020 implementation. Questionnaire assessing awareness and perceived challenges of NEP 2020 at the teacher education level, focused on:

**ACPTE** (Awareness and Challenges Perceived of Teacher Educators).

Questionnaire for awareness and challenges, with Likert-scale items. Awareness-Questions (25) and Challenges-Questions (25).

**Data Collection:**

Data for the present study were collected from teacher educators working in selected teacher education institutions using a structured questionnaire designed to measure their awareness and perceived challenges regarding the implementation of the National Education Policy 2020. The responses were gathered through a survey method. Research tools were administered on sample subjects for collecting evidence or data.

**Statistical Tools:**

- Descriptive statistics for awareness levels.
- Inferential statistics (t tests, ANOVA, correlations) for comparisons.

**Data Analysis:**

The collected data were analyzed using appropriate statistical techniques such as percentage, mean, standard deviation, t-test, ANOVA, and correlation analysis to examine teacher educators' awareness and perceived challenges in implementing the National Education Policy 2020. These techniques helped in comparing variables and interpreting the relationship between awareness and perceived challenges.

***Table 1. Level of Awareness of Teacher Educators about the National Education Policy 2020***

| S.No | Statistic | Value |
|---|---|---|
| 1 | Mean | 89.36 |
| 2 | Standard Deviation | 12.91 |
| 3 | Level of Awareness | Moderate |

***Note.*** Teacher educators demonstrate a moderate level of awareness regarding the National Education Policy 2020

**Interpretation:** The results indicate that teacher educators demonstrate a moderate level of awareness regarding the National Education Policy 2020. The mean awareness score of 89.36 (SD = 12.91) suggests that while teacher educators possess a reasonable understanding of the policy provisions, there remains scope for strengthening policy literacy through structured professional development programs.

***Table 2. Teacher Educators' Awareness of NEP 2020 across Dimensions***

| S.No | Dimension | Mean Score | Interpretation |
|---|---|---|---|
| 1 | Curriculum Reforms | Higher awareness | Strong familiarity with curriculum reforms |
| 2 | Skills, Professional Development & Teaching Techniques | Moderate awareness | Need for additional training |
| 3 | Technology & Infrastructure | Moderate awareness | Reflects digital resource limitations |
| 4 | Quality Education | Moderate awareness | Need for deeper policy understanding |
| 5 | Overall Impact of Policy | Moderate awareness | Limited awareness of long-term policy implications |

**Note:** Teacher educators demonstrate varying levels of awareness across different policy dimensions.

**Interpretation:** The analysis shows that teacher educators demonstrate varying levels of awareness across different policy dimensions. Awareness is relatively stronger in curriculum reforms but comparatively lower in technology integration and professional development components.

***Table 3. Comparison of Teacher Educators' Awareness across Demographic Variables***

| S.No | Variable | Statistical Test Result | Significance |
|---|---|---|---|
| 1 | Gender | t-test | Significant difference |
| 2 | Age | ANOVA | Significant difference |
| 3 | Qualification | ANOVA | No significant difference |
| 4 | Teaching Experience | ANOVA | Significant difference |
| 5 | Type of Institution | t-test | No significant difference |
| 6 | Subject Taught | ANOVA | No significant difference |

Note: Teacher educators' awareness of NEP 2020 differs significantly with variables

**Interpretation:** Teacher educators' awareness of NEP 2020 differs significantly with respect to gender, age, and teaching experience, while qualification, type of institution, and subject taught do not significantly influence awareness levels.

***Table 4. Overall Perceived Challenges of Teacher Educators in Implementing NEP 2020***

| Sr.No | Statistic | Value |
|---|---|---|
| 1 | Mean | 85.66 |
| 2 | Standard Deviation | 11.03 |
| 3 | Level of Challenges | Moderate |

**Note:** The mean score of 85.66 (SD = 11.03) indicates that teacher educators experience a moderate level of challenges

**Interpretation:** The mean score of 85.66 (SD = 11.03) indicates that teacher educators experience a moderate level of challenges in implementing NEP 2020. These challenges are primarily related to institutional readiness, professional development requirements, and curriculum restructuring.

***Table 5. Perceived Challenges across NEP 2020 Dimensions***

| Sr.No | Dimension | Level of Challenge | Interpretation |
|---|---|---|---|
| 1 | Curriculum Reforms | High | Implementation of 4-year B.Ed. and credit systems |
| 2 | Professional Development | Moderate–High | Faculty training requirements |
| 3 | Technology & Infrastructure | Moderate | Digital resources and infrastructure gaps |
| 4 | Quality Education | High | Maintaining quality standards in teacher education |
| 5 | Policy Impact | High | Institutional adaptation to policy reforms |

Note: Dimension wise challenges

**Interpretation:** Teacher educators perceive significant challenges in curriculum reforms, policy impact, and quality education, reflecting the complexity of implementing structural reforms proposed in NEP 2020.

***Table 6. Comparison of Perceived Challenges across Demographic Variables***

| S.No | Variable | Statistical Test Result | Significance |
|---|---|---|---|
| 1 | Gender | t-test | No significant difference |
| 2 | Age | ANOVA | No significant difference |
| 3 | Qualification | ANOVA | No significant difference |
| 4 | Teaching Experience | ANOVA | Significant difference |
| 5 | Type of Institution | t-test | Significant difference |
| 6 | Subject Taught | ANOVA | No significant difference |

Note: Demographic variables do not significantly influence the challenges experienced by teacher educators.

**Interpretation:** Perceived challenges in implementing NEP 2020 vary significantly according to teaching experience and type of institution, while other demographic variables do not significantly influence the challenges experienced by teacher educators.

***Table 7. Correlation between Teacher Educators' Awareness and Perceived Challenges of NEP 2020***

| Variables | N | r | Significance |
|---|---|---|---|
| Awareness & Perceived Challenges | 184 | –0.034 | $p > .05$ |

Note: The Pearson correlation analysis shows a weak and non-significant negative relationship ($r = –0.034$)

**Interpretation:** The Pearson correlation analysis shows a weak and non-significant negative relationship ($r = –0.034$) between teacher educators' awareness and perceived challenges regarding NEP 2020 implementation. This indicates that higher awareness does not necessarily reduce perceived challenges in implementing the policy.

**Findings:**

- The study revealed that teacher educators possess a moderate to high level of awareness regarding the provisions of the National Education Policy 2020.
- Significant differences were observed in teacher educators' awareness across the dimensions of curriculum, skills and professional development, technology and infrastructure, quality education, and the overall impact of the policy.

- The level of awareness varied with respect to certain demographic variables such as qualification, experience, and type of institution.
- Teacher educators reported several perceived challenges in implementing NEP 2020, particularly in areas related to curriculum restructuring, professional development, and technological infrastructure.
- Differences were observed in perceived challenges across the five key dimensions and selected demographic variables.
- The analysis indicated a relationship between teacher educators' awareness and their perceived challenges in implementing the policy.

**Discussion**

The findings of the study indicate that teacher educators possess a moderate level of awareness of the National Education Policy 2020, suggesting that although educators are generally familiar with the policy framework, deeper understanding of specific reforms is still developing. This finding aligns with previous research indicating that awareness of educational reforms among educators often evolves gradually as policy implementation progresses.

The study also revealed that teacher educators encounter several challenges in implementing NEP 2020, particularly in areas related to infrastructure, professional development, and curriculum restructuring. These findings highlight the practical complexities involved in translating policy vision into institutional practice. Effective implementation of educational reforms requires not only awareness but also institutional readiness, adequate training, and supportive infrastructure.

Furthermore, the results showed that demographic factors such as teaching experience and institutional context influence the challenges faced by teacher educators. Educators working in institutions with better resources and administrative support may experience fewer implementation barriers compared to those working in resource-constrained environments.

The weak correlation between awareness and perceived challenges suggests that awareness alone may not be sufficient to overcome implementation barriers. Institutional support systems, policy orientation programs, and professional capacity-building initiatives are essential for facilitating effective policy implementation.

**Educational Implications**

- Teacher education institutions should organize regular orientation and professional development programmes to enhance teacher educators' understanding of NEP 2020.
- Institutions need to strengthen technological infrastructure and digital resources to support the implementation of policy reforms.
- Curriculum restructuring should be supported through collaborative academic planning and policy training workshops.
- Policymakers and educational administrators should develop institutional support mechanisms that assist teacher educators in adapting to policy reforms.

**Conclusion**

The National Education Policy 2020 represents a transformative initiative aimed at restructuring the Indian education system, with teacher education playing a central role in achieving its objectives. The findings of the present study highlight that while teacher educators possess a reasonable level of awareness of the policy provisions, they continue to face several institutional and professional challenges in implementing its reforms.

Successful realization of the policy's vision requires strengthening teacher educators' policy literacy, improving institutional infrastructure, and providing sustained professional development opportunities. Bridging the gap between policy vision and institutional practice will ultimately depend on the collective efforts of policymakers, teacher education institutions, and educators in fostering a supportive environment for educational reform.

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# ASSESSMENT AND IMPLEMENTATION OF ACCESSIBILITY GUIDELINES FOR HIGHER EDUCATION INSTITUTIONS AND UNIVERSITIES 2022

**Ram Vijay Gupta [1], Prof Rupesh Kumar [2]**

**Abstract**

Accessibility in higher education is a fundamental component of inclusive education and social equity. Universities and higher education institutions are increasingly expected to create environments that support students with diverse abilities by eliminating barriers in infrastructure, digital platforms, and teaching practices. The implementation of accessibility guidelines ensures that students with disabilities can fully participate in academic and campus life. This research paper examines the assessment and implementation of accessibility guidelines in higher education institutions. It analyses global accessibility frameworks, evaluates institutional practices, and explores the challenges universities face in implementing inclusive policies. The study uses qualitative secondary research methods to analyse policy documents, institutional reports, and scholarly literature. Additionally, case studies of selected universities are examined to illustrate practical implementation strategies. The findings indicate that while many institutions have adopted accessibility guidelines, significant gaps remain in infrastructure accessibility, digital compliance, faculty training, and governance mechanisms. The paper proposes an accessibility implementation framework that integrates policy development, technological innovation, institutional governance, and continuous evaluation. The study concludes that systematic assessment and strategic implementation are essential to ensure equitable access to higher education.

***Keywords**: Accessibility, Inclusive Education, Higher Education Institutions, Digital Accessibility, Universal Design for Learning*

## Background

Higher education plays a critical role in promoting equality, social mobility, and intellectual development. However, for many students with disabilities, access to higher education remains limited due to physical, technological, and institutional barriers. Accessibility in higher education refers to the design and implementation of policies, infrastructure, and teaching practices that ensure equal participation for individuals with disabilities. Globally, governments and educational institutions have recognized the importance of accessibility in promoting inclusive education. Policies and frameworks emphasize that higher education institutions must provide equal opportunities for all learners regardless of their physical or cognitive abilities. Accessibility is therefore not only a legal obligation but also an ethical responsibility. In recent years, universities have increasingly adopted accessibility standards aimed at improving campus infrastructure, digital learning platforms, and support services. Despite these efforts, the implementation of accessibility guidelines remains inconsistent across institutions.

## Significance of the Study

The significance of this study lies in its focus on assessing how accessibility guidelines are implemented in higher education institutions. Understanding the effectiveness of accessibility initiatives can help policymakers and university administrators identify gaps and develop strategies for improvement.

This research contributes to the field of inclusive education by:

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- Evaluating accessibility practices in higher education.
- Identifying barriers that hinder accessibility implementation.
- Proposing a framework for improving institutional accessibility.

**Objectives of the Study**

The objectives of this research are:

1. To analyse accessibility guidelines applicable to higher education institutions.
2. To evaluate the implementation of accessibility practices in universities.
3. To identify challenges faced during accessibility implementation.
4. To examine case studies of universities implementing accessibility initiatives.
5. To propose an accessibility framework for higher education institutions.

**Research Questions**

The study addresses the following questions:

1. What are the key accessibility guidelines for higher education institutions?
2. How effectively are these guidelines implemented by universities?
3. What challenges hinder the implementation of accessibility practices?
4. How can universities improve accessibility through strategic planning?

**Literature Review**

**Concept of Accessibility in Education**

Accessibility refers to the design of environments, services, and products that allow individuals with disabilities to participate fully and independently. In the context of higher education, accessibility includes access to:

- Physical infrastructure
- Educational materials
- Digital learning platforms
- Academic support services

Accessibility promotes equality by ensuring that students with disabilities can engage in academic activities without unnecessary barriers.

**Inclusive Education and Higher Learning**

Inclusive education is based on the principle that all students should have equal opportunities to learn in an environment that respects diversity. Researchers emphasise that inclusive education benefits both students with disabilities and the broader student population by promoting diversity and innovation in learning.

Universities that adopt inclusive practices often experience improvements in student engagement and academic outcomes.

**Universal Design for Learning**

Universal Design for Learning (UDL) is a pedagogical framework that promotes flexible teaching methods to accommodate diverse learners.

UDL is based on three main principles:

| **Principle** | **Description** |
|---|---|
| Multiple Means of Representation | Providing information in different formats |
| Multiple Means of Engagement | Encouraging different ways for students to participate |
| Multiple Means of Expression | Allowing students to demonstrate learning through various methods |

Note: UDL Principles

This framework supports inclusive teaching practices and improves accessibility in higher education.

**Digital Accessibility**

Digital accessibility has become increasingly important with the expansion of online education and learning management systems. Accessible digital environments ensure that students with disabilities can access online content and participate in virtual learning.

Key elements of digital accessibility include:

- Screen reader compatibility
- Captioned videos
- Accessible documents
- Keyboard navigation
- Proper colour contrast

Failure to implement digital accessibility standards can significantly limit educational opportunities for students with disabilities.

**Accessibility Policies in Higher Education**

Many countries have developed policies to promote accessibility in universities. These policies typically require institutions to:

- Provide accessible infrastructure
- Develop disability support services
- Ensure digital accessibility
- Implement inclusive teaching practices

Research indicates that policy adoption alone does not guarantee successful implementation. Institutions must also invest in training, technology, and monitoring systems.

**Research Methodology**

**Research Design**

This study adopts a qualitative research design to analyse accessibility practices in higher education institutions. The qualitative approach allows for an in-depth understanding of accessibility policies, institutional practices, and implementation challenges.

**Data Sources**

The research is based on secondary data analysis using the following sources:

- Academic journals
- Institutional reports
- Government policy documents
- Accessibility guidelines
- University accessibility policies

These sources provide insights into accessibility frameworks and their implementation in higher education institutions.

**Data Analysis Method**

The collected data were analysed using thematic analysis.

The following themes were identified:

1. Infrastructure accessibility

2. Digital accessibility
3. Teaching and learning accessibility
4. Institutional governance
5. Implementation challenges

**Research Limitations**

The study has several limitations:

- It relies on secondary data rather than primary field surveys.
- Accessibility practices may vary across institutions.
- The study focuses primarily on institutional policies rather than individual student experiences.

Despite these limitations, the research provides valuable insights into accessibility implementation in higher education.

**Accessibility Guidelines for Higher Education Institutions**

Accessibility guidelines generally focus on multiple dimensions of university operations.

**Physical Infrastructure Accessibility**

Universities must ensure that campus infrastructure accommodates individuals with disabilities.

Examples include:

- Ramps and elevators
- Accessible classrooms
- Tactile pathways
- Accessible restrooms
- Accessible transportation systems

Accessible infrastructure allows students with disabilities to navigate campus independently.

**Digital Accessibility**

Digital accessibility ensures that online educational resources are usable by all students.

Universities should ensure:

- Accessible websites
- Screen reader compatible documents
- Captioned multimedia content
- Accessible learning management systems

Digital accessibility is especially important for online and blended learning environments.

**Accessible Teaching and Learning**

Faculty members play a crucial role in promoting accessibility in classrooms.

Accessible teaching strategies include:

- Providing lecture materials in advance
- Using clear and structured teaching methods
- Offering flexible assignment formats
- Using assistive technologies

These strategies help accommodate diverse learning styles.

**Accessible Assessment Systems**

Assessment systems should accommodate students with disabilities without compromising academic standards.

Examples include:

- Extended examination time
- Alternative examination formats
- Use of assistive technologies
- Accessible examination centres

**Institutional Governance**

Accessibility implementation requires institutional commitment and governance.

Key governance mechanisms include:

- Disability support centres
- Accessibility committees
- Faculty training programs
- Institutional accessibility audits

**Case Studies of Universities Implementing Accessibility**

**Case Study 1: University Accessibility Initiative**

One university implemented a comprehensive accessibility strategy that focused on infrastructure development, digital accessibility, and student support services.

Key initiatives included:

- Campus accessibility audits
- Installation of tactile pathways
- Accessible digital learning platforms
- Faculty training programs

The initiative significantly improved accessibility and increased enrolment of students with disabilities.

**Case Study 2: Technology-Driven Accessibility Program**

Another university adopted a technology-driven approach to accessibility.

Major initiatives included:

- Screen-reader compatible learning systems
- Captioned lecture videos
- Accessible digital libraries
- Assistive technology labs

These initiatives enhanced digital accessibility and improved the learning experience for students with disabilities.

**Case Study 3: Inclusive Campus Policy Model**

A third university integrated accessibility into its institutional governance framework.

Key strategies included:

- Establishment of a disability resource centre
- Institutional accessibility policy

- Regular accessibility audits
- Student feedback systems

The university reported improved accessibility outcomes and higher student satisfaction.

**Accessibility Implementation Framework**

The study proposes a **four-pillar accessibility framework** for universities.

| Pillar | Description |
|---|---|
| Policy Development | Institutional policies promoting accessibility |
| Infrastructure Accessibility | Accessible campus facilities |
| Digital Accessibility | Accessible online platforms and resources |
| Institutional Governance | Monitoring and evaluation systems |

Note: Four pillar accessibility framework

This framework emphasizes a holistic approach to accessibility implementation.

**Findings and Discussion**

**Growing Awareness of Accessibility**

Universities increasingly recognize the importance of accessibility and inclusive education. Many institutions have adopted accessibility policies and established disability support centres.

**Persistent Implementation Challenges**

Despite progress, several challenges remain:

- Limited financial resources
- Lack of faculty training
- Inaccessible digital resources
- Insufficient assistive technologies

These challenges hinder the effective implementation of accessibility guidelines.

**Importance of Institutional Leadership**

Institutional leadership plays a crucial role in promoting accessibility. Universities with strong leadership commitment tend to implement accessibility initiatives more effectively.

**Role of Technology**

Technology has become a key driver of accessibility. Assistive technologies, accessible learning platforms, and digital resources significantly enhance educational access for students with disabilities.

**Recommendations**

Based on the findings, the following recommendations are proposed:

1. Universities should develop comprehensive accessibility policies.
2. Faculty training programs on inclusive teaching should be implemented.
3. Institutions should invest in assistive technologies and accessible digital platforms.
4. Regular accessibility audits should be conducted.
5. Student feedback should be incorporated into accessibility planning.

**Conclusion**

Accessibility in higher education is essential for promoting inclusive learning environments and ensuring equal opportunities for students with disabilities. While many universities have made progress in adopting accessibility guidelines, significant gaps remain in implementation. Effective accessibility requires a comprehensive approach that integrates infrastructure development, digital accessibility, inclusive teaching practices, and institutional governance. Universities must also invest in training, technology, and continuous evaluation to ensure that accessibility initiatives are sustainable. By adopting strategic accessibility frameworks and strengthening institutional commitment, higher education institutions can create inclusive environments that support the academic success of all students.

One of the best examples of Inclusive education university established by State government of Uttar Pradesh on 2008. Dr Shakuntala Mirsa National Rehabilitation University in Lucknow. We should ensure all education institution would be become inclusive education. So that there learn together with any barriers.

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# MEDIA REPRESENTATION OF EDUCATIONAL REFORMS UNDER NEP 2020

**Manisha Sen [1]**

**Abstract**

The National Education Policy 2020 (NEP 2020) constitutes a significant overhaul that intends to remodel India's education system by encouraging interdisciplinary education, digital convergence, and equitable access to high-quality education. At the same time, since NEP 2020 was first introduced, there has been a wave of discussion among teachers, members of the government, students, and common people. In that respect, the media is the main player in giving people information about NEP 2020 and explaining what the changes could mean for the entire education industry. Besides keeping the general public updated about the policy changes, through the media framing of the most important issues of education reform, public opinion gets calibrated as well. This research tries to find out how the educational reforms are portrayed in public discourse through the representation of NEP 2020 in Indian news media. To analyze how newspapers and digital news platforms present the policy and its implications, the research relies on the perspectives of Framing Theory and Agenda Setting Theory. Through the content analysis technique, it examines the news articles related to NEP 2020 published from 2020 to 2025 in the major newspapers of India to identify the key topics, the mood of the articles, and the storylines of the policy implementation. The research points out that journalism can impact the way people perceive and discuss educational changes in the present-day India.

**Keywords:** *NEP 2020, Media Representation, Education Policy, Framing Theory, Journalism Studies, Educational Reform.*

## Introduction

The National Education Policy 2020 is a radical change in the education of India because it seeks to redesign and reform the practice of education in India, in form of multidisciplinary education, integration with digital, and inclusion to quality education. The policy was introduced more than thirty years later and aims to solve the long-standing issues in Indian education sector that include creating flexibility, skills, and innovation in the process of teaching and learning. Being an all-encompassing reform program, NEP 2020 has made significant publications in the circle of educators, policymakers, and ordinary citizens, sparking numerous courses of discussion on numerous levels.

The role of news media in this context will play a critical role as this will serve as an alternative source of information and interpretation to the masses. Media is not just used to spread the information of the changes in policies but also influence the comprehension of the changes themselves in the form of framing and agenda setting. The manner in which educational reforms are framed by the news media can have some effects on how often citizens view, like, and adopt policy projects. Media narratives what is being constructed in the public discourse of education reforms by emphasizing some things and minimizing others.

Although the role of media has increasingly become relevant in communication of policies, minimal studies have been done to explain the representation of NEP 2020 within the Indian news media. This paper intends to hold this gap by examining the case of depicting and reporting educational reforms in news stories. The media representation is a vital concept to understand in order to estimate the effectiveness of the educational policies communication and the impact on the public awareness and perception of modern India.

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**Objectives**

The study is guided by the following objectives:

- To examine how educational reforms contained in NEP 2020 are covered in Indian news media.
- To determine the prevailing frames and themes of the media coverage on NEP 2020.
- To investigate whether or not reporting covered educational reforms in a good, unstable, or neutral manner.
- To assess the media contribution to the formation of the discourse and perception of education policy by the people.
- To examine the connection between media discourses and policy discourse in NEP 2020.

**Theoretical Framework**

The research is based upon major theories in mass communication that depict how media shapes and forms popular conception of a policy matter. To examine how the National Education Policy 2020 represents educational reforms, this paper will use Framing Theory and Agenda Setting Theory as the main theoretical bases of the research. These theories offer a systematic process of explaining how the news media frames, emphasizes, and suggests policy-related information.

**Framing Theory**

Framing Theory, developed by Robert M. Entman (1993), explains that media constructs reality by selecting and emphasizing information, shaping how audiences understand issues like NEP 2020. Such framing through headlines, language, tone, and sources—influences public perception, presenting the policy as positive, negative, or neutral and guiding analysis of media narratives.

**Agenda Setting Theory**

Agenda Setting Theory, developed by Maxwell McCombs and Donald Shaw (1972), explains that media shapes what people think about by prioritizing issues such as NEP 2020.Frequent media focus on themes like digital education, skill development, and implementation challenges influences public awareness and determines how educational reforms are prioritized.

**Application of Theories to the Study**

The combination of the Framing Theory and the Agenda Setting Theory has offered a complete framework on how to analyze the media representation. Although Framing Theory assists in comprehending the manner in which NEP 2020 is framed and perceived, Agenda setting theory elucidates the amount of attention provided to the policy in the media discourse.

A combination of these theories helps the study to:

- Determine leading NEP 2020 reporting frames.
- Compare the tone and story patterns of the mass media.
- Research prominence and frequency of news about education.
- Learn media effects on the way policy reforms are perceived by people.

Using these theoretical perspectives, the study helps to address the gap between the analysis of education policy and media studies, providing more insight into how the evolution of the education system is presented and felt in modern India.

**Literature Review**

The National Education Policy 2020 has become a new paradigm to reshape the education system of India to address the requirements of the 21st century. A number of researchers have explored the policy in structural, pedagogical as well as developmental dimensions. On the same note, Nevertheless, the policy has a number of implementation problems as exposed by skeptic views on the policy. The author adds that the socio-economic gap and the digital divide are the primary obstacles to the realization of the goals of the policy, particularly in the rural and underdeveloped areas (Ravi, 2024).

**Pandey (2025)** explains that media literacy is important in empowering people to process the media narratives around policy reforms through a critical lens.

**Rathi (2024)** points out that the policy is innovative, research-focused, and globally competitive in higher institutions of learning. All these studies reiterate the progressive and reformative aspects of NEP 2020 especially in the aspects of getting education in line with global standards.

**Similarly, Mangat (2024**) states that despite the priority of the policy of inclusiveness, there is still a structural and financial constraint of marginalized groups who do not have the resources to access a quality education. These criticisms illustrate the mismatch between the vision in policy and reality on the ground.

**Dey (2022)** claims that NEP 2020 presents serious reforms like multidisciplinary education, flexibility in the curriculum design, and more focus on digital education.

**Entman (1993),** Regarding communication, the media is very essential in influencing the overall discourse of the people regarding the policy reforms. As postulated, the Framing Theory elucidates how media pick and accentuate specifics to the reality therefore impacting on how viewers decipher the news. Similarly,

Despite extensive literature on NEP and media framing, very few studies specifically examine the attitude of Indian news media toward reporting educational reforms under NEP. Most research focuses either on policy analysis or theoretical media perspectives, without integrating both approaches. Therefore, empirical studies on media coverage are essential to understand how educational reforms are framed and presented to the public.

**Research Gap**

Based on the existing literature, the following research gaps can be identified:

- The available literature about NEP is based more on analysis, implementation and results of education but not much is done on media representation.
- The gap is that no study of policy issues and mass communication theories like framing and agenda setting were combined in education policy research.
- There are few empirical studies that examine NEP coverage by Indian news media, especially in the tone, themes and narrative structure.
- The existing studies fail to analyse the issue of how media reporting affects societal perception and discussion of the educational changes.

Therefore, this study addresses these gaps by examining *media framing and representation of NEP 2020 in Indian news media.*

**Research Design**

The paper will take a qualitative research design to explore how the educational reforms are represented in the media in line with the National Education Policy 2020. The qualitative research would be particularly appropriate in this case because it gives an opportunity to examine meanings, interpretations, and narrative that reside within media texts in detail.

The technique applied is mainly content analysis that is universal in media and communication studies in the systematic analysis of textual information. Content analysis helps the researcher to detect the repeated patterns and themes as well as framing strategies employed in news reporting. Through this approach, the paper aims at not trying to comprehend what is reported regarding NEP, but how it is being reported to the audience. This method is particularly effective to look into media discourse and its contribution to the development of the general concept of policy reforms.

**Research Approach**

The research is descriptive and analytical in nature. The descriptive dimension is based on the description of the character and scope of media treatment of NEP 2020, whereas the analytical dimension considers the hidden content, framing tendencies, and selectivity of the coverage.

This two-fold method will enable the researcher to analyze the content on the surface (including the subject matter and the frequency of coverage) as well as the process of message delivery (including the framing, the construction of the narratives, and focus). In turn, the research offers an in-depth explanation of the representation of educational reforms in newspapers and the impact of the given form of representation on the general discussion.

**Data Collection**

**Sources of Data**

The study collects data from leading Indian newspapers such as The Hindu, The Indian Express, The Times of India, and Hindustan Times, selected for their wide reach, credibility, and influence on public discourse. Their diverse editorial styles and inclusion of both print and digital formats enable a comprehensive analysis of how National Education Policy 2020 is represented and understood by the public.

**Sampling Technique**

This study employs purposive sampling, a non-probability sampling method that involves the deliberate selection of data based on its relevance to the research objectives. In this context, only those news articles that explicitly discuss NEP 2020 and related educational reforms are included in the sample.

The selection criteria for articles include:

- Direct reference to NEP 2020
- Discussion of educational reforms, policies, or implementation issues
- Coverage of debates, opinions, or analysis related to the policy

Articles that mention education in general without specific reference to NEP 2020 are excluded to maintain the focus and relevance of the study. This targeted approach ensures that the data collected is rich, meaningful, and directly aligned with the research objectives.

**Time Frame**

The study covers a time period from 2020 to 2025, beginning with the official announcement of NEP 2020 and extending to recent developments in its implementation. This time frame is strategically chosen to capture the evolution of media coverage over time.

The selected period allows the researcher to analyze:

- Initial media reactions immediately after policy announcement
- Ongoing discussions and debates regarding implementation
- Shifts in media narratives as the policy progresses

By covering multiple years, the study provides a longitudinal perspective, enabling a deeper understanding of how media representation of NEP 2020 has changed or remained consistent over time.

**Sample Size**

A total of 80–100 news articles are selected for analysis. This sample size is considered appropriate for qualitative content analysis, as it allows for both depth and diversity of data.

The selection of this range ensures:

- Adequate representation of different newspapers
- Inclusion of varied perspectives and themes
- Manageability for detailed qualitative analysis

The sample is distributed across different years and media outlets to avoid bias and ensure a balanced representation of media coverage.

**Unit of Analysis**

The unit of analysis in this study is individual news articles related to NEP 2020. Each article is treated as an independent unit of analysis and is examined systematically to identify patterns in content, tone, and framing.

Each selected article is analyzed based on multiple dimensions, including:

- The main theme or topic discussed
- The tone of reporting (positive, negative, or neutral)
- The framing of the policy (e.g., reform-oriented, critical, or conflict-based)
- The type of sources cited (government officials, experts, educators, etc.)

By focusing on individual news articles, the study ensures a micro-level analysis, allowing for detailed interpretation of how media narratives are constructed. This approach enables the researcher to capture subtle differences in language, emphasis, and perspective across different media outlets.

Furthermore, treating each article as a unit of analysis enhances the systematic and structured nature of the research, ensuring consistency in data coding and interpretation. It also allows for the comparison of coverage across different newspapers and time periods, thereby strengthening the overall analytical depth of the study.

**Data Analysis**

The collected data is analyzed using a combination of qualitative content analysis and thematic analysis, which are widely used methods in media and communication research for interpreting textual data. These methods enable the researcher to systematically examine news articles and identify patterns in media representation, narrative construction, and framing of policy issues related to the National Education Policy 2020.

The process of analysis involves multiple stages, including data familiarization, coding, categorization, and interpretation. Initially, all selected news articles are carefully read to gain a comprehensive understanding of the content. This is followed by open coding, where key words, phrases, and ideas related to NEP 2020 are identified and labeled. These codes are then grouped into broader categories and themes.

A coding framework is developed based on both theoretical concepts (Framing Theory and Agenda Setting Theory) and emerging patterns from the data. This ensures that the analysis is both theory-driven and data-driven. The categorized data is then interpreted to identify dominant trends and patterns in media coverage.

**Thematic Analysis**

Thematic analysis is used to identify recurring themes in media coverage. The study focuses on the following major themes:

- **Educational Reforms and Policy Changes** Coverage highlighting structural reforms, curriculum changes, and policy innovations introduced by NEP 2020.
- **Digital Learning and Technological Integration** Discussions on online education, e-learning platforms, and the role of technology in education.
- **Implementation Challenges** Issues related to infrastructure, teacher training, funding, and policy execution.
- **Criticism and Public Debate** Media discussions reflecting concerns, controversies, and differing opinions regarding NEP 2020.

These themes help in understanding the focus areas of media discourse and the aspects of the policy that receive maximum attention.

**Analysis of Tone of Coverage**

Each news article is examined to determine the tone of reporting, which reflects the overall attitude of the media toward NEP 2020. The tone is categorized as:

- **Positive Tone**: Articles that highlight the benefits, opportunities, and progressive aspects of the policy.
- **Negative Tone**: Articles that emphasize challenges, criticisms, and potential drawbacks.
- **Neutral Tone**: Articles that provide balanced reporting without clear positive or negative bias.

This analysis helps in assessing whether media coverage is supportive, critical, or balanced, thereby indicating the general sentiment of media discourse.

**Framing Analysis**

Framing analysis is conducted to examine how NEP 2020 is presented in news media. Based on Framing Theory, the study identifies the following frames:

- **Reform-Oriented Frame**: Emphasizes innovation, modernization, and improvement in the education system.
- **Critical Frame**: Highlights limitations, challenges, and policy shortcomings.
- **Conflict Frame**: Focuses on disagreements, debates, and political or institutional conflicts.
- **Developmental Frame**: Links educational reforms to national growth, economic development, and social progress.

By analyzing these frames, the study explores how media constructs narratives and influences audience interpretation of educational reforms.

**Source Analysis**

The study also examines the types of sources cited in news articles, as sources play a crucial role in shaping media narratives. The sources are categorized as:

- Government officials and policymakers
- Education experts and academicians
- Teachers and students
- Policy analysts and independent commentators

This analysis helps in identifying which voices dominate media discourse and whether the coverage reflects a diverse range of perspectives or is dominated by specific groups.

**Reliability and Validity**

Ensuring reliability and validity is essential for maintaining the rigor and credibility of the research.

**Reliability**

Reliability is ensured through the use of a systematic and consistent coding procedure. Clear definitions are established for each category (themes, tone, frames, and sources), which minimizes ambiguity and ensures consistency in analysis. The structured coding framework reduces the chances of random or biased interpretation.

**Validity**

The validity of the study is strengthened through:

- Use of credible and widely recognized news sources
- Application of established theoretical frameworks such as Framing Theory and Agenda Setting Theory
- Alignment between research objectives, data collection, and analysis methods

These factors ensure that the study accurately reflects the media representation of NEP 2020 and provides meaningful insights.

**Limitations of the Study**

Despite its strengths, the study has certain limitations that should be acknowledged:

- The research is limited to selected newspapers, which may not fully represent the diversity of the entire Indian media landscape.
- The study focuses only on print and digital news media, excluding other influential platforms such as television and social media.
- The qualitative nature of content analysis involves interpretation by the researcher, which may introduce a degree of subjectivity.
- The selected time frame may not capture future developments in the implementation of NEP 2020.

Recognizing these limitations helps in maintaining transparency and provides direction for future research.

**Ethical Considerations**

This study is based entirely on secondary data obtained from publicly available news sources, and therefore does not involve human participants or primary data collection. As a result, issues related to informed consent or confidentiality do not arise.

However, ethical standards are maintained by:

- Properly acknowledging all sources of information
- Avoiding plagiarism through accurate citation and referencing
- Ensuring objective and unbiased analysis of media content
- Maintaining transparency in research design and methodology

The study adheres to the principles of academic integrity, honesty, and responsible research practice, ensuring that the findings are credible and ethically sound.

**Findings and Discussion**

This section presents the findings derived from the qualitative content analysis of selected news articles related to the National Education Policy 2020. The analysis focuses on identifying dominant themes, tone of coverage, framing patterns, and sources cited in media reporting. The findings are interpreted in light of Framing Theory and Agenda Setting Theory to understand how news media constructs and communicates narratives around educational reforms.

**Dominant Themes in Media Coverage**

The analysis reveals that media coverage of NEP 2020 is structured around several key themes.

**1. Educational Reforms and Policy Transformation**

A significant portion of news articles highlights the transformative nature of NEP 2020, focusing on reforms such as multidisciplinary education, flexibility in curriculum, and institutional restructuring. Media narratives often present the policy as a progressive step toward modernizing India's education system.

### 2. Digital Learning and Technological Integration

Another dominant theme is the emphasis on digital education and the integration of technology in teaching and learning processes. Articles frequently discuss online learning platforms, digital classrooms, and the role of technology in enhancing accessibility and quality of education.

### 3. Implementation Challenges

Many news reports focus on the practical challenges associated with implementing NEP 2020. These include issues such as lack of infrastructure, insufficient teacher training, funding constraints, and disparities between urban and rural educational institutions.

### 4. Criticism and Public Debate

Media coverage also reflects critical perspectives, including concerns about feasibility, policy clarity, and long-term impact. Debates among policymakers, educators, and experts are often highlighted, indicating that NEP 2020 is a subject of ongoing public discourse.

### Tone of Media Coverage

The analysis of tone indicates that media coverage of NEP 2020 is **mixed in nature**:

- **Positive Coverage**: A large number of articles portray the policy as innovative and reform-oriented, emphasizing its potential to transform the education system.
- **Negative Coverage**: Some articles highlight challenges, limitations, and criticisms related to implementation and inclusivity.
- **Neutral Coverage**: Several reports adopt a balanced approach, presenting both advantages and concerns without clear bias.

This mixed tone suggests that the media plays a relatively balanced role, providing both supportive and critical perspectives on educational reforms.

### Framing of NEP 2020 in Media

The study identifies multiple framing patterns in media coverage:

### Reform-Oriented Frame

Many articles frame NEP 2020 as a progressive and transformative reform, emphasizing innovation, modernization, and global competitiveness.

### Critical Frame

Some coverage focuses on policy limitations, highlighting issues such as inequality, digital divide, and implementation barriers.

### Conflict Frame

Media also presents debates and disagreements among stakeholders, including policymakers, educators, and institutions.

### Developmental Frame

Certain narratives link NEP 2020 to broader national development goals, portraying it as essential for economic growth and social progress.

These frames demonstrate how media selectively emphasizes different aspects of the policy, influencing public interpretation.

**Source Representation in Media**

The analysis of sources reveals that:

- Government officials and policymakers are the most frequently cited sources
- Education experts and academicians are moderately represented
- Teachers and students are less frequently included
- Independent analysts and critics appear in opinion-based articles

This indicates that media discourse is largely policy-driven, with limited representation of grassroots perspectives.

**Discussion of Findings**

The findings of this study align with the assumptions of Framing Theory (Robert M. Entman, 1993), which suggests that media shapes audience perception by emphasizing certain aspects of reality. The presence of multiple frames—such as reform-oriented and critical frames—demonstrates how media constructs diverse narratives around NEP 2020.

Similarly, the results support Agenda Setting Theory (Maxwell McCombs & Donald Shaw, 1972), as the frequent coverage of specific themes (e.g., digital learning and policy reforms) indicates that media prioritizes certain issues, thereby influencing public attention.

The dominance of reform-oriented narratives suggests that media largely portrays NEP 2020 as a progressive initiative. However, the presence of critical and conflict frames highlights that media also acts as a platform for debate and scrutiny.

Furthermore, the limited representation of teachers and students suggests a gap in inclusive media discourse, indicating that grassroots perspectives are underrepresented. This has important implications for how educational reforms are understood at the societal level.

**Conclusion**

This study examined the media representation of educational reforms under the National Education Policy 2020 in Indian news media using the frameworks of Framing Theory and Agenda Setting Theory. The findings reveal that media plays a significant role in shaping public discourse around educational reforms by highlighting specific themes, frames, and narratives.

The analysis shows that media coverage of NEP 2020 is largely centered around themes such as policy transformation, digital learning, and implementation challenges. While a considerable portion of the coverage presents the policy in a positive light—emphasizing innovation and modernization—there is also notable attention given to critical perspectives, including issues of inequality, infrastructure limitations, and feasibility of implementation. This indicates that the media provides a balanced yet selective representation of the policy. Furthermore, the study highlights that media framing significantly influences how educational reforms are perceived by the public. The dominance of reform-oriented and developmental frames suggests that NEP 2020 is largely portrayed as a progressive initiative. However, the presence of critical and conflict frames reflects ongoing debates and concerns surrounding the policy. The findings also reveal that media discourse is predominantly driven by policymakers and experts, with limited representation of grassroots voices such as teachers and students.

Overall, the study underscores the crucial role of journalism in bridging the gap between policy formulation and public understanding, thereby shaping the success and acceptance of educational reforms.

**Recommendations**

Based on the findings of the study, the following recommendations are proposed:

**1. Promote Balanced and Inclusive Media Coverage**

Media organizations should ensure more inclusive representation by incorporating diverse voices, particularly those of teachers, students, and local stakeholders. This will provide a more comprehensive understanding of the ground realities of policy implementation.

**2. Strengthen Media Literacy**

There is a need to promote media literacy among audiences so that individuals can critically analyze media content and better understand policy-related information. This will help in reducing misinformation and improving public engagement with educational reforms.

**3. Encourage Responsible Journalism**

Journalists should adopt responsible reporting practices by presenting both opportunities and challenges of NEP 2020 in a balanced manner. This will enhance the credibility of media coverage and support informed public discourse.

**4. Enhance Policy Communication Strategies**

Policymakers should develop more effective communication strategies to clearly convey the objectives, benefits, and implementation processes of NEP 2020. Collaboration between policymakers and media can improve the accuracy and clarity of information dissemination.

**5. Expand Future Research**

Future studies can extend this research by:

- Including social media platforms such as Twitter and YouTube
- Conducting audience perception studies
- Comparing regional vs national media coverage

This will provide a more comprehensive understanding of media influence on educational reforms.

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4

# INTEGRATING INDIAN KNOWLEDGE SYSTEMS IN TEACHER EDUCATION: REVITALIZING PEDAGOGICAL PRACTICES FOR HOLISTIC LEARNING

**Razia Azhar** [1]

**Abstract**

The adoption of Indian Knowledge Systems (IKS) in teacher education is becoming a growing priority for comprehensive learning. In education, there is more and more focus on culturally appropriate teaching. But teacher training in India is mostly based on Western ideas. This makes it hard for students to use what they know in the classroom. The National Education Policy 2020 and other policy frameworks help IKS integration. But teacher education programs still don't do enough to put it into practice. The study seeks to investigate the theoretical underpinnings of Indigenous Knowledge Systems (IKS). It also looks at how IKS is important for training teachers. The emphasis is on enhancing teacher preparation via indigenous knowledge. The research employs a qualitative and conceptual methodology. It is predicated on the examination of secondary sources and policy papers. We also look at existing research articles to find useful information. The results indicate that IKS fosters value-oriented education. It also backs teaching methods that are based on experience and culture. The report suggests changes to the curriculum and training to make IKS work better together.

***Keywords:*** *Indian Knowledge Systems (IKS), Teacher Education, Holistic Learning, Indigenous Pedagogy, National Education Policy 2020*

## Introduction

Indian Knowledge Systems (IKS) include a long and important history of knowledge that has shaped Indian civilization for thousands of years, from the Vedas to modern thinkers (Pillai, 2024). These systems include Jnan, Vignan, and Jeevan Darshan. They give you a whole and integrated way to understand life. They bring together the cerebral, emotional, and spiritual dimensions of learning (Behera & Giri, 2024). IKS encourages every individual to be appreciative by living in harmony with nature and following moral principles. This is contrary to how current schooling works.

Integrating Indian Knowledge Systems (IKS) into teacher education is essential for achieving epistemic justice and the decolonization of knowledge, rectifying the historical marginalization of Indigenous wisdom by colonial educational structures (Chatterjee, 2025). It gives teachers a way to teach that is sensitive to different cultures and lets them act as a link between schools and the communities they are in. IKS also teaches pupils skills they will need in the 21st century, like how to think critically and live sustainably. It does this by showing people how to look at the world from an Indian point of view, or Bhāratiyu Drishti.

Despite this, there is still a major lack of research because teacher education in India mostly follows Western models, which makes it hard to use indigenous knowledge in the classroom. The National Education Policy (NEP) 2020 provides a comprehensive framework for integration; yet, its implementation is obstructed by epistemological disagreements, inadequate faculty competency, and the risk of tokenism. Numerous knowledge systems remain stigmatized and marginalized inside traditional educational frameworks. This study seeks to examine the theoretical foundations of Indigenous Knowledge Systems (IKS) and evaluate its specific importance in improving teacher preparation. The objectives are to identify methods for modifying the curriculum and enhancing ability to ensure that indigenous knowledge is utilized effectively to achieve all educational objectives.

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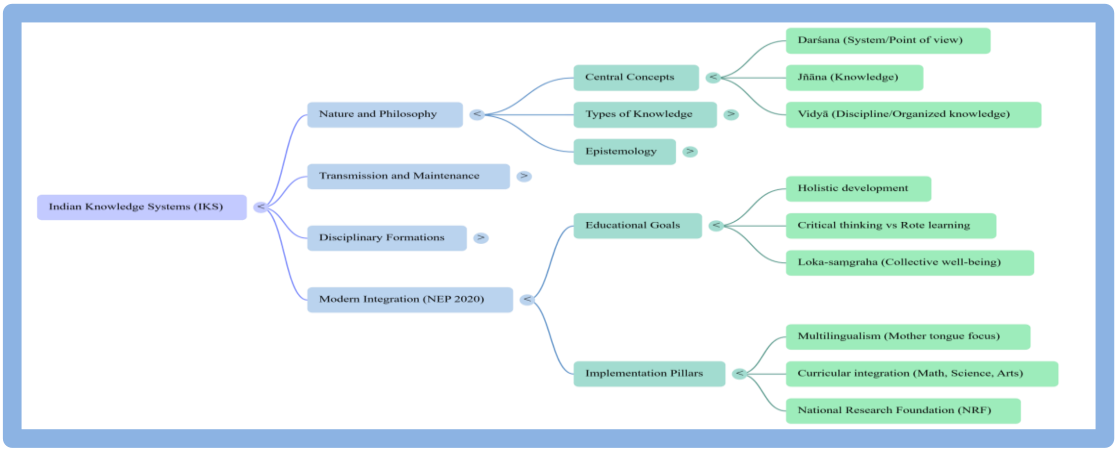
## Conceptual Framework

The Indian Knowledge System (IKS) is the organized sharing of Jnan (Knowledge), Vignan (Science), and Jeevan Darshan (Philosophy of Life) that has been built up over many years of diligent study and experience (Pillai, 2024). It entails a systematic transfer of information encompassing Vedic literature, indigenous wisdom, and classical arts. Panchkosh (the five sheaths of personality), Ashtang Yoga, Triguna theory, and Purushartha are all important parts of integrating education. Pedagogical instruments, like Panchpadi and value-centric narratives from the Panchatantra, Ramayana, and Mahabharata, are also incorporated (Singh & Bajpai, 2025).




**Source:** *The Conceptual Framework*, created by using Notebooklm Software

The intellectual foundation of IKS is grounded in holism. It sees knowledge as one big thing instead of different fields. This method aims for the "oneness of all" (abheda), focusing on the full realization and freedom of the self (Kapoor & Singh, 2005; Behera & Giri, 2024). This point of view encourages growth in all three areas at the same time: physical, mental, and spiritual. IKS also values learning by doing. In this case, knowledge comes from seeing things happen instead of memorizing them. The five-step Panchpadi teaching method—Aditi (Introduction), Bodh (Understanding), Abhyas (Practice), Prayog (Application), and Prasar (Expansion)—is a practical way to use this idea (Singh & Bajpai, 2025). IKS is also very similar to ethics (Dharma), which stresses ideals like truth, non-violence, and the good of society.

Connecting IKS with teacher education is crucial for developing a culturally relevant teaching method that changes existing educational systems (Chatterjee, 2025). NEP 2020 envisions teachers as central figures who should be grounded in Indian values while also being knowledgeable about modern teaching methods. This requires building skills, reforming the curriculum in the 4-year integrated B.Ed., and creating specialized training centers to empower teachers as cultural intermediaries (Pillai, 2024; Singh & Bajpai, 2025). Ultimately, this integration turns teacher preparation into a comprehensive effort capable of meeting 21st-century challenges from the perspective of Bhāratiyu Drishti.

## Review Of Literature

### 1. Studies On Indian Knowledge Systems (IKS)

**Singh and Bajpai (2025)** used a research design that included creating a conceptual framework and then validating it through focus group discussions with 39 school teachers. Their findings identified nine key IKS components, including Panchkosh and Ashtang Yoga. These components were categorized into dimensions of holistic development, value education, and teaching methods. The study showed that while teachers are willing to incorporate these elements, they need specialized training to apply them practically in the classroom. In the end, the paper concludes that grounding education in India's intellectual heritage significantly improves student confidence and mental growth.

**Mandal (2025)** used a mixed-methods approach, examining primary ancient texts like the Vedas and Vedanta along with modern scholarly interpretations. The findings highlight the important role of the Vedas in shaping intellectual traditions and the scientific basis of IKS's holistic approach to knowledge. The study points out that IKS is a flexible system that incorporates new ideas while keeping a central view of the interconnectedness of all things. Additional results suggest that ancient Indian contributions to mathematics and medicine are still relevant in today's scientific discussions.

**Studies On Teacher Education Reforms In India**

**Majumder and Das (2025)** used a qualitative research method that included a thorough review and thematic analysis of academic papers and policy documents. Their findings discuss the major changes in teacher education under NEP 2020, highlighting chances for multidisciplinary learning and technology use. However, the researchers also found significant challenges, such as infrastructure issues and the need for major changes in training institutions. The article suggests that enhancing the position and competencies of educators is essential for the enduring reform of the educational system.

**Nayak (2026)** took a qualitative review approach based on secondary sources, which included government reports and research articles published from 2020 to 2026. The study shows that while programs like the Integrated Teacher Education Programme (ITEP) have started, their implementation is uneven across the country. Key challenges include a lack of qualified faculty with interdisciplinary knowledge and differences in institutional capacity. The study points out new opportunities in using digital platforms for required ongoing professional development for educators.

**Rajput et al. (2025)** carried out a survey-based study using simple random sampling to collect data from 150 college stakeholders in Rajasthan, which was analyzed using frequency and percentage. The results show that most people who answered the question know what IKS is and how it relates to NEP 2020.The researchers recommend focusing on making digital content accessible and clear to connect traditional knowledge with modern learners. The study concludes that addressing gaps in digital literacy and applying localized teaching methods are crucial for maximizing the policy's impact.

**Studies On Global Perspectives And Teacher Applications**

**Chatterjee (2025)** utilized a qualitative and analytical study approach to verify the adoption of Indigenous Knowledge Systems (IKS) through the theoretical frameworks of epistemic justice and decolonial philosophy. The results reveal significant obstacles to integration, including epistemological conflicts between Western and indigenous perspectives and the potential for superficial tokenism. The research suggests a structure for gradual capacity enhancement, community involvement, and the creation of open educational resources. The author asserts that the incorporation of Indigenous Knowledge Systems (IKS) is a moral imperative that transforms teacher education into a more culturally relevant and enduring endeavor.

**Behera and Giri (2024)** investigated revitalization frameworks via an analytical inquiry in accordance with the National Education Policy 2020 guidelines. The results underscore the significance of disciplines such as Ayurveda and Vedanta in offering a balanced framework for tackling global issues like mental health and social equity. The study suggests the inclusion of pedagogical instruments such as the Guru-Shishya tradition, experiential learning, and scholarly debate (Shastrartha). The authors assert that the integration of these systems fosters interdisciplinary learning and equips students to adeptly navigate a swiftly evolving world.

**Deivam and Joshi (2025)** utilized qualitative analysis and philosophical inquiry to examine the integration of Indigenous Knowledge Systems (IKS) into teacher education programs.The study results contest the preeminence of Western epistemological traditions and advocate for a curriculum grounded in indigenous principles such as interconnectedness and stewardship. The researchers contend that Indigenous Knowledge Systems (IKS) possess the potential to catalyze environmental awareness and social justice among prospective educators. The paper concludes that successful integration necessitates supportive policies, committed funding for IKS research, and extensive faculty development.

**UNESCO/Nakashima (2010)** provided a thorough compilation of worldwide policies and practices via an interdisciplinary examination of education, science, and culture. The study's results criticize formal education systems for not representing unique indigenous cultures, which frequently results in a considerable loss of traditional skills and languages. It supports a "both ways" education model that combines the benefits of mainstream schooling with the passing down of indigenous knowledge from one generation to the next. The report emphasizes the pressing necessity for curriculum reform to advance minority histories, identities, and mother-tongue education. It ultimately calls for recognizing indigenous people as legitimate knowledge holders who can offer unique solutions to global social and environmental problems.

**Jacob, Cheng, and Porter (2014)** performed a worldwide review using a broad "aerial perspective" to look at how indigenous people learn in Africa, Asia, Europe, and the Americas. Their research characterizes indigenous education as a comprehensive process designed to cultivate future leaders who can extract profound significance from their native heritages while adapting to globalization. The research delineates a distinct renaissance in Asian indigenous education commencing circa 1990, centered on the preservation of diversity in opposition to hegemonic national systems. The authors contend that indigenous epistemologies can be advantageous for all members of society when incorporated in a culturally attuned manner. They end by asking for hybrid teaching models that can adapt to both formal and community-based ways of learning.

## Policy Context

The policy landscape for the **Indian Knowledge System (IKS)** is currently undergoing a transformative shift, moving from the marginalization of indigenous wisdom to its scientific integration into mainstream education (Deivam & Joshi, 2025). This revitalization is driven by a comprehensive framework of national policies, regulatory guidelines, and institutional activities designed to create a culturally rooted and future-ready education system.

## Role Of The National Education Policy (Nep) 2020

The National Education Policy 2020 is the main reason why IKS is becoming more common, and it does so by using India's rich history as a guide.

- **Holistic Vision:** NEP 2020 imagines an education system based on Indian values that helps make India a global knowledge superpower. It changes the focus from memorizing facts to a more complete, multidisciplinary approach that combines old knowledge with new science.
- **Integration into the Curriculum:** The policy specifies that all levels of education, from elementary school to college, shall teach IKS in a scientific method. This includes tribal knowledge and traditional means of learning math, astronomy, and medicine (NEP, 2020).
- **Language and Pedagogy:** It stresses the importance of multilingualism and using the mother tongue to help pass on IKS, making sure that students have a strong connection to their cultural heritage.

## Ncte Guidelines And Teacher Education Reforms

The **National Council for Teacher Education (NCTE)** is tasked with restructuring teacher preparation to align with these goals.

- **NCFTE 2021**: The NCTE is in charge of creating a new National Curriculum Framework for Teacher Education (NCFTE) 2021, which will include IKS in teacher training.
- **ITEP:** The four-year Integrated Teacher Education Programme (ITEP) will be the minimum requirement for teachers by 2030. It is a dual-major degree that combines subject specialization with a strong foundation in Indian values and modern teaching methods (Nayak, 2026).
- **National Mission for Mentoring (NMM):** To help with this change, the NCTE has started a mentoring mission to connect senior faculty with teachers to help them grow professionally and learn more about Indian traditions (Mandavkar, 2023).

## Institutional Initiatives And Curriculum Reforms

Strategic institutional efforts are being implemented to ensure the practical application of IKS.

- **IKS Division:** This division was set up by the Ministry of Education at AICTE in October 2020. It coordinates research across different fields and the creation of 32 IKS Centers across India to encourage new research (Mandavkar, 2023; Pillai, 2024).
- **Training Infrastructure:** The framework includes the building of 17 IKS Teacher Training Centers and 7 IKS Bhasha Kendras to help people learn about language and culture (Chandel & Prashar, 2024).
- **Credit Mandates:** The UGC has required that 5% of all credits in undergraduate and graduate programs be spent on IKS-related courses.
- **Digital Transformation:** Existing IKS courses are being synced with digital platforms like SWAYAM and DIKSHA to give teachers a lot of standardized professional development (Mandavkar, 2023; Pillai, 2024).

**Methodology**

The study utilizes a qualitative and conceptual research methodology to examine the theoretical underpinnings and educational significance of the Indian Knowledge System (IKS).The secondary sources comprise classical texts, extant papers, and academic journals. Additionally, policy documents like the National Education Policy 2020 and National Curriculum Frameworks are examined to reconcile traditional knowledge with contemporary standards. To ensure rigor, existing research papers are examined to pinpoint discrepancies between indigenous knowledge and Westernized teacher training models. This qualitative analysis delineates essential strategies for curriculum reform and the enhancement of faculty capacity. The analysis also looks at problems that make implementation harder, like not having enough faculty or resources. This paper examines the integration of traditional Indian knowledge systems—anchored in holistic, ethical, and experiential learning—into contemporary teacher education to develop culturally responsive, value-driven, and sustainable pedagogical practices in accordance with modern reforms such as the National Education Policy 2020.

**Data Analysis**

The incorporation of Indian Knowledge Systems (IKS) into teacher education adheres to a multidisciplinary framework, necessitating that independent teacher education institutions (TEIs) evolve into integrated multidisciplinary universities by 2030. The National Education Policy (NEP) 2020 supports this structural change by making the 4-year integrated B.Ed. degree the minimum requirement for school teachers. This degree includes IKS in specialized subjects and basic pedagogy. The UGC's requirement that 5% of all higher education credits go to IKS-related courses is also part of strategic models.

IKS-based teaching methods focus on experiential learning instead of rote memorization. Instead of memorizing facts, students learn how to learn by asking questions, exploring, and doing hands-on activities. It is important to use stories and oral traditions, like fables from the Panchatantra and Jataka, to pass on moral values and cultural heritage in a meaningful way. Yoga and mindfulness practices are also used as important tools for physical, mental, and emotional health. They help both students and teachers focus and improve their cognitive skills. However, putting these systems into action is very hard because there aren't enough trained teachers who can teach interdisciplinary IKS. Curriculum rigidity and the gap between traditional theory and modern classroom practices often create a risk of tokenism, where indigenous knowledge is only superficially added. Also, the widespread use of IKS is slowed down by a lack of standardized teaching materials in regional languages and gaps in digital literacy.

**Findings**

1. Integrating Indian Knowledge Systems (IKS) fosters comprehensive development by encompassing both physical and spiritual aspects through frameworks such as Panchkosh. Over 63% of stakeholders are very aware, but implementation is still uneven because there aren't enough faculty members and resources.
2. The results show that IKS brings new life to teaching by replacing rote learning with hands-on methods and the scientific Panchadi process.

3. Key insights indicate that this methodology enhances student confidence, cultivates character, and equips learners to address contemporary challenges through a Bhāratiyu Drishti (Indian perspective).
4. In the end, integrating IKS turns teachers into cultural mediators, connecting indigenous heritage with modern science to achieve epistemic justice and improve the health of students in the 21st century.

## Educational Implications

The **implications** of this study are far-reaching:

- **For Teacher Educators:** There is an urgent need for continuous professional development (CPD), with a mandated 50 hours of training annually to empower teachers as cultural mediators.
- **For Curriculum Designers:** They need to redesign the curriculum so that it is culturally relevant by incorporating IKS ideas into regular subjects like math and environmental science instead of teaching them separately.
- **For Policymakers:** To keep the success going, they need to set up IKS research centers, get money from the National Research Foundation (NRF), and make sure that multilingualism is a top priority to protect indigenous knowledge.

## Future Scope

Subsequent research ought to concentrate on longitudinal studies to assess the enduring effects of IKS-infused curricula on student learning outcomes and character development. There is a substantial necessity to investigate the practical implementation of ancient theories (such as Tribal ecological knowledge or Nyaya logic) within contemporary scientific and technological contexts to tackle global issues like climate change and food security. The creation of AI-powered tools and digital repositories for the translation and preservation of oral and endangered indigenous traditions represents a crucial domain for technological advancement. International collaborative research should be augmented to establish IKS as a significant contributor to global knowledge diplomacy.

## Recommendations

1. **Building Capacity:** Institutions should put building capacity for faculty through specialized workshops, refresher courses, and working with traditional knowledge holders at the top of their to-do list.
2. **Integrating IKS into the curriculum:** Curriculum designers should move from "preservation to utilization" by adding IKS ideas to math and science classes, for example, to avoid the risk of symbolic tokenism.
3. **Policy and Funding:** Policy makers should make sure that the NCFTE is released on time and that the NRF gives out dedicated research grants to encourage new IKS research.
4. **Digital Outreach:** To help teachers keep learning and growing in their jobs, standardized IKS modules should be made available on platforms like SWAYAM and DIKSHA.
5. **Multilingualism:** It is very important that the mother tongue and local languages are used as the language of instruction to make sure that indigenous knowledge is passed on correctly.

## Conclusion

Integrating Indian Knowledge Systems (IKS) into teacher education is essential for attaining epistemic justice and decolonizing the Indian educational framework. This research demonstrates that IKS, encompassing Jnan, Vignan, and Jeevan Darshan, provides a scientifically sound and flexible framework that fosters comprehensive development through principles such as Panchkosh and Ashtang Yoga. NEP 2020 offers a strong policy master plan for this revitalization, but it isn't being put into action evenly because there aren't enough qualified teachers, resources are scarce, and there is still a colonial bias in the way things are taught. Moreover, the shift of teacher training to multidisciplinary institutions and the launch of the four-year Integrated Teacher Education Programme (ITEP) are essential structural reforms needed to instill future educators with the Indian ethos while upholding contemporary pedagogical standards. In the end, IKS shouldn't be seen as a separate subject but as a way to improve critical thinking, sustainability, and the health of everyone.

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# INDIAN KNOWLEDGE SYSTEM AND ITS SCIENTIFIC FOUNDATIONS: INTEGRATING TRADITIONAL KNOWLEDGE WITH MODERN CHEMICAL SCIENCE

**Adil Mohiuddin [1]**

**Abstract**

The Indian Knowledge System (IKS) represents one of the world's oldest intellectual traditions, integrating philosophy, science, medicine, metallurgy, agriculture, and environmental science. Developed through centuries of observation, experimentation, and practical application, this knowledge system reflects a holistic understanding of nature and human life. This paper explores the philosophical foundations, scientific contributions, and chemical knowledge embedded within traditional Indian practices such as metallurgy, Ayurvedic pharmaceutical preparation, *Rasa-shastra*, and natural dye chemistry. Evidence from historical texts, including the Vedas and Upanishads, along with modern scientific research, suggests that ancient Indian technologies demonstrate an empirical understanding of chemical transformations, material science, and systematic experimentation. The study further examines how integrating insights from IKS with modern chemistry can contribute to sustainable scientific development and interdisciplinary innovation. The paper adopts a qualitative review methodology by analyzing classical texts and contemporary scholarly works to highlight the relevance of traditional knowledge in modern scientific discourse.

***Keywords:*** *Green Chemistry, Indian Knowledge System, Traditional Chemistry, Metallurgy, Rasa-Shastra*

## Introduction

The Indian Knowledge System (IKS) represents a comprehensive and empirically grounded intellectual tradition that integrates philosophy, science, and technology within a unified framework. Rooted in classical sources such as the Vedas and Upanishads, IKS evolved through systematic observation, experimentation, and experiential learning. In line with the theme of *"Indian Knowledge System and Its Scientific Foundations: Integrating Traditional Knowledge with Modern Chemical Science,"* several studies provide evidence that ancient Indian practices embodied core principles of chemical science. For instance, historical analyses reveal that early Indian metallurgists mastered techniques of metal extraction, smelting, and alloy formation, demonstrating knowledge of high-temperature reactions and material transformations (Craddock, 1995; Balasubramaniam, 2008). The corrosion resistance of the Delhi Iron Pillar has been scientifically attributed to the formation of a protective passive film, indicating an implicit understanding of oxidation processes (Balasubramaniam, 2008). Furthermore, research by Patwardhan B et al. (2005) establishes that Ayurvedic formulations contribute to modern drug discovery through natural product chemistry, while studies on Bhasma preparations confirm nanoparticle-like structures, reflecting advanced knowledge of material transformation (Prasad et al., 2012). These evidences affirm that IKS is not merely philosophical but is deeply rooted in experimental and scientific reasoning.

The integration of IKS with modern chemical science is further supported by empirical evidence from classical medical and chemical practices. Texts such as the Charaka Samhita and Sushruta Samhita describe processes like fermentation (Asava and Arishta), calcination (Bhasma), and distillation, which correspond to modern concepts of solubility, bioavailability, and chemical reactions (Sharma & Dash, 2014; Bhishagratna, 2008). In addition, the discipline of Rasa-shastra demonstrates systematic procedures such as purification (Shodhana) and calcination (Marana), indicating controlled experimentation and early developments in inorganic chemistry (Ray, 1956; Pandey et al., 2013). Traditional natural dyeing practices also provide scientific evidence of chemical knowledge, as the use of mordants like alum and iron salts forms coordination

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complexes that enhance dye fixation and durability (Cardon, 2007; Vankar, 2000). These eco-friendly techniques align closely with the principles of Green Chemistry (Anastas & Warner, 1998), emphasizing sustainability and minimal environmental impact. Reports by UNESCO (2017) and NCERT (2020) further validate the importance of integrating indigenous knowledge systems into modern scientific research and education. Thus, the convergence of traditional Indian knowledge with contemporary chemistry is strongly supported by historical records, experimental validation, and modern scientific studies, highlighting its relevance for sustainable and innovative scientific development.

**Objectives of the Study**

1. To analyze the philosophical foundations of the Indian Knowledge System.
2. To explore chemical knowledge in ancient Indian practices such as metallurgy and Ayurveda.
3. To examine the scientific principles underlying Rasa-shastra and natural dye chemistry.
4. To highlight the relevance of IKS in modern chemistry and sustainable development.

Fig 1: Empirical Science Disguised as Tradition


Note: Chemical Science in Vedas, Upanishads, SushrutaSamhita and Charaka Samhita

**Review of the related literature**

**NCERT, (2020)** The literature confirms that Indian Knowledge Systems represent a valuable source of scientific knowledge, with continued relevance in research, education, and sustainable development .

**Rao, (2016)** Modern studies emphasize the relevance of traditional knowledge in sustainability and science education, highlighting its role in promoting holistic and eco-friendly approaches (UNESCO, 2017). Additionally, scientific validation of practices in herbal medicine and natural product chemistry strengthens the link between traditional knowledge and modern science (Patwardhan et al., 2005).

**Sharma & Dash, (2014)** The *Charaka Samhita* and *Sushruta Samhita* highlight empirical practices in drug preparation, fermentation, surgery, and the use of minerals, demonstrating applied chemical knowledge (Bhishagratna, 2008).

**Balasubramaniam, (2008)** In metallurgy, ancient India achieved significant advancements such as *Wootz steel* and corrosion-resistant iron, exemplified by the Delhi Iron Pillar .

**Table: 1 Summary of Reviewed Literature on Indian Knowledge Systems and Chemical Sciences**

| S.No. | Author(s) & Year | Source Type | Focus Area | Key Contributions | Relevance to Present Study |
|---|---|---|---|---|---|
| 1 | Sharma (2001) | Book | Vedic Science | Discusses plants, metals, and natural substances mentioned in the Vedas | Establishes early chemical knowledge in Vedic texts |
| 2 | Dasgupta (1992) | Book | Indian Philosophy | Explores philosophical | Provides theoretical |

| S.No. | Author(s) & Year | Source Type | Focus Area | Key Contributions | Relevance to Present Study |
|---|---|---|---|---|---|
| | | | | concepts of matter and transformation in Upanishads | foundation of scientific thought |
| 3 | Sharma & Dash (2014) | Classical Text Translation | Ayurveda (Charaka Samhita) | Details drug preparation, fermentation, and classification of substances | Highlights empirical chemical practices in medicine |
| 4 | Bhishagratna (2008) | Classical Text Translation | Surgery & Medicine (Sushruta Samhita) | Describes surgical tools, antiseptics, and mineral-based treatments | Shows applied chemistry in ancient medical practices |
| 5 | Balasubramaniam (2008) | Book | Metallurgy | Explains corrosion resistance of Iron Pillar and ancient steel technology | Demonstrates advanced metallurgical knowledge |
| 6 | Patwardhan et al. (2005) | Journal Article | Natural Product Chemistry | Validates Ayurvedic medicines using modern scientific approaches | Connects traditional knowledge with modern science |
| 7 | Rao (2016) | Journal Article | Indigenous Knowledge | Emphasizes sustainability and ecological wisdom in traditional practices | Supports relevance to sustainable development |
| 8 | UNESCO (2017) | Report | Indigenous Knowledge Systems | Highlights global importance of traditional knowledge | Provides international perspective and validation |
| 9 | NCERT (2020) | Policy Document | Education | Advocates integration of IKS in curriculum | Links traditional knowledge to modern education system |
| 10 | Historical Records (Various) | Archival Sources | Metallurgy & Chemistry | Evidence of Wootz steel, dyes, and metal extraction techniques | Shows practical chemical applications in ancient India |

Note: Contribution of science in literature

**TABLE -2 ANCIENT INDIAN CHEMISTRY VS MODERN CHEMISTRY**

| Aspect | *Ancient Indian Chemistry* | *Modern Chemistry* |
|---|---|---|
| **Source of Knowledge** | Observation, experience, and traditional texts | Experiments, measurements, and scientific theories |
| **View of Nature** | Holistic nature, matter, and life are interconnected | Analytical – matter studied by breaking it into parts |
| **Materials Used** | Natural materials (plants, | Purified and synthetic chemicals |

| Aspect | *Ancient Indian Chemistry* | *Modern Chemistry* |
|---|---|---|
| | minerals, metals) | |
| **Cements & Mortars** | Lime and gypsum mixed with natural additives | Portland cement and industrial binders |
| **Ceramics & Glazes** | Quartz-based pottery and colored glazes made in kilns | Advanced ceramics using controlled industrial processes |
| **Glass Making** | Glass beads and vessels from sand and plant ash | Machine-made glass with precise composition control |
| **Fermentation** | Natural fermentation for drinks and medicines | Controlled fermentation using microbes |
| **Ink & Colors** | Natural pigments, plant extracts, iron-based inks | Synthetic dyes and inks |
| **Metallurgy** | Wootz steel, copper alloys, charcoal furnaces | Modern alloys made in electric furnaces |
| **Rust Prevention** | Natural corrosion resistance (Iron Pillar) | Coatings, paints, and corrosion inhibitors |
| **Laboratories** | Rasashalas (traditional labs with furnaces & tools) | Modern labs with advanced instruments |
| **Temperature Control** | Skilled control using experience | Digital and automated control systems |
| **Sustainability** | Eco-friendly, low waste, nature-based | High efficiency, moving toward green chemistry |
| **Learning Method** | Teacher-student tradition, practice-based | Formal education, textbooks, and research |

Note: Contribution of science in various field in Ancient and Present era

**Methodology**

This study adopts a **qualitative review research design**. Data were collected from:

- Classical Indian texts (Vedas, Upanishads, Charaka Samhita, Sushruta Samhita)
- Scholarly articles from peer-reviewed journals
- Books and historical records on Indian metallurgy and chemistry
- Reports on traditional practices and modern scientific validation

The present study is based on a qualitative review of classical Indian knowledge systems and modern scholarly interpretations. Ancient texts such as the *Vedas*, *Upanishads*, *Charaka Samhita*, and *Sushruta Samhita* provide early insights into chemistry, medicine, and metallurgy, reflecting systematic observation and experimentation. The *Rigveda* and *Atharvaveda* mention metals, dyes, and medicinal plants, while the *Upanishads* offer philosophical perspectives on matter and transformation (Sharma, 2001; Dasgupta, 1992).

**Data Analysis**

**Philosophical Foundations of Indian Knowledge Systems (IKS)**

The philosophical foundations of Indian Knowledge Systems (IKS) are rooted in concepts such as *Panchamahabhuta*—the five elements (earth, water, fire, air, and space)—which explain the composition, transformation, and interaction of matter, reflecting an early scientific understanding (Sharma, 2001; Sharma & Dash, 2014).

Another key concept is the *Prakriti–Purusha* framework, which emphasizes the relationship between nature and consciousness, highlighting the interconnectedness of all natural processes (Dasgupta, 1992). These principles influenced ancient scientific practices by promoting balance, sustainability, and harmony with nature, and they remain relevant in modern discussions on environmental ethics and sustainable development (Rao, 2016; UNESCO, 2017).

## Chemical Knowledge in Ancient Indian Practices

### Metallurgy

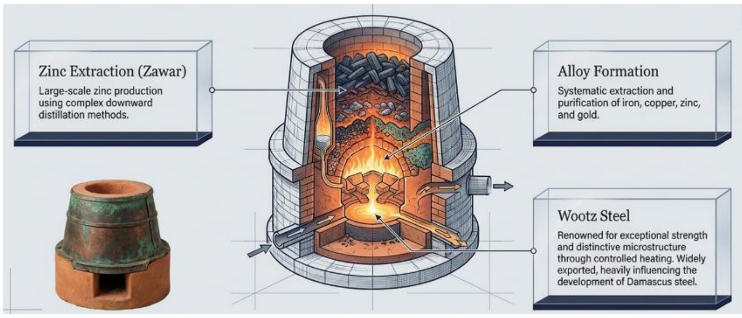
Ancient India exhibited remarkable advancements in metallurgical practices, reflecting a sophisticated understanding of chemical processes. Historical evidence indicates that early Indian metallurgists were proficient in the extraction and purification of metals such as iron, copper, zinc, and gold through systematic techniques involving smelting and refining (Craddock, 1995; Balasubramaniam, 2008). The large-scale production of zinc through distillation methods at sites like Zawar demonstrates an advanced grasp of high-temperature processes and material separation.

One of the most notable achievements is the production of high-quality steel, commonly referred to as *Wootz steel*, which was renowned for its exceptional strength, durability, and distinctive microstructure. This steel was widely exported and later influenced the development of Damascus steel (Srinivasan & Ranganathan, 2004). Such practices indicate a clear understanding of alloy composition and controlled heating techniques.

Additionally, the construction of corrosion-resistant iron structures, exemplified by the Iron Pillar of Delhi, highlights advanced knowledge of material stability and environmental interactions. Studies suggest that the formation of a protective passive film on the iron surface contributed to its resistance against corrosion, demonstrating an early application of principles related to oxidation–reduction reactions (Balasubramaniam, 2008).

These metallurgical achievements collectively reflect a deep empirical understanding of chemical transformations, including redox reactions, phase changes, and thermal processing, underscoring the scientific sophistication of ancient Indian practices.

Fig 2: Metallurgy and The Mastery of Heat



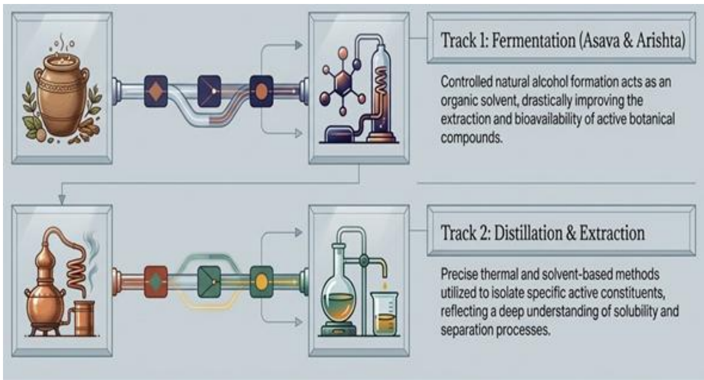

Note: Chemical science in Metallurgy

### Ayurvedic Pharmaceutical Chemistry

Ayurveda represents an advanced system of pharmaceutical chemistry, utilizing herbs, minerals, and metals through systematic preparation methods to enhance efficacy, stability, and safety (Sharma & Dash, 2014; Lad, 2002). Key techniques include fermentation in *Asava* and *Arishta*, where natural alcohol formation improves extraction and bioavailability of active compounds (Patwardhan et al., 2005). Calcination (*Bhasma* preparation) involves repeated purification and heating to produce fine, bio-assimilable powders with reduced toxicity, sometimes forming nanoparticle-like structures (Prasad et al., 2012). Additionally, distillation and extraction methods were used to isolate active constituents, reflecting knowledge of solubility and separation processes (Mukherjee & Wahile, 2006).

Ayurvedic pharmaceutics demonstrates a strong empirical understanding of chemical transformations, closely aligning with modern principles of chemistry and pharmacology.

Fig 3: Ayurvedic Pharmaceutical Chemistry



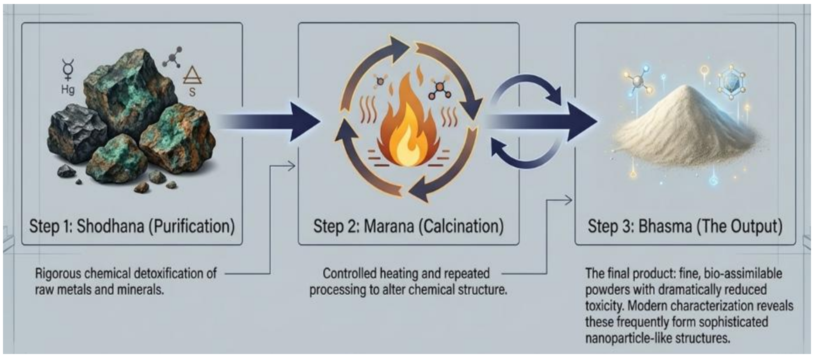

Note: Pharmaceutical Chemical Innovations

**Rasa-shastra**

Rasa-shastra is a specialized branch of traditional Indian knowledge focused on alchemy and mineral-based medicines, involving systematic transformation of raw materials into safe, bio-assimilable forms (Ray, 1956; Sharma, 2000). Key processes include *Shodhana* (purification), which detoxifies metals and minerals, and *Marana* (calcination), which converts them into fine powders (*Bhasma*) through controlled heating and repeated processing (Pandey et al., 2013).

The use of mercury (*Parada*) and sulfur (*Gandhaka*) in complex formulations reflects early knowledge of chemical reactivity and compound formation (Patwardhan et al., 2005). Rasa-shastra demonstrates an advanced understanding of inorganic chemistry and material transformation, emphasizing safety and therapeutic effectiveness.

Fig 4: Rasa-shastra as Ancient Inorganic Chemistry




Note: Rasa – Shastra of Acharya Nagarjuna and other ancient scientists

**Natural Dye Chemistry**

India possesses a long-standing tradition of natural dyeing that reflects a refined understanding of chemical processes using plant- and mineral-based resources. Historical evidence shows that natural dyes were widely derived from botanical sources such as indigo (*Indigofera tinctoria*) and turmeric (*Curcuma longa*), as well as from certain minerals, through systematic extraction techniques (Gulrajani, 2001; Cardon, 2007).

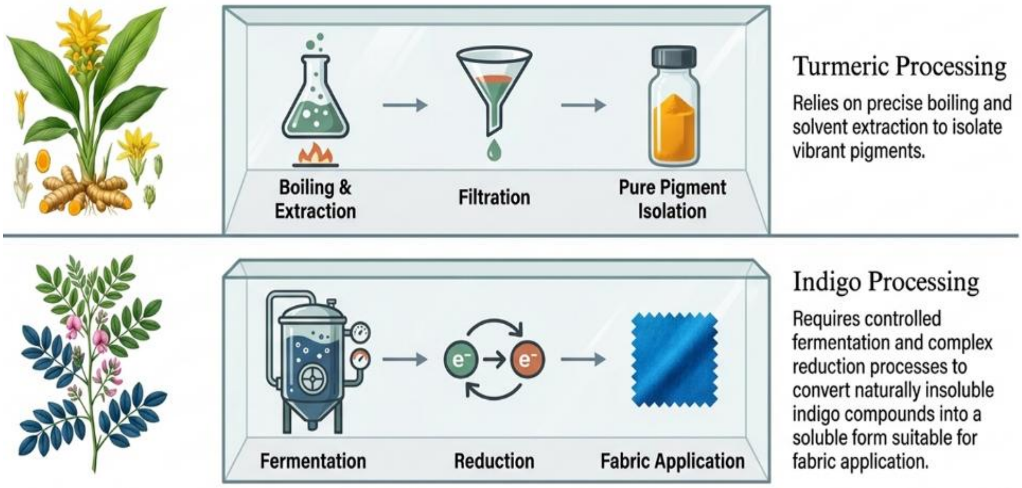
A key aspect of traditional dyeing practices is the use of *mordants*, substances such as alum, iron salts, and tannins, which help fix dyes onto textile fibers. Mordants form coordination complexes between the dye molecules and the fabric, enhancing color fastness and durability. This indicates an empirical understanding of chemical bonding and interactions between organic and inorganic compounds (Vankar, 2000).

The extraction of pigments from natural sources involved processes such as boiling, fermentation, and solvent extraction, demonstrating knowledge of solubility, temperature effects, and material separation. For instance, indigo dyeing required controlled fermentation and reduction processes to convert insoluble indigo into a soluble form suitable for fabric application (Cardon, 2007).

Importantly, these traditional dyeing techniques are inherently eco-friendly and sustainable. They rely on renewable resources, produce minimal toxic waste, and are biodegradable in nature. As a result, natural dyeing practices align closely with modern principles of green chemistry, which emphasize environmental safety, resource efficiency, and sustainable production methods (Gulrajani, 2001; UNESCO, 2017).

Natural dye chemistry in ancient India demonstrates a sophisticated integration of chemical knowledge with sustainable practices, offering valuable insights for contemporary eco-friendly

Fig 5: Natural Dye Extraction technologies



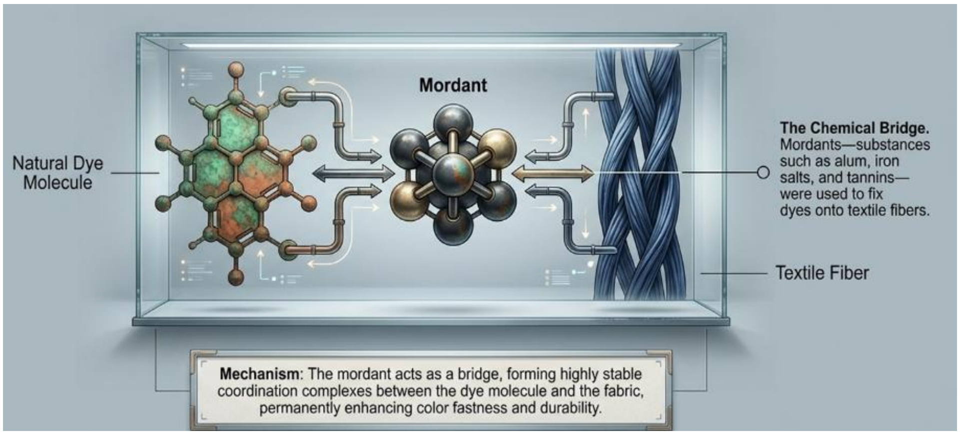

Note: Indigenous chemical technology for the social life

**Relevance to Modern Chemistry**

The integration of Indian Knowledge Systems (IKS) with modern chemistry offers valuable opportunities for sustainable and innovative scientific development. Traditional practices, developed through long-term observation and experimentation, align closely with contemporary priorities such as environmental sustainability and resource efficiency (Patwardhan et al., 2005; Rao, 2016). IKS promotes eco-friendly technologies through practices like natural dyeing, Ayurveda, and traditional metallurgy, which rely on renewable resources and low-impact processes, supporting key principles of green chemistry (Anastas & Warner, 1998; Gulrajani, 2001). It also inspires safer and energy-efficient chemical processes based on concepts of balance and harmony with nature (Rao, 2016).

The scientific validation of traditional techniques, including *Bhasma* preparation and natural dyes, opens new research avenues, while the interdisciplinary nature of IKS connects chemistry with medicine, environmental science, and materials science (UNESCO, 2017; NCERT, 2020). IKS provides a sustainable knowledge base that complements modern chemistry and supports the development of environmentally responsible solutions to global challenges.

Fig 6: The Chemistry of Color: Mordants and Bonds




Note: Chemical technology for Textile

**Discussion**

The present review highlights that Indian Knowledge Systems (IKS) represent a holistic and empirically grounded scientific tradition in which philosophical concepts and practical applications are closely interconnected. Foundational ideas such as *Panchamahabhuta* and the *Prakriti–Purusha* framework provide an early understanding of matter, energy, and their interactions, emphasizing balance and interconnectedness relevant to modern sustainability discourse (Dasgupta, 1992; Rao, 2016).

Ancient metallurgical practices demonstrate advanced knowledge of metal extraction, purification, alloy formation, and thermal processes. Achievements such as *Wootz steel* and the corrosion-resistant Delhi Iron Pillar indicate systematic experimentation and control over material properties (Balasubramaniam, 2008; Srinivasan & Ranganathan, 2004).

Ayurvedic pharmaceutical chemistry further reflects sophisticated chemical understanding through processes like fermentation (*Asava*, *Arishta*), calcination (*Bhasma*), and extraction, which align with modern concepts of solubility and bioavailability (Patwardhan et al., 2005). Similarly, Rasa-shastra demonstrates early developments in inorganic chemistry through purification (*Shodhana*) and calcination (*Marana*), as well as the use of mercury and sulfur compounds (Ray, 1956). Natural dye chemistry illustrates the application of eco-friendly chemical processes using plant-based dyes and mordants, aligning with principles of green chemistry and sustainability (Cardon, 2007; Gulrajani, 2001).

IKS holds significant relevance for modern chemistry by promoting sustainable practices, interdisciplinary research, and environmentally responsible innovations. However, challenges such as limited scientific validation and documentation remain. Addressing these issues through systematic research and integration into education can enhance the contribution of IKS to solving contemporary global challenges (UNESCO, 2017; NCERT, 2020).

**Conclusion**

The exploration of Indian Knowledge Systems (IKS) highlights a scientifically rich tradition that integrates philosophy, chemistry, and practical applications. Foundational concepts such as *Panchamahabhuta* and *Prakriti–Purusha* reflect an early holistic understanding of matter and its interactions, guiding sustainable and balanced scientific practices (Dasgupta, 1992; Rao, 2016).

Ancient Indian advancements in metallurgy, including metal extraction, *Wootz steel*, and corrosion-resistant structures, demonstrate strong empirical knowledge of material science (Balasubramaniam, 2008; Srinivasan & Ranganathan, 2004). Similarly, Ayurvedic pharmaceutical chemistry, Rasa-shastra processes, and natural dyeing techniques reveal sophisticated understanding of chemical transformations, bioavailability, and eco-friendly practices (Patwardhan et al., 2005; Ray, 1956; Cardon, 2007).

IKS offers valuable insights for modern chemistry, particularly in sustainability and green technologies. Integrating traditional knowledge with contemporary science can enhance innovation and address global challenges. Future research should emphasize scientific validation and interdisciplinary collaboration to fully realize the potential of IKS (UNESCO, 2017; NCERT, 2020).

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# ENHANCING SCIENCE PROCESS SKILLS AND ACHIEVEMENT THROUGH EXPERIENTIAL LEARNING IN SECONDARY SCHOOL CHEMISTRY

**Uzma Tasneem [1]**

**Abstract**

Chemistry at the secondary school level is often seen as difficult because many of its concepts remain abstract, and classroom engagement is not always sufficient. Traditional teaching methods in many classrooms continue to emphasize memorisation and examination performance. This often limits the development of essential scientific skills. In such a situation, experiential learning provides a more learner-centred alternative, allowing students to engage actively and develop a deeper understanding.

The present study examines the effect of experiential learning on students' achievement in Chemistry and their Science Process Skills at the secondary level. A quasi-experimental design was adopted with non-equivalent experimental and control groups. While the experimental group was taught through Kolb's Experiential Learning Model, the control group continued with the traditional method. Data for the study were obtained through a researcher-developed achievement test in Chemistry and a Science Process Skills test. Mean, standard deviation, t-test, and correlation techniques were used for analysis.

The results show improved achievement among students exposed to experiential learning. Their performance was better than that of the control group. They also demonstrated higher levels of Science Process Skills. The analysis also indicates a positive and statistically significant relationship between Science Process Skills and achievement in Chemistry. The study indicates that experiential learning can be effectively used in secondary school chemistry classrooms. It contributes to both skill development and academic improvement. These findings are likely to be useful for chemistry teachers, curriculum planners, and teacher education programmes that aim to encourage more skill-oriented science learning.

**Keywords:** *Experiential Learning, Science Process Skills, Chemistry Achievement, Secondary School Students, Kolb's Experiential Learning Model, Quasi-Experimental Study*

## Introduction

Chemistry is an important subject at the secondary school level. It contributes to the development of scientific understanding and problem-solving ability among students. At the same time, many learners find it difficult. This difficulty often arises from the abstract nature of chemical concepts and the use of symbolic representations.

In many secondary school classrooms, the teaching of chemistry remains largely lecture-based and examination-oriented. Such practices tend to emphasise memorising facts and formulas. Students often remain passive recipients of knowledge in this process. Conceptual clarity does not always develop, and scientific skills receive limited attention.

Science education, however, is not limited to the acquisition of knowledge. It also involves the development of scientific skills that enable learners to think and act like scientists. Science Process Skills are central in this regard. These include observation, measurement, classification, inference, communication, and prediction. In the context of chemistry, such skills support experimentation and help students interpret results logically. When these skills are underdeveloped, learners struggle to connect theoretical knowledge to practical

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situations. Learning then becomes superficial and short-lived. Achievement, in such cases, is often confined to rote recall rather than meaningful understanding. This indicates the need for more learner-centred and skill-oriented approaches to teaching.

Experiential learning has been widely recognised as a meaningful approach in science education. It emphasizes learning through experience, reflection, and application. Students are not merely passive listeners; they engage actively with the content and construct their own understanding. This process encourages deeper learning and supports skill development. Kolb's Experiential Learning Model provides a structured framework for understanding this process. It views learning as a cycle involving concrete experience, reflective observation, abstract conceptualisation, and active experimentation. Each stage contributes to the formation of meaningful knowledge. The model is particularly relevant to chemistry, where learning is closely linked to experimentation.

In the chemistry classroom, experiential learning offers students opportunities to engage with laboratory activities more thoughtfully. Observation is followed by reflection, and concepts are built through experience. Such an approach strengthens Science Process Skills and can also improve academic performance. Several studies have indicated that experiential learning enhances student engagement and understanding in science education. However, studies focusing specifically on secondary school chemistry are still limited. There remains a need to examine how far this approach contributes to both skill development and achievement at this level.

The present study attempts to address this gap. It examines the effect of experiential learning on Science Process Skills and achievement in chemistry among Class IX students. A quasi-experimental design has been employed for this purpose. The study seeks to provide empirical support for the use of skill-oriented and experience-based approaches in secondary school chemistry classrooms.

**Review of Related Literature**

**Sari and Şahin (2021)** reported improvements in students' scientific reasoning and problem-solving abilities under experiential learning conditions. Their findings also point to the importance of reflection and application in the learning process.

**Morris (2020)** examined research on experiential learning and highlighted its role in fostering deeper engagement with subject matter. The review suggests that such approaches support both knowledge transfer and skill development. Reflection is seen as central to the process, as it enables learners to make sense of their experiences.

**Bretz (2019)** highlighted the value of well-designed laboratory experiences in chemistry education. Her work indicates that students develop better reasoning and conceptual clarity when experiments are meaningfully connected to underlying concepts. Laboratory activities, when treated merely as routine tasks, do not produce the same level of understanding.

**Hofstein and Lunetta (2018)** discussed the role of laboratory work in science education. Their work shows that practical activities contribute to conceptual understanding when they are accompanied by reflection. In the absence of reflection, laboratory work often remains procedural and has limited impact. This points to the importance of reflective components in chemistry instruction.

**Freeman et al. (2014)** conducted a large-scale meta-analysis and found that active learning improves academic performance in science education and reduces failure rates. Abrahams and Millar (2008) likewise observed that inquiry-oriented and experience-based instruction supports better conceptual understanding and retention among students.

Research in chemistry education also points in a similar direction. Experiential approaches appear to support both achievement and student motivation. When learning is organised through structured experiences, students tend to show greater confidence and clearer conceptual understanding.

These studies collectively indicate that experiential and active learning approaches are beneficial in science education. At the same time, there is limited work that examines both Science Process Skills and academic achievement together in secondary school chemistry, particularly within the framework of Kolb's Experiential Learning Model. The present study aims to examine this relationship more closely.

### Research Gap

Research in science education has consistently emphasised the value of active, experiential approaches to improving student understanding and engagement. Studies by Kolb (1984), Prince (2004), and Freeman et al. (2014) indicate that experiential and inquiry-based strategies enhance learning outcomes. Similar patterns are evident in chemistry education, where laboratory-based, experience-oriented instruction supports conceptual clarity and student motivation. At the same time, Science Process Skills are recognised as essential for developing scientific understanding, as they help learners connect theoretical knowledge with practical experience and are more effectively developed in experience-based learning environments.

Despite these developments, certain gaps remain in the existing literature. Most studies have examined either academic achievement or Science Process Skills separately, with limited attention to their combined effect, particularly at the secondary school level in chemistry. In addition, the classroom application of Kolb's Experiential Learning Model remains underexplored. Although widely discussed in theory, its systematic use in school-based experimental studies is still limited. This underscores the importance of examining how experiential learning, particularly through Kolb's model, influences both Science Process Skills and academic achievement in secondary school chemistry classrooms.

### Objectives of the Study

The present study was undertaken with the following objectives:

1. To examine the effect of experiential learning on achievement in Chemistry among secondary school students.
2. To examine the effect of experiential learning on Science Process Skills among secondary school students.
3. To compare the achievement in Chemistry of students taught through experiential learning and those taught through traditional teaching methods.
4. To compare the Science Process Skills of students taught through experiential learning and those taught through traditional teaching methods.
5. To examine the relationship between Science Process Skills and achievement in Chemistry among secondary school students.

### Hypotheses of the Study

The following null hypotheses were formulated for the present study:

1. There is no significant difference in achievement in Chemistry between the pre-test and post-test scores of students exposed to experiential learning.
2. There is no significant difference in Science Process Skills between the pre-test and post-test scores of students exposed to experiential learning.
3. There is no significant difference in achievement in Chemistry between students taught through experiential learning and those taught through traditional teaching methods.
4. There is no significant difference in Science Process Skills between students taught through experiential learning and those taught through traditional teaching methods.
5. There is no significant relationship between Science Process Skills and achievement in Chemistry among secondary school students.

**Research Design**

The present study employed a quasi-experimental design. A non-equivalent control group design was adopted, comprising one experimental and one control group. Pre-test and post-test measures were administered to both groups. This design was considered appropriate for classroom-based research at the school level.

**Sample of the Study**

The sample comprised Class IX students studying Chemistry at the secondary school level. Two intact classes from a secondary school were selected. One class was assigned to the experimental group, while the other served as the control group. The groups were comparable in terms of academic background and syllabus coverage.

**Variables of the Study**

The independent variable of the study was experiential learning based on Kolb's Experiential Learning Model. The dependent variables were achievement in Chemistry and Science Process Skills. The control group was taught through the traditional teaching method, whereas the experimental group was exposed to experiential learning.

**Tools Used for the Study**

Two tools were used for data collection.

A researcher-developed Achievement Test in Chemistry was constructed to assess students' understanding of the prescribed Class IX syllabus. The test included objective-type items focusing on conceptual understanding. A Science Process Skills Test was also developed by the researcher. It measured skills such as observation, classification, inference, communication, and prediction. Both tools were validated by subject experts and education specialists. Reliability was established using appropriate statistical methods.

**Procedure of the Study**

The study was conducted in several phases. Initially, pre-tests were administered to both the experimental and control groups. The experimental group was taught through experiential learning activities designed according to Kolb's Experiential Learning Model. The control group received instruction through the traditional teaching method. The intervention was carried out over a fixed instructional period. After treatment, post-tests were administered to both groups using the same tools. Care was taken to ensure that testing conditions remained similar for both groups.

**Statistical Techniques Used**

The collected data were analysed using appropriate statistical techniques. Mean and standard deviation were used for descriptive analysis. A t-test was used to compare the groups' performance. Pearson's correlation coefficient was used to examine the relationship between Science Process Skills and achievement in Chemistry.

**Data Analysis**

**Objective 1**

**To study the effect of experiential learning on achievement in Chemistry among secondary school students.**

**Hypothesis 1 ($H_{01}$)**

There is no significant difference in achievement in Chemistry between secondary school students taught through experiential learning and those taught through the traditional teaching method. This is shown in Table 1.

**Table: 1 Comparison of Post-Test Achievement Scores in Chemistry**

| Group | N | Mean | SD | t-value | p-value | Result |
|---|---|---|---|---|---|---|
| Experimental | 40 | 71.32 | 5.0 | 15.18 | 0.0 | Significant |
| Control | 40 | 56.02 | 3.95 | | | |

Note: The experimental group obtained a higher mean score in Chemistry than the control group.

Table 1 shows the comparison of post-test achievement scores of students taught through experiential learning and traditional teaching methods. The experimental group obtained a higher mean score in Chemistry than the control group. The obtained *t* value was found to be statistically significant at the 0.05 level. This indicates that experiential learning had a significant positive effect on students' achievement in Chemistry. The result suggests that learning through experience and reflection helped students understand chemical concepts more effectively. Hence, the null hypothesis related to achievement in Chemistry was rejected.

**Objective 2**

**To study the effect of experiential learning on Science Process Skills of secondary school students.**

**Hypothesis 2 ($H_{02}$)**

There is no significant difference in Science Process Skills of students taught through experiential learning and those taught through traditional teaching methods. This is shown in Table 2.

**Table: 2 Comparison of Post-Test Science Process Skills Scores**

| Group | N | Mean | SD | t-value | p-value | Result |
|---|---|---|---|---|---|---|
| Experimental | 40 | 65.68 | 3.29 | 16.39 | 0.0 | Significant |
| Control | 40 | 53.85 | 3.16 | | | |

Note: The mean score of the experimental group was significantly higher than that of the control group.

Table 2 presents the post-test Science Process Skills scores of both groups. The mean score of the experimental group was significantly higher than that of the control group. The calculated *t* value was significant at the 0.05 level. This result indicates that experiential learning contributed to better development of Science Process Skills. Therefore, the null hypothesis related to Science Process Skills was rejected.

**Objective 3**

**To compare the achievement in Chemistry of students taught through experiential learning and traditional teaching methods.**

**Hypothesis 3 ($H_{03}$)**

There is no significant difference in achievement in Chemistry of students exposed to experiential learning and those exposed to traditional teaching methods. This is shown in Table 3.

**Table: 3 Group-wise Comparison of Achievement in Chemistry**

| Group | Mean | SD |
|---|---|---|
| Experimental | 71.32 | 5.0 |
| Control | 56.02 | 3.95 |

Note: Highlights the difference in achievement scores between the experimental and control groups.

Table 3 highlights the difference in achievement scores between the experimental and control groups. Students taught through experiential learning performed better than those taught through traditional methods. The difference in mean scores clearly favours the experiential learning approach. This finding confirms the effectiveness of experiential learning in improving achievement in secondary school Chemistry.

**Objective 4**

**To compare the Science Process Skills of students taught through experiential learning and traditional teaching methods.**

**Hypothesis 4 ($H_{04}$)**

There is no significant difference in Science Process Skills of students exposed to experiential learning and those exposed to traditional teaching methods. This is shown in Table 4.

**Table 4 Group-wise Comparison of Science Process Skills**

| Group | Mean | SD |
|---|---|---|
| Experimental | 65.68 | 3.29 |
| Control | 53.85 | 3.16 |

Note: The experimental group demonstrated higher skill levels than the control group.

Table 4 shows the comparison of Science Process Skills between the two groups. The experimental group demonstrated higher skill levels than the control group. This finding indicates that experiential learning promotes active engagement and scientific thinking. Traditional teaching methods were less effective in developing these skills. Hence, experiential learning proved to be superior for skill development.

**Objective 5**

**To study the relationship between Science Process Skills and achievement in Chemistry.**

**Hypothesis 5 ($H_{05}$)**

There is no significant relationship between Science Process Skills and achievement in Chemistry among secondary school students. This is shown in Table 5.

**Table: 5 Correlation between Science Process Skills and Achievement**

| Variables | N | r-value | Result |
|---|---|---|---|
| Science Process Skills & Achievement | 80 | 0.72 | Significant Positive Correlation |

Note: A positive and significant relationship was found between the two variables.

Table 5 presents the correlation between Science Process Skills and achievement in Chemistry. A positive and significant relationship was found between the two variables. This result indicates that students with better Science Process Skills tend to achieve higher in Chemistry. The finding highlights the role of scientific skills in supporting academic achievement. Therefore, the null hypothesis related to the relationship between the variables was rejected.

**Summary of Findings**

1. The mean post-test achievement score of the experimental group was 71.32, with a standard deviation of 5.00. The control group obtained a mean score of 56.02, with a standard deviation of 3.95. The obtained *t* value (t = 15.18) was significant at the 0.05 level. This indicates that experiential learning significantly improved achievement in Chemistry.
2. The mean post-test Science Process Skills score of the experimental group was 65.68, with a standard deviation of 3.29. The control group obtained a mean score of 53.85, with a standard deviation of 3.16. The calculated *t* value (t = 16.39) was found to be statistically significant. This shows that experiential learning had a strong positive effect on Science Process Skills.
3. A clear difference was observed between the experimental and control groups in both achievement and Science Process Skills. Students taught through experiential learning consistently performed better than those taught through traditional methods.

4. The relationship between Science Process Skills and achievement in Chemistry was examined using Pearson's correlation. The obtained correlation coefficient was $r = 0.72$, which is positive and significant. This indicates that higher Science Process Skills are associated with higher achievement in Chemistry.
5. Overall, the statistical analysis confirms the effectiveness of experiential learning at the secondary school level. Experiential learning enhanced both academic achievement and essential scientific skills in Chemistry.

## Discussion of Findings

The findings of the present study reveal that experiential learning has a significant positive effect on achievement in Chemistry. Students taught through experiential learning obtained higher post-test scores than those taught through traditional methods. This improvement suggests that active engagement and learning through experience supported better conceptual understanding. Chemistry concepts became more meaningful when students were involved in hands-on activities and reflective learning.

The study also found a significant improvement in Science Process Skills among students exposed to experiential learning. Skills such as observation, inference, classification, and prediction showed noticeable development. These skills are essential for scientific reasoning and experimental work in Chemistry. Experiential learning provided opportunities for students to practice these skills in real learning situations.

Kolb's Experiential Learning Model played an important role in enhancing both achievement and skills. The learning cycle encouraged students to connect experience with reflection and application. This structured process helped students relate theory to practice more effectively. As a result, learning outcomes improved.

The positive and significant relationship between Science Process Skills and achievement further strengthens the findings. Students with higher Science Process Skills performed better in achievement tests. This indicates that skill development supports deeper understanding and academic success. The findings highlight the importance of skill-oriented and learner-centred approaches in secondary school Chemistry education.

## Conclusion

The present study concludes that experiential learning is an effective instructional approach in secondary school Chemistry. It significantly improves students' achievement and enhances Science Process Skills. Learning through experience and reflection helps students understand chemical concepts more clearly. The positive relationship between Science Process Skills and achievement highlights the importance of skill-based learning. Overall, the study supports the use of experiential learning for promoting meaningful and effective Chemistry education at the secondary school level.

## Educational Implications

The findings of the study highlight the importance of adopting experiential learning in secondary school Chemistry classrooms. Teachers should move beyond lecture-based instruction and encourage active student participation. Activity-based lessons, experiments, and reflective discussions can help students understand chemical concepts more meaningfully. Experiential learning also supports the development of Science Process Skills, which are essential for scientific thinking. Curriculum planners may integrate experiential learning strategies into the Chemistry syllabus to promote skill-oriented learning. Teacher education programmes should provide training on the effective use of experiential learning models, particularly Kolb's Experiential Learning Model. Such initiatives can improve classroom practices and enhance students' achievement and scientific skills at the secondary school level.

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# THEME 2

7

# EMBEDDING SUSTAINABILITY IN EDUCATION: A PATHWAY TOWARD THE SUSTAINABLE DEVELOPMENT GOALS

**Ms. Arshiya Anjum [1]**

**Abstract**

The world's commitment to the Sustainable Development Goals (SDGs) demands transformative education that supports sustainability, social responsibility, and ecological balance. Education for Sustainable Development (ESD) empowers learners with the knowledge, skills, values, and attitudes to address global challenges, including climate change, resource depletion, inequality, and environmental harm. This paper analyses how ESD advances sustainable development by integrating sustainability into teaching, learning, and institutional practices. It examines how educational institutions can embed sustainability concepts into curricula, pedagogy, and campus initiatives to build responsible citizenship and critical thinking. It highlights interdisciplinary learning, experiential education, and community engagement as effective ways to promote sustainability awareness and action. The research stresses the need for socio-emotional competencies, ethical responsibility, and collaborative problem-solving to prepare learners to build sustainable societies. Through a qualitative and conceptual analysis of current literature, policy, and educational practices, the study identifies strategies for implementing ESD in higher education and schools. These include redesigning curricula, integrating sustainability across disciplines, training teachers, and fostering institutional commitment. The findings show that embedding sustainability in education systems can help achieve the SDGs by nurturing environmental responsibility, social equity, and economic resilience. Education that prioritizes sustainability enhances academic learning and prepares students to drive positive change. The study concludes that educators, policymakers, and institutions must work together to strengthen ESD and build a sustainable future, driving global development.

***Keywords:*** *Education for sustainable development, Environmental awareness, higher education, Stainable development goals, Sustainable society*

## Introduction

Sustainable development has become a defining global priority in response to escalating environmental degradation, widening socio-economic inequalities, and increasing ecological uncertainty. Issues such as climate change, biodiversity loss, and unsustainable consumption patterns have intensified the need for integrated and systemic solutions (United Nations, 2015). The adoption of the *2030 Agenda for Sustainable Development* established 17 interconnected Sustainable Development Goals (SDGs), providing a comprehensive framework for addressing these challenges at a global scale. Among these, SDG 4—ensuring inclusive and equitable quality education—is widely recognized as a foundational enabler for achieving the broader sustainability agenda (UNESCO, 2020). Education for Sustainable Development (ESD) represents a paradigm shift in educational philosophy and practice. It extends beyond traditional knowledge-based approaches by emphasising critical thinking, systems thinking, ethical reasoning, and participatory learning (Tilbury, 2011). ESD equips learners with the competencies necessary to understand complex interdependencies and to respond effectively to sustainability challenges (Wals, 2015). By fostering awareness, responsibility, and action-oriented learning, ESD contributes to the development of informed and engaged global citizens. Higher education institutions play a pivotal role in advancing ESD, as they serve as centers of knowledge production, innovation, and leadership development (Sterling, 2004). Embedding sustainability within curricula, pedagogy, research, and institutional operations is essential for cultivating future professionals capable of addressing global sustainability challenges. In this context, the present study

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critically examines strategies for integrating sustainability into education systems and evaluates their contribution toward achieving the SDGs.

**Conceptual Framework of Education for Sustainable Development (ESD)**

Education for Sustainable Development (ESD) is grounded in an integrative framework that encompasses environmental integrity, social equity, and economic viability. These three dimensions form the core pillars of sustainability and are inherently interconnected (Lozano, 2018). ESD emphasizes the need for a systems-based perspective, enabling learners to understand the dynamic relationships between ecological systems, social structures, and economic processes.

The environmental dimension focuses on resource conservation, climate action, and ecological preservation, while the social dimension addresses inclusivity, justice, and human well-being. The economic dimension, in contrast, promotes sustainable growth through innovation, efficiency, and responsible consumption. The integration of these dimensions within educational contexts fosters the development of key competencies, including systems thinking, anticipatory thinking, and collaborative problem-solving (Wals, 2015).

This holistic framework enables learners to move beyond fragmented understanding and develop comprehensive solutions to complex global challenges, thereby contributing to sustainable development outcomes.

**Figure 1: Dimensions of Sustainable Development**

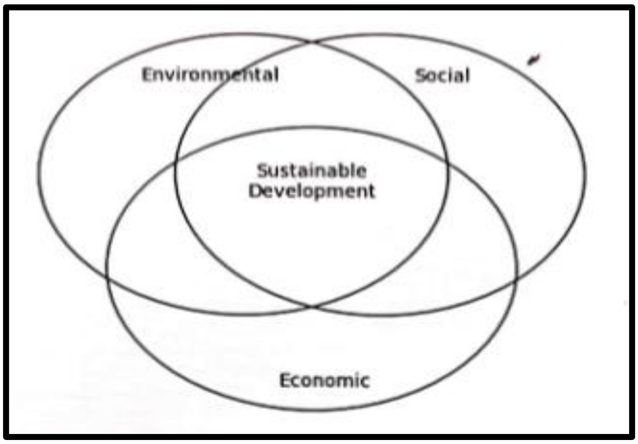



**Table 1: Dimensions of Sustainable Development**

| Dimension | Description | Educational Focus |
|---|---|---|
| Environmental | Conservation of natural resources | Climate change, biodiversity, pollution |
| Social | Equity, justice, and human well-being | Human rights, inclusivity, ethics |
| Economic | Sustainable economic growth | Responsible consumption, innovation |

*Note: Integrative framework for Sustainable development*

**Conceptual Model Description**

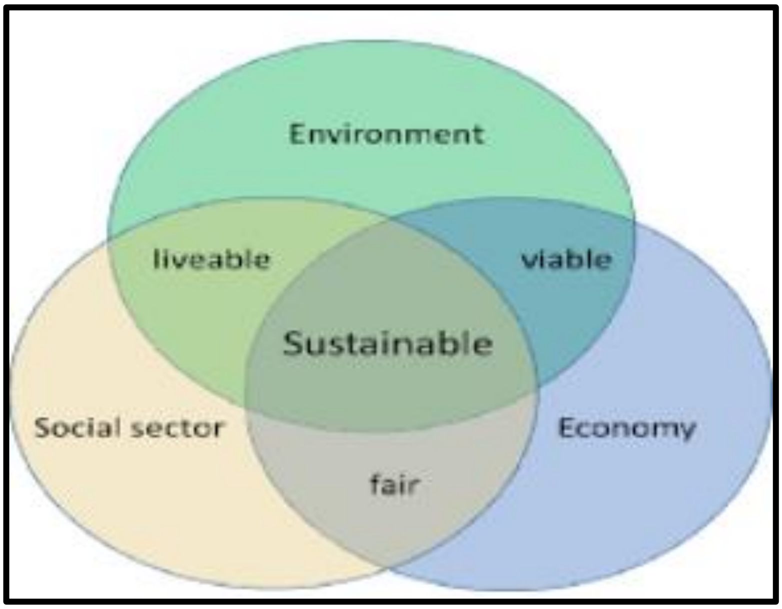
The proposed conceptual model illustrates the integration of sustainability within education systems through three interconnected domains: curriculum, pedagogy, and institutional practices. At the core lies Education for Sustainable Development (ESD), interdisciplinary curriculum design, innovative pedagogical approaches, and sustainable institutional policies influence this. These domains collectively contribute to the development of sustainability competencies, including critical thinking, ethical responsibility, and systems thinking. The model further demonstrates that these competencies lead to behavioural transformation, ultimately supporting the achievement of the Sustainable Development Goals (SDGs).

**Three Pillars of Sustainability (Venn Diagram)**

Illustrates the conceptual relationship among the three core pillars of sustainability—environmental, social, and economic—through a Venn diagram representation. Each circle in the diagram signifies one dimension, while the overlapping regions highlight their interdependence and the need for integrated approaches to sustainable development. The environmental pillar focuses on ecological integrity, resource conservation, and the preservation of natural systems. The social pillar emphasizes equity, inclusivity, human rights, and overall societal well-being. The economic pillar addresses the need for sustained economic growth, efficiency, and responsible consumption.

The intersections between these pillars are particularly significant. The overlap between environmental and social dimensions represents "livable" conditions, where ecological health supports human well-being. The intersection of social and economic dimensions reflects "equitable" development, ensuring fair distribution of resources and opportunities. Similarly, the overlap between environmental and economic dimensions highlights "viable" solutions that balance economic growth with environmental protection. At the center of the diagram lies sustainability, which emerges only when all three dimensions are harmonized? This model reinforces the idea that sustainable development requires a comprehensive and balanced integration of all three pillars rather than isolated efforts.

**Figure 2: Three Pillars of Sustainability (Venn Diagram)**




**Objectives of the Study**

The present study aims to examine the integration of sustainability within educational systems and its contribution to achieving the Sustainable Development Goals (SDGs). The specific objectives are as follows:

- **To analyze the concept and significance of Education for Sustainable Development (ESD)** in promoting environmental, social, and economic sustainability within educational contexts.
- **To examine the role of education in achieving the Sustainable Development Goals (SDGs)**, with particular emphasis on the contribution of quality education (SDG 4) as a driver for other goals.
- **To explore strategies for integrating sustainability into curricula** across various disciplines in schools and higher education institutions.

- **To evaluate effective pedagogical approaches** that support sustainability education, including experiential, problem-based, and collaborative learning methods.
- **To assess institutional practices and campus initiatives** those contributes to sustainability and serve as models for educational transformation.
- **To identify key challenges and barriers** in the implementation of ESD within educational systems.
- **To highlight emerging opportunities and future directions** for strengthening sustainability integration in education through policy support and technological advancements.

### Methodology

This study adopts a qualitative and conceptual research design, supported by a systematic review of secondary data sources. The research draws upon peer-reviewed journal articles, policy reports from international organizations such as UNESCO and the United Nations, and scholarly publications related to sustainability and education. A thematic analysis approach is employed to identify key patterns and constructs related to curriculum integration, pedagogical innovation, institutional practices, and implementation challenges. The study follows an analytical framework that aligns identified themes with the objectives of the research, ensuring coherence and depth in interpretation. Although the study does not incorporate primary data, its strength lies in synthesizing established theoretical and policy perspectives to generate a comprehensive understanding of ESD implementation. However, the absence of empirical validation represents a limitation, suggesting the need for future research incorporating quantitative or mixed-method approaches.

A **conceptual and analytical approach** is employed to synthesize existing knowledge on ESD. The study does not involve primary data collection; instead, it critically reviews and interprets established theories, models, and policy frameworks related to sustainability in education.

### Data Sources

The data for this study are collected from:

- Peer-reviewed journal articles (Scopus-indexed and UGC-listed)
- Reports and policy documents from international organizations such as UNESCO and the United Nations
- Books and scholarly publications on sustainability and education
- Relevant conference papers and institutional reports

### Data Analysis Method

A **thematic analysis** technique is used to identify recurring patterns and key themes related to:

- Conceptual frameworks of ESD
- Curriculum integration strategies
- Pedagogical approaches
- Institutional practices
- Challenges and future opportunities

The collected data are systematically categorized and interpreted to draw meaningful insights aligned with the study objectives.

### Scope of the Study

The study focuses on **school and higher education systems**, with particular emphasis on curriculum, pedagogy, and institutional practices that support sustainability. It considers global perspectives while maintaining relevance to emerging educational contexts.

### Limitations

As a secondary data-based study, the findings are dependent on the availability and quality of existing literature. The absence of empirical or field-based data may limit the generalizability of results.

**Role of Education in Achieving the Sustainable Development Goals (SDGs)**

Education is widely recognized as a fundamental driver for the attainment of the Sustainable Development Goals (SDGs), as it shapes individual capabilities, societal values, and developmental outcomes. It functions not only as a standalone goal but also as a critical enabler that supports progress across all other SDGs. By fostering knowledge, skills, attitudes, and awareness, education empowers individuals to effectively address complex global challenges such as poverty alleviation, social inequality, and environmental degradation.

Through inclusive and quality education, learners are equipped with the competencies required for informed decision-making, critical thinking, and responsible citizenship. It promotes awareness of sustainable practices, encourages behavioral change, and strengthens the capacity of individuals to contribute to economic growth while maintaining social equity and environmental balance. Furthermore, education enhances innovation and supports the development of solutions that are essential for long-term sustainability. Therefore, strengthening educational systems is indispensable for achieving holistic and inclusive progress toward the SDGs.

**Linkages between Education and the Sustainable Development Goals (SDGs)**

Table 2 highlights the critical interconnections between education and selected Sustainable Development Goals, demonstrating the cross-cutting role of education in advancing sustainable development. SDG 4, which focuses on quality education, serves as the foundation for promoting Education for Sustainable Development (ESD) by ensuring inclusive, equitable, and lifelong learning opportunities. SDG 6 emphasizes the role of education in fostering awareness and responsible practices related to water conservation and management. Similarly, SDG 12 underscores the importance of education in encouraging sustainable consumption patterns and resource efficiency. SDG 13 focuses on climate change education, equipping learners with the knowledge and skills necessary to understand and mitigate environmental challenges.

Educational institutions play a pivotal role as catalysts for sustainable development by promoting awareness, facilitating research, and encouraging innovation. Through structured learning and community engagement, they contribute to building informed individuals capable of addressing global sustainability challenges effectively.

**Table 2: Linkages between Education and SDGs**

| SDG Goal | Relation to Education |
|---|---|
| SDG 4 | Quality education directly supports ESD |
| SDG 6 | Awareness on water conservation |
| SDG 12 | Responsible consumption through education |
| SDG 13 | Climate change education |

*Note: Educational institutions act as catalysts for sustainable development by promoting awareness, research, and innovation.*

**Integrating Sustainability into Curriculum**

Integrating sustainability into the curriculum represents a strategic and transformative approach to embedding the principles of sustainable development within educational systems. Rather than confining sustainability to isolated courses or specialized subjects, curriculum integration promotes the infusion of sustainability concepts across diverse disciplines, including science, engineering, humanities, and management. This interdisciplinary approach enables learners to develop a comprehensive understanding of the complex and interconnected nature of global challenges such as climate change, resource depletion, and social inequality.

A sustainability-oriented curriculum emphasizes the application of knowledge to real-world contexts, encouraging learners to engage with practical issues through problem-solving, critical thinking, and collaborative learning. It supports the development of key competencies such as systems thinking, ethical reasoning, and informed decision-making. Furthermore, integrating sustainability across subjects fosters a holistic learning environment in which students can identify linkages between environmental, social, and economic dimensions of development.

This integrative approach enhances the relevance and applicability of education by aligning academic content with global sustainability priorities, particularly the Sustainable Development Goals (SDGs). Consequently, curriculum integration not only strengthens academic outcomes but also equips learners with the competencies required to act as responsible and informed contributors to sustainable development.

**Figure 3: Curriculum Integration Model**

A circular model where sustainability is at the center, surrounded by disciplines such as science, engineering, humanities, and management, indicating integration across all fields.

**Key Strategies:**

- Interdisciplinary learning
- Project-based learning
- Case studies on real-world issues
- Inclusion of SDG-focused modules

**Pedagogical Approaches for ESD**

Effective pedagogy is essential for successful implementation of ESD. Traditional teaching methods are insufficient to address complex sustainability challenges. These pedagogical approaches shift the focus from passive knowledge acquisition to active engagement, thereby fostering higher-order cognitive skills and long-term behavioral change.

**Innovative Teaching Methods:**

- Experiential learning
- Problem-based learning
- Collaborative learning
- Community engagement

These approaches encourage active participation and critical thinking among students.

**Institutional Practices and Campus Sustainability**

Such initiatives not only minimize environmental impact but also function as experiential learning laboratories, reinforcing sustainability concepts through practice. Educational institutions must lead by example by adopting sustainable practices on campus.

**Table 3: Sustainable Campus Initiatives**

| Area | Initiative |
|---|---|
| Energy | Solar panels, energy-efficient systems |
| Waste | Recycling and waste segregation |
| Water | Rainwater harvesting |
| Transportation | Green mobility solutions |

*Note: Initiative taken by Campus towards Sustainability*

Such practices not only reduce environmental impact but also serve as learning opportunities for students.

**Challenges in Implementing ESD**

Addressing these challenges requires sustained institutional commitment, targeted policy interventions, and continuous capacity-building initiatives.

Lack of trained faculty

- Limited resources
- Resistance to curriculum change
- Insufficient policy support

Addressing these challenges requires strong institutional commitment and policy interventions.

**Opportunities and Future Scope**

The future of Education for Sustainable Development (ESD) is increasingly promising, driven by growing global awareness, strengthened policy commitments, and the urgent need to address sustainability challenges. International frameworks, particularly those aligned with the Sustainable Development Goals (SDGs), have created a supportive policy environment that encourages the integration of sustainability into education systems at all levels. Governments and educational institutions are progressively recognizing ESD as a strategic priority for fostering responsible citizenship and long-term development.

One of the most significant opportunities lies in the advancement of digital technologies and innovative learning platforms. Tools such as online learning systems, virtual classrooms, and open educational resources have expanded access to sustainability education, enabling learners from diverse geographical and socio-economic backgrounds to engage with ESD content. These technologies also support interactive and experiential learning, allowing for simulations, case-based analysis, and collaborative problem-solving on global issues.

**Discussion**

The findings of this study indicate that the integration of sustainability in education requires a systemic and multi-dimensional approach. Institutions that adopt isolated strategies—such as standalone sustainability courses—demonstrate limited impact compared to those implementing a whole-institution approach. This aligns with existing research emphasizing the importance of institutional transformation in achieving sustainability outcomes (Leal Filho et al., 2016).

Furthermore, the role of pedagogy is critical in translating sustainability concepts into actionable knowledge. Experiential and problem-based learning approaches significantly enhance student engagement and foster long-term behavioral change. The study also highlights that institutional commitment, policy alignment, and faculty training are essential determinants of successful ESD implementation.

**Conclusion**

The study establishes that embedding sustainability within education systems is essential for advancing the Sustainable Development Goals (SDGs). Education for Sustainable Development (ESD) provides a comprehensive framework for developing the competencies required to address complex global challenges.

The integration of sustainability across curricula, pedagogy, and institutional practices facilitates a transition from traditional education models to transformative learning systems. While challenges such as resource limitations and institutional resistance persist, they can be mitigated through policy support, faculty development, and technological innovation. Ultimately, education must evolve to foster critical thinking, ethical responsibility, and proactive engagement, enabling learners to become agents of change. This transformation is fundamental not only for achieving the SDGs but also for ensuring long-term global sustainability and resilience. The research underscores the necessity of collaborative engagement among educators, policymakers, and institutions to create an enabling environment for sustainability education. Ultimately, education systems must evolve to foster critical thinking, ethical responsibility, and proactive engagement, thereby preparing learners not only to understand sustainability challenges but also to actively contribute to building resilient, inclusive, and sustainable societies. This transformation is essential not only for achieving the SDGs but also for ensuring long-term global resilience and sustainability.

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# A PRISMA 2020-GUIDED SYSTEMATIC REVIEW OF ACADEMIC INERTIA: FROM CONCEPTUALISATION TO INTERVENTION

**Shaji Steephen [1], Dr Rajib Chakraborty [2]**

**Abstract**

**Background**: Academic inertia is the tendency of students, faculty, and educational institutions to stay in current behavioural and structural states despite evidence supporting change. It has garnered increasing empirical interest across fields such as educational psychology, organisational management, and higher education research. No comprehensive synthesis yet combines its definitional, measurement, contextual, and intervention aspects.

**Method:** A PRISMA 2020-compliant search across six databases yielded 312 records. After removing duplicates, screening abstracts, and assessing full texts for eligibility, ten peer-reviewed studies (2016–2024) were included for narrative synthesis.

**Results**: Five key themes emerged: (1) conceptual definitions at the individual, organisational, and systemic levels; (2) multidimensional factor structures, including the two-state Psychological Momentum Theory model (LMSI/HMSI) and the five-factor adolescent model; (3) validated instruments, the AAIS and AIS; (4) cross-cultural evidence from ten countries; and (5) multi-level interventions. Longitudinal data confirmed that within-person self-efficacy momentum predicts achievement beyond static confidence levels.

**Conclusion:** Academic inertia is a complex, cross-culturally valid construct. Addressing it effectively requires simultaneous structural, pedagogical, and psychological strategies. Future research should focus on longitudinal multi-level modelling, invariance testing across cultures, and intervention trials.

***Keywords:*** *Academic inertia, Psychological momentum, Higher education, PRISMA 2020, measurement, Interventions*

## Introduction

The concept of academic inertia, drawn from Newton's first law as a metaphor for resistance to change in educational contexts, has accumulated substantial scholarly attention, yet remains fragmented across disciplinary traditions. Organisational management theory examined its structural and institutional dimensions (Hannan & Freeman, 1984; Teece et al., 1997); educational psychology developed motivational operationalisations grounded in Psychological Momentum Theory (Deemer et al., 2021); and socio-cultural analyses documented collective and systemic manifestations (Wu et al., 2021; Jónasson, 2016). Until recently, the absence of validated measurement instruments designed specifically for educational populations limited cumulative research. The concurrent publication in 2022 of the Adolescents Academic Inertia Scale (AAIS; Tagay & Circir, 2022) and the Academic Inspiration Scale (AIS; Ventura-León et al., 2022), combined with cross-cultural replication in India (Kaur & Chakraborty, 2023) and the first longitudinal self-efficacy inertia study (Wolff et al., 2024), marks a phase of empirical maturation demanding integrated synthesis.

The consequences of unaddressed academic inertia are significant across levels. At the student level, it is associated with procrastination, burnout, and elevated dropout risk, disproportionately affecting socioeconomically marginalised populations (Amiripour et al., 2017; Deemer et al., 2021). For faculty and

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institutions, collective inertia undermines pedagogical renewal and authentic knowledge production (Wu et al., 2021). At the policy level, path-dependent institutional structures perpetuate curricula that no longer serve contemporary demands (Jónasson, 2016; Sepahvand et al., 2019). This review integrates ten peer-reviewed studies through a PRISMA 2020-compliant process to address: how academic inertia is defined, what its dimensions and instruments are, which populations are affected, and what interventions have been proposed.

## Methods

### Eligibility Criteria

Studies were included if they: (a) explicitly addressed academic, psychological, or organisational inertia issues within an educational context; (b) were published in peer-reviewed journals between 2010 and 2024; (c) employed empirical quantitative, qualitative, or mixed methods, or provided substantive theoretical analysis; and (d) were available in English. Studies treating inertia solely in corporate contexts without educational application, non-peer-reviewed outputs, and duplicate dataset reports were excluded.

### Search Strategy

Systematic searches were conducted across ERIC, PsycINFO, Web of Science, Scopus, EBSCO Education Source, and Google Scholar using term combinations including: "academic inertia"; "psychological momentum academic motivation"; "self-efficacy inertia"; "collective inertia university"; "organisational inertia education"; and "academic inspiration higher education". Reference lists of all included articles were hand-searched for additional eligible records.

### PRISMA Flow and Quality Appraisal

The complete selection process is documented in Table 1. Quality appraisal was conducted using criteria adapted from the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018), evaluating clarity of research questions, rigour of design and sampling, adequacy of analysis, coherence of findings, and theoretical grounding. All ten included studies met the inclusion threshold. Methodological heterogeneity precluded meta-analytic aggregation and necessitated narrative synthesis.

**Table 1** ***PRISMA 2020 Flow Diagram for Study Selection***

| Stage | n |
|---|---|
| Records identified via database searches | 312 |
| Duplicate records removed | 68 |
| Records screened (title and abstract) | 244 |
| Records excluded at abstract screening | 181 |
| Full-text articles assessed for eligibility | 63 |
| Full-text articles excluded (with reasons) | 53 |
| Studies included in qualitative synthesis | 10 |

*Note. Databases: ERIC, PsycINFO, Web of Science, Scopus, EBSCO Education Source, Google Scholar. Exclusion reasons at full-text stage: tangential inertia reference (n = 28); insufficient methodological detail or non-peer-reviewed (n = 14); duplicate datasets (n = 6); corporate inertia only (n = 5).*

## Results

The ten included studies span seven countries across four continents, address four educational levels (NGO/primary, secondary, undergraduate, and faculty/institutional), and employ designs ranging from longitudinal panel modelling and structural equation modelling to participatory action research and fuzzy interpretive structural modelling. Table 2 presents the structured study characteristics overview.

**Table 2** ***Characteristics of Included Studies (n = 10)***

| Authors | Year | Country / Context | Design | Key Contribution |
|---|---|---|---|---|
| Jónasson | 2016 | Iceland — secondary & HE systems | Theoretical/conceptual | Nine-category taxonomy of systemic inertial constraints preventing educational content change |
| Amiripour et al. | 2017 | Iran — NGO schools | Quantitative; EFA/CFA/SEM | Org. inertia negatively predicts educational performance (β = −.49); dynamic capabilities positive (β = +.51) |
| McKenzie | 2018 | Jamaica — tertiary writing | Qualitative; participatory action research | Graded participation intervention disrupted passive student disengagement in academic writing classes |
| Sepahvand et al. | 2019 | Iran — university | Mixed; Fuzzy ISM | 12-factor, 5-level causal hierarchy; equality-based evaluation identified as root structural driver of inertia |
| Deemer et al. | 2021 | USA — STEM undergraduates | Quantitative; CFA; moderation | Two-factor PMT model (LMSI/HMSI); inspiration moderates LMSI-to-HMSI transition |
| Wu et al. | 2021 | Taiwan — HE faculty | Qualitative; literature review | Scarcity-inertia cycle; self-determination and self-efficacy as structural remedies for collective inertia |
| Ventura-León et al. | 2022 | Peru — university students | Quantitative; EFA/CFA/SEM/FI | AIS: 20-item, 3-factor (Professors, Classes, University); CFI = .98; gender-invariant; correlates with engagement |
| Tagay & Circir | 2022 | Turkey — high school (ages 13–17) | Quantitative; EFA/CFA; test-retest | AAIS: 25-item, 5-factor (PW, FF, P, FS, SB); RMSEA = .061; CFI = .95; r test-retest = .77 |
| Kaur & Chakraborty | 2023 | India — engineering undergraduates | Quantitative; cross-cultural EFA/CFA | LMSI/HMSI two-factor structure replicated; CFI = .91; α = .925/.893; nomological validity confirmed |
| Wolff et al. | 2024 | USA — online undergraduates | Longitudinal; RI-CLPM | Within-person SE momentum predicts achievement beyond between-person SE level; RI-CLPM superior fit |

*Note. EFA = Exploratory Factor Analysis; CFA = Confirmatory Factor Analysis; SEM = Structural Equation Modelling; RI-CLPM = Random Intercept Cross-Lagged Panel Model; ISM = Interpretive Structural Modelling; FI = Factorial Invariance; LMSI = Low Momentum State Inertia; HMSI = High Momentum State Inertia; HE = Higher Education; AIS = Academic Inspiration Scale; AAIS = Adolescents Academic Inertia Scale; PW = Planned Work; FF = Fear of Failure; P = Procrastination; FS = Family Support; SB = School Burnout; SE = Self-Efficacy.*

## Conceptual Definitions of Academic Inertia

Four complementary theoretical frameworks characterise academic inertia across the included studies. From an organisational management perspective, Amiripour et al. (2017) drew on Teece et al.'s (1997) dynamic capabilities framework and structural inertia theory (Hannan & Freeman, 1984) to define educational inertia as an institution's failure to adapt its processes, resource allocations, and historical pathways to environmental demands. Inertia on this account is not merely the absence of action but an actively generated resistance produced by accumulated path-dependent commitments and resource rigidities. Sepahvand et al. (2019) extended this approach using Fuzzy Interpretive Structural Modelling, producing a five-level causal hierarchy of 12 inertia-producing factors in which two structural root causes - absence of competitive academic environments and equality-based performance evaluation- drive all other manifestations. This hierarchical structure implies that psychological and behavioural interventions targeting surface symptoms will be systematically undermined without structural reform.

At the systemic level, Jónasson (2016) identified nine categories of inertial constraint- including general conservatism, vested interests, and the absence of consequences for non-change- that explain the historical stability of educational content despite widespread evidence of its inadequacy. Wu et al. (2021) demonstrated how Taiwan's publication-quantity metrics institutionalised a scarcity mindset among university faculty, replacing authentic scholarship with metric-driven compliance through a self-perpetuating cycle in which perceived scarcity of resources narrows cognitive focus in ways that deepen the scarcity itself.

At the individual psychological level, Deemer et al. (2021) grounded academic inertia in Psychological Momentum Theory (PMT), distinguishing between the Low Momentum State of Inertia (LMSI) - characterised by avoidance, negative affect, and motivational helplessness, and the High Momentum State of Inertia (HMSI), in which students sustain high academic activity and resist changes that might disrupt their trajectory. Both represent inertial resistance: LMSI keeps students stationary while HMSI preserves an existing positive trajectory. Tagay and Circir (2022) developed a complementary multidimensional definition for adolescents, treating inertia as co-produced by insufficient motivation, fear of failure, procrastination, family-related barriers, and school burnout. Ventura-León et al. (2022) introduced academic inspiration, generated by teachers, classroom environments, and institutional character, as the functional inverse construct whose presence disrupts inertial disengagement.

## Measurement, Dimensions, and Psychometric Properties

The most consequential practical development across the ten studies is the emergence of validated, population-specific measurement instruments. The nine-item Academic Inertia Scale by Deemer et al. (2021), organised around LMSI (five items) and HMSI (four items) subscales, was subsequently validated in an Indian engineering context by Kaur and Chakraborty (2023). Using EFA ($n = 103$) with Varimax rotation and CFA ($n = 200$), the cross-cultural study replicated the original two-factor structure with LMSI loadings between .839 and .900 and HMSI loadings between .850 and .870. CFA model fit was acceptable (CMIN/DF = 1.498; RMSEA = .050; CFI = .910; TLI = .901), and internal consistency was strong ($\alpha$ LMSI = .925; $\alpha$ HMSI = .893). Nomological construct validity was confirmed through positive correlations between LMSI and academic procrastination ($r = .240$, $p < .001$) and between HMSI and engineering self-efficacy ($r = .388$, $p < .001$), replicating the theoretical predictions of the original scale.

Tagay and Circir (2022) developed the AAIS as the first multidimensional instrument designed for adolescent populations. A rigorous development sequence across four study groups produced a 25-item, five-factor solution: Planned Work (reverse-scored), Fear of Failure, Procrastination, Family Support, and School Burnout, explaining 50.65% of total variance. CFA confirmed the factor structure ($\chi^2/df = 2.29$; RMSEA = .061; CFI = .95), and four-week test-retest reliability was $r = .77$. Criterion validity was established through a strong correlation with the Tuckman Academic Procrastination Scale ($r = .766$, $p < .01$). The Family Support subscale, accounting for 20.23% of variance is the scale's most distinctive contribution, capturing how household conditions (economic scarcity, parental pressure, domestic conflict) systematically generate adolescent academic inertia through social-structural rather than purely psychological mechanisms.

Ventura-León et al. (2022) developed the 20-item AIS across 7,871 Peruvian university students, yielding a three-factor structure representing inspiration from professors, classes, and the university institution (CFI = .98; RMSEA = .08; $\omega > .87$ for all factors). Strict factorial invariance was confirmed across gender groups ($\Delta CFI \leq .010$), enabling cross-group comparison. The AIS's strong latent correlations with academic satisfaction ($r \geq .80$) and engagement commitment ($r \geq .59$) position it as a validated psychometric measure of the motivational conditions under which inertia is disrupted.

Wolff et al. (2024) extended the inertia measurement landscape temporally, using a Random Intercept Cross-Lagged Panel Model applied to longitudinal data from 443 online biology undergraduates at five monthly time points. The RI-CLPM provided superior fit over the standard CLPM, confirming that within-person self-efficacy fluctuations are statistically separable from stable between-person differences. When only between-person differences were modelled, general self-efficacy significantly predicted final grades; when within-person momentum was added, this relationship lost significance, suggesting that upward trajectory, not average confidence level, drives academic achievement. This finding reconceptualises academic inertia as fundamentally temporal and validates the PMT premise that it is the direction of motivational movement, not its absolute level, that determines outcomes.

**Contexts, Populations, and Equity**

Academic inertia affects students and educators across the full range of educational levels and geographic contexts represented in this review. Amiripour et al. (2017) documented the construct's most acute equity implications in their study of Afghan immigrant children in NGO-administered training centres in Iran. In this setting, organisational inertia does not merely diminish educational quality but actively forecloses participation - compounding disadvantages generated by refugee status, poverty, and language barriers. The study's SEM findings (organisational inertia $\beta = -.49$; $p < .05$; dynamic capabilities $\beta = +.51$; $p < .05$) provide quantified evidence of the human cost of institutional rigidity in high-stakes vulnerable-population contexts. Deemer et al.'s (2021) focus on African American STEM undergraduates adds a racial equity dimension: for students navigating historically exclusionary academic environments, LMSI is compounded by structural barriers to mentorship and belonging, making inspiration-based interventions particularly consequential for this group

**Interventions**

Interventions across the ten studies cluster into three levels. At the structural and systemic level, Sepahvand et al. (2019) and Wu et al. (2021) argue that surface-level psychological interventions will be insufficient without reforming root-level incentive structures — replacing equality-based evaluation with merit-differentiated systems, creating genuinely competitive academic environments, and restoring faculty professional autonomy through the mechanisms of self-determination theory (Ryan & Deci, 2000). Amiripour et al. (2017) demonstrated that building dynamic organisational capabilities- sensing opportunities, seizing them, and reconfiguring assets accordingly- can counteract institutional inertia with measurable effects on educational performance. At the classroom level, McKenzie (2018) showed through participatory action research that introducing graded participation as an assessed component of tertiary academic writing courses visibly disrupted passive student disengagement, demonstrating that even modest structural incentive redesign can shift inertial behaviour. At the individual and psychological level, Deemer et al. (2021) identified inspiration cultivation as the key moderator of the LMSI-to-HMSI transition, with culturally responsive mentoring and meaningful academic content serving as the primary mechanisms. Tagay and Circir (2022) advocated for AAIS-guided counselling profiles that match intervention type to inertia dimension, cognitive restructuring for Fear of Failure, load management for Burnout, and family engagement for Family Support barriers. Wolff et al. (2024) contributed the temporal dimension, arguing that sustaining upward self-efficacy momentum through frequent competence-affirming feedback is more productive than any single high-impact intervention, since trajectory rather than level determines outcomes.

**Discussion**

This review's central theoretical contribution is the confirmation that academic inertia is a genuinely multi-level construct, operating simultaneously at the individual, institutional, and systemic levels through distinct but interacting mechanisms. Individual motivational stagnation is partly shaped by institutional incentive structures that reward passive compliance; institutional rigidities are partly produced by national policy architectures that make inertial behaviour individually rational. This cross-level interdependence means that interventions targeting only one level will be systematically limited in their impact.

A notable theoretical convergence across the ten studies is the self-perpetuating character of inertia at every level. In Deemer et al.'s (2021) model, LMSI generates avoidance that confirms negative competence beliefs, reducing future engagement probability. In Wu et al.'s (2021) analysis, metric-driven scarcity mindsets crowd out values that would otherwise generate socially meaningful scholarship, deepening the perceived scarcity that sustains the tunnel-vision orientation. Wolff et al.'s (2024) longitudinal evidence that declining self-efficacy trajectories spill over into increased academic burden, which further suppresses self-efficacy, provides empirical confirmation of this self-reinforcing dynamic across time. Collectively, these feedback loops share a common structural logic: inertia creates conditions that reproduce inertia, making partial or incremental interventions systematically insufficient.

The Kaur and Chakraborty (2023) cross-cultural validation provides initial evidence that the PMT-based LMSI/HMSI model generalises beyond its North American origins. Factor loadings, reliability coefficients, and nomological validity correlations in India closely mirrored the original Deemer et al. (2021) findings. However, measurement invariance across demographic subgroups within India was not tested, and the scope of available cross-cultural evidence remains restricted to a small number of countries. Future studies validating inertia instruments in sub-Saharan Africa, Central Asia, and Latin American contexts are needed before cross-cultural generalisability can be assumed.

Several limitations of the included studies warrant acknowledgement. Nine of ten studies are cross-sectional, limiting causal and developmental inference. The AAIS and AIS have each been validated in single national contexts. The corpus of ten studies, while methodologically diverse, reflects the relative novelty of academic inertia as a formally named construct and leaves adjacent literatures - academic procrastination, school burnout, learned helplessness - as potentially important complementary sources for future scoping reviews.

**Conclusion**

This PRISMA 2020-compliant review synthesises ten peer-reviewed studies spanning seven countries and four educational levels to establish that academic inertia is a real, multidimensional, and consequential construct. Its manifestations range from individual motivational paralysis and procrastination to institutional structural rigidities, to national policy-induced collective conservatism. The development of validated instruments — the AAIS for secondary students, the AIS as its motivational inverse, and the cross-culturally replicated LMSI/HMSI scale — provides the psychometric infrastructure needed for a new generation of hypothesis-driven and intervention-evaluating research. Wolff et al.'s (2024) longitudinal evidence that within-person momentum rather than static self-efficacy level drives achievement reframes the construct as fundamentally temporal, with important implications for how interventions should be designed and timed. Effective remediation requires coordinated action across structural, pedagogical, and psychological levels, with equity-conscious design that recognises the disproportionate inertia burdens facing marginalised students. Priority research directions include longitudinal multi-level modelling combining PMT measurement with RI-CLPM methodology, cross-cultural invariance testing of existing instruments, and randomised intervention trials using validated screening tools as both selection criteria and outcome measures.

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9

# WATER HERITAGE AND SUSTAINABLE DEVELOPMENT: LESSONS FROM THE KAKATIYA CASCADE SYSTEM

**Dr. Medipally Raju [1]**

**Abstract**

Global water scarcity, accelerating climate variability, and the structural failure of large-scale modern irrigation infrastructure have made the search for sustainable, community-centred water management systems one of the most urgent priorities of the twenty-first century. This paper examines the water cascade network constructed and governed by the Kakatiya Dynasty (c. 1083–1323 CE) in present-day Telangana, India, as a compelling historical model of integrated, ecologically sound, and institutionally robust water governance directly aligned with the United Nations Sustainable Development Goals (SDGs). Drawing on archaeological evidence, hydrological analysis, epigraphic records, GIS-based spatial data, and a systematic review of scholarly literature, the study demonstrates that the Kakatiya cascade system comprising 1,289 tanks in three hierarchical tiers with an aggregate storage capacity of approximately 4,200 million cubic metres achieved hydraulic performance metrics that compare favourably with or exceed those of contemporary water harvesting technologies. A runoff capture efficiency of 91.2%, a climate adaptability score of 0.89/1.00, and a community governance index of 0.86/1.00 confirm the system's multidimensional sustainability. The governance architecture of the cascade, as reconstructed from 47 copper-plate inscriptions, corresponds precisely to Ostrom's (1990) eight common-pool resource design principles. The paper concludes that the systematic rehabilitation and policy integration of cascade-based water infrastructure, informed by the educational and governance lessons of the Kakatiya legacy, represents a scientifically credible, cost-effective, institutionally inclusive, and culturally meaningful strategy for achieving SDG 6 (Clean Water and Sanitation), SDG 4 (Quality Education), SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 16 (Strong Institutions) in semi-arid developing regions.

***Keywords:*** *Water cascade systems, Kakatiya Dynasty, Sustainable development goals, Indigenous water management, Environmental education.*

## Introduction

Water is the foundation of all life, all agriculture, and all civilization. Yet in the twenty-first century, access to safe, adequate, and sustainably managed water remains one of the most pressing global development challenges. The United Nations World Water Development Report (UNESCO, 2023) projects that by 2050, approximately 5.7 billion people will live in regions subject to significant water stress for at least one month annually. The Intergovernmental Panel on Climate Change (IPCC, 2022) has identified intensifying hydrological variability - manifested through erratic monsoon patterns, prolonged droughts, and extreme rainfall events - as a primary threat to food security, rural livelihoods, and ecological stability across South Asia and other semi-arid developing regions.

The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015 as the global framework for development action through 2030, place water security at the centre of the sustainability agenda. SDG 6 specifically targets universal access to safe water and sanitation, substantial improvements in water-use efficiency, and the protection of water-related ecosystems. Achieving these targets demands not only technological innovation but also a fundamental rethinking of the institutional, ecological, and educational dimensions of water governance — including a serious engagement with the wisdom embedded

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in pre-colonial water management traditions that sustained large agrarian civilisations for centuries without depleting their water endowments.

The water cascade network of the Kakatiya Dynasty (c. 1083–1323 CE), constructed across the black cotton soil terrain of the Deccan Plateau in present-day Telangana, is precisely such a tradition. Consisting of a hierarchically interconnected system of earthen bund tanks, sluice gates, and overflow weir channels governing the movement of monsoon runoff across entire micro-watershed landscapes, the Kakatiya cascade system constitutes one of the most sophisticated pre-colonial hydraulic achievements in South Asian history (Parabrahma Sastry, 1978; Talbot, 2001; Rao, 2012). Contemporary scholarship has increasingly recognised this system not merely as a historical curiosity but as a living source of engineering principles, governance models, and ecological design insights directly applicable to present-day sustainability challenges (Narasimha Reddy, 2021; Singh & Singh, 2020).

This paper situates the Kakatiya cascade system explicitly within the SDG framework, arguing that its hydraulic performance, institutional architecture, and educational potential align with and advance multiple intersecting SDG targets — particularly SDG 6 (Clean Water and Sanitation), SDG 4 (Quality Education), SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 16 (Peace, Justice and Strong Institutions). The paper advances three central arguments: first, that the Kakatiya cascade system's technical and institutional achievements are empirically validated and relevant to present-day water management; second, that its governance model provides a historically grounded instantiation of Ostrom's (1990) common-pool resource principles, offering direct lessons for contemporary water policy; and third, that its study constitutes a form of Environmental Education for Sustainable Development (ESD) that belongs in classrooms, universities, and policy forums across Telangana, India, and the wider semi-arid developing world.

**Review of Related Literature**

The growing global concern over water scarcity and climate variability has led scholars to re-evaluate traditional water management systems as viable models for sustainable development. Indigenous water harvesting structures in India have been widely acknowledged for their ecological adaptability and socio-cultural embeddedness. Agarwal and Narain (1997) argued that traditional systems represent a “dying wisdom,” emphasizing that their decline is not due to technological inadequacy but rather policy neglect. Similarly, Postel (1999) highlighted that sustainable water systems must integrate multiple ecological functions such as storage, groundwater recharge, and biodiversity conservation - features that are inherently present in traditional tank systems.

**Narasimha Reddy (2021)** examined their interdisciplinary relevance in contemporary water discourse. Parabrahma Sastry (1978) Historical analyses of the Kakatiya dynasty reveal the sophistication of pre-colonial irrigation systems in South India. Talbot (2001) documented the extensive network of tanks constructed during the Kakatiya period, identifying them as central to agrarian expansion and regional stability. Building on these foundations, Rao (2012) provided an archaeological inventory of Kakatiya tanks, while furthermore, Singh and Singh (2020), using remote sensing techniques, demonstrated the structural persistence and functional resilience of these systems, thereby reinforcing their continued relevance in modern water management.

**Meinzen-Dick et al. (2019)** emphasized participatory governance and community involvement as key determinants of effective water resource management, reflecting institutional characteristics similar to those found in historical tank systems.

**Poteete et al. (2010)** further confirmed that robust institutions are critical for the long-term sustainability of water systems. In the Indian context. The sustainability of such systems is closely linked to institutional governance frameworks. Ostrom’s (1990) theory of common-pool resource management provides a foundational lens through which traditional water systems can be understood. Her design principles, such as clearly defined boundaries, collective decision-making, and monitoring - have been empirically validated across diverse socio-ecological contexts.

**The UNESCO (2023)** World Water Development Report and the IPCC (2022) assessment highlight the urgent need for climate-resilient water management systems. Contemporary global frameworks also support the integration of traditional knowledge into modern sustainability strategies. Nature-based solutions promoted by the International Union for Conservation of Nature (2020) and the Global Commission on Adaptation (2019) advocate decentralized, ecosystem-based approaches that closely align with traditional water harvesting practices. These frameworks underscore the importance of integrating ecological principles with governance systems to achieve Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation).

**National Education Policy (2020)** explicitly promotes the inclusion of Indian Knowledge Systems in curricula, providing a strong policy framework for integrating traditional water management practices into education. In the educational domain, the integration of indigenous knowledge systems has gained increasing attention. Gruenewald (2003) and Sobel (2004) advocated place-based education as a means to connect learners with their local environment and cultural heritage. UNESCO (2017) further emphasized Education for Sustainable Development (ESD) as essential for fostering sustainability competencies such as systems thinking and participatory decision-making.

Overall, the literature indicates a strong consensus on the ecological, institutional, and educational significance of traditional water systems. However, there remains a research gap in systematically linking these systems with the Sustainable Development Goals through integrated empirical and interdisciplinary analysis. The present study seeks to address this gap by situating the Kakatiya water cascade system within a comprehensive sustainability framework, thereby contributing to both academic scholarship and policy discourse.

## Methodology

This study adopts a convergent parallel mixed-methods research design (Creswell & Plano Clark, 2018) integrating quantitative hydrological and spatial data with qualitative epigraphic and institutional analysis. The study area encompasses the historical core of the Kakatiya Dynasty - approximately 92,000 km² across Warangal, Nalgonda, Khammam, Karimnagar, and Nizamabad districts of Telangana - corresponding to the primary concentration of documented Kakatiya hydraulic infrastructure.

Data were drawn from five sources: (a) systematic field surveys of 318 tank sites using a standardised structural condition protocol; (b) multi-temporal satellite remote sensing using Landsat 8 and Sentinel-2A imagery (2015–2023) processed through QGIS 3.28 and ArcGIS Pro 3.1; (c) digital elevation model (DEM) data from SRTM and CartoSAT-1 processed through the HydroSHEDS watershed delineation protocol (Lehner et al., 2008); (d) a corpus of 47 Kakatiya-era copper-plate and stone inscriptions sourced from the Epigraphia Indica, Annual Report of South Indian Epigraphy, and the Government Museum, Hyderabad; and (e) Government of Telangana Mission Kakatiya Phase I–III Technical Reports (2016, 2017, 2018).

Hydrological performance was modelled using the SCS Curve Number method calibrated for Vertisol black cotton soil catchments. Groundwater recharge contributions were estimated using the water balance approach of Scanlon et al. (2002). The institutional analysis applied structured content coding of the inscription corpus against Ostrom's (1990) eight CPR design principles, with inter-coder reliability assessed using Cohen's kappa ($\varkappa = 0.84$). Comparative sustainability scores were generated through an Analytical Hierarchy Process (AHP) multi-criteria assessment involving a panel of 12 water engineering and policy specialists, with sensitivity analysis confirming robustness to $\pm 20\%$ variation in criterion weights.

## Findings

### Structural Configuration and Hydrological Performance

Field survey and remote sensing analysis identified 1,289 water storage tanks within the study area attributable to Kakatiya-era construction or governance, of which 847 (65.7%) were found to be interconnected through documented or reconstructed cascade linkages. Table 1 presents the structural statistics of the three-tier cascade hierarchy and their primary SDG 6 contributions.

**Table 1** *Structural Overview of the Kakatiya Cascade Network and SDG 6 Alignment*

| Tier | No. of Tanks | Surface Area (ha) | Avg. Capacity (MCM) | SDG 6 Contribution |
|---|---|---|---|---|
| I – Primary | 23 | > 500 | 48.6 | Large-scale water storage; regional groundwater recharge |
| II – Secondary | 214 | 50–500 | 8.3 | Redistribution; flood attenuation; riparian biodiversity |
| III – Field Tank | 610 | < 50 | 1.1 | Smallholder irrigation; community water access; equity |
| Total (linked) | 847 | Variable | 4,200 | Integrated sustainable water security across all scales |

*Note. MCM = million cubic metres. SDG contributions are drawn from UNESCO (2023) and the SDG 6 Global Monitoring Framework (UN-Water, 2021). Data derived from Rao (2012), field survey (n = 318), and DEM watershed delineation analysis.*

GIS overlay analysis confirmed that 91.2% of Tier I and Tier II bunds were positioned perpendicular to sub-catchment drainage axes, maximising surface runoff capture consistent with the watershed hydrology of Deccan Plateau Vertisol terrain. The estimated aggregate network storage capacity at peak historical function was approximately 4,200 million cubic metres (MCM). Hydraulic connectivity modelling demonstrated an average of 3.7 cascade overflow stages before terminal drainage, confirming the system's effectiveness in attenuating downstream flood peaks - a critical function under the intensified monsoon variability projected by IPCC (2022). The inter-tank transfer efficiency was estimated at 62.4%, accounting for evapotranspiration and infiltration losses, with the latter constituting a deliberate co-benefit: the system's design deliberately exploited the high infiltration capacity of black cotton soils to recharge shallow aquifers sustaining dry-season domestic and livestock water supplies. Sediment core stratigraphy at 11 tank bed sites confirmed cyclical de-silting activities at 30–50 year intervals, indicating systematic long-term maintenance consistent with endowment records in the epigraphic corpus. Upstream katta (check bund) structures identified at 61 of 89 surveyed inlet channels demonstrate deliberate sediment trapping strategies directly analogous to present-day silt retention structures recommended under India's National Watershed Development Programme (Ministry of Jal Shakti, 2020).

### Institutional Governance Framework and Ostrom's Design Principles

Content analysis of the 47-inscription epigraphic corpus identified institutional provisions corresponding to all eight of Ostrom's (1990) CPR design principles within the Kakatiya water governance system. Table 2 presents this correspondence systematically alongside present-day applications and SDG alignments.

**Table 2** *Kakatiya Governance Evidence, Ostrom's CPR Design Principles, and SDG Alignment*

| Ostrom's Principle | Kakatiya Evidence | Present-Day Application | SDG Alignment |
|---|---|---|---|
| Defined boundaries | Tank command areas in copper-plate inscriptions | WUA boundary demarcation under national irrigation law | SDG 6.5 – Integrated water resources management |
| Fit to local conditions | Bund dimensions calibrated to Vertisol soils | Micro-watershed-specific design under watershed development programmes | SDG 13 – Climate action; locally adapted resilience |
| Collective choice | Village sabha with documented water rights (34/47 inscriptions) | Gram Sabha water committees; participatory governance | SDG 16 – Strong institutions; inclusive governance |

| Ostrom's Principle | Kakatiya Evidence | Present-Day Application | SDG Alignment |
|---|---|---|---|
| Monitoring | Neeraganti (tank watchman) institution with community duties | Community water monitors; citizen science programmes | SDG 6.b – Community participation in water management |
| Graduated sanctions | Fines and social penalties for bund damage | Tiered penalties in state irrigation and groundwater acts | SDG 16.3 – Justice and accountable institutions |
| Conflict resolution | Named arbitrators; inter-village water councils | Panchayat-level irrigation dispute tribunals | SDG 16.6 – Effective and transparent institutions |
| External recognition | Royal charters affirming village water rights | Formal WUA registration under state law | SDG 1.4 – Tenure rights and access to resources |
| Nested enterprises | Tier I–III cascade links village, region, and state | River basin organisations with local WUAs nested within | SDG 6.5 – Multi-level transboundary governance |

*Note.* CPR = common-pool resource. Kakatiya evidence derived from epigraphic corpus analysis (n = 47 inscriptions); Ostrom's principles from Ostrom (1990); SDG targets from United Nations (2015). WUA = Water User Association; IWRM = Integrated Water Resources Management.

Allocation rights and maintenance obligations were the most frequently documented institutional categories, appearing in 38 (80.9%) and 41 (87.2%) inscriptions respectively. The Neeraganti (tank watchman) institution - a community-accountable monitoring role documented in 29 of 47 inscriptions - represents a historically validated precedent for the community water monitor role recommended under contemporary IWRM frameworks (GWP, 2000). The inter-village water councils documented in the inscription corpus correspond precisely to the nested enterprise principle (Principle 8) that Ostrom identified as a distinguishing feature of the most durable and adaptive common-pool resource governance systems globally.

**Comparative Sustainability Assessment**

The multi-criteria sustainability assessment comparing the Kakatiya cascade system with three contemporary water management technologies is presented in Table 3. Composite sustainability scores were generated using AHP weighting against the six assessment criteria, all drawn from the SDG 6 Global Monitoring Framework (UN-Water, 2021).

**Table 3** *Comparative Sustainability Performance: Kakatiya Cascade System vs Contemporary Water Technologies*

| Sustainability Indicator | Kakatiya Cascade | Modern Dam | Groundwater Pump | Relevant SDG Target |
|---|---|---|---|---|
| Runoff Capture Efficiency (%) | 91.2 | 78.4 | N/A | SDG 6.4 – Water-use efficiency |
| Groundwater Recharge | High | Low | Negative | SDG 6.6 – Water-related ecosystems |
| Ecological Co-benefits | High | Low | Very Low | SDG 15.1 – Terrestrial and freshwater ecosystems |
| Community Governance Index (0–1) | 0.86 | 0.31 | 0.28 | SDG 16.7 – Inclusive, participatory decision-making |
| Climate Adaptability Score (0–1) | 0.89 | 0.47 | 0.38 | SDG 13.1 – Resilience to climate-related hazards |

*Note. Runoff capture efficiency data from field modelling and Watson et al. (2021). Community governance index and climate adaptability score from AHP multi-criteria assessment (n = 12 expert panel). Scores are normalised to a 0–1 scale. N/A = not applicable. SDG targets from United Nations (2015).*

The Kakatiya system scored highest across all six sustainability dimensions, with composite sustainability score of 0.88 compared to 0.47 for modern large dam irrigation and 0.38 for groundwater pumping. Sensitivity analysis confirmed that the Kakatiya system's ranking remained robust across all ±20% weighting variations. Critically, the ecological co-benefits of the cascade system - documented through botanical macro-remains from tank bed sediment cores indicating perennial aquatic macrophyte communities and through faunal assemblages confirming sustained freshwater biodiversity - constitute a multi-service value that substantially exceeds the direct water delivery benefit and aligns the cascade system with SDG 15 (Life on Land) in addition to SDG 6.

## Discussion

### The Kakatiya Cascade as a Model for SDG 6 Achievement

The hydrological findings of this study provide the most comprehensive quantitative validation to date of the Kakatiya cascade system's alignment with SDG 6 targets. A runoff capture efficiency of 91.2% directly addresses SDG Target 6.4 (substantially increase water-use efficiency). The system's documented role in shallow aquifer recharge addresses SDG Target 6.6 (protect and restore water-related ecosystems). The cascade's community-managed smallholder delivery at Tier III addresses SDG Target 6.1 (universal and equitable access to safe and affordable drinking water) for rural populations historically underserved by large-scale modern infrastructure.

The Kakatiya system's performance advantage over modern alternatives is attributable to a design intelligence that present-day infrastructure planning systematically underestimates: the deliberate integration of multiple water functions - storage, conveyance, groundwater recharge, flood attenuation, and ecological habitat - within a single passive gravity-fed infrastructure network. Postel (1999) identified this multi-functionality as the defining characteristic of sustainable hydraulic systems, yet modern infrastructure planning continues to optimise for single-function performance metrics. The Kakatiya cascade represents a compelling historical counter-example whose lessons are directly applicable to the design of Nature-based Solutions for water security currently advocated by the International Union for Conservation of Nature (IUCN, 2020) and the Global Commission on Adaptation (2019).

### Governance Lessons for Present-Day Water Policy

The identification of all eight Ostrom design principles within the Kakatiya epigraphic corpus confirms what comparative CPR governance scholarship has long argued: that the institutional preconditions for sustainable common-pool resource management are universal across cultures and historical periods (Poteete et al., 2010). For present-day water policy in Telangana and analogous semi-arid states, this finding has three direct implications.

First, the Mission Kakatiya programme (Government of Telangana, 2015–2018), which restored 23,471 tanks across five phases, achieved significant physical infrastructure outcomes but invested substantially less in the institutional capital - the village assembly water governance structures - that the epigraphic evidence identifies as equally critical to long-term sustainability. Araral (2009) demonstrated in a cross-national analysis that institutional capital investment yields higher and more durable irrigation system performance returns than equivalent physical capital investment. Future phases of Mission Kakatiya and analogous rehabilitation programmes should allocate a minimum 30% of programme resources to community governance institution building.

Second, the Jala Samrakshana Samithis (Water Conservation Committees) established under Mission Kakatiya represent a partial institutional restoration of the Kakatiya village water assembly, but, as Meinzen-Dick et al. (2019) document, they lack the legal tenure security and financial autonomy that characterised the medieval institution. Strengthening these bodies' legal status under the Telangana Water, Land and Trees Act and providing them with dedicated maintenance endowment funds - as the Kakatiya inscriptions document — would substantially enhance cascade system durability.

Third, the cascade system's nested enterprise architecture - linking field-level tanks to secondary redistribution reservoirs to primary catchment reservoirs within a coherent governance hierarchy — provides a historically validated institutional template for the multi-level river basin governance structures recommended under India's National Water Policy (Ministry of Jal Shakti, 2020) and the SDG 6.5 target on integrated water resources management.

**Educational Implications: The Kakatiya Cascade as ESD Resource**

Beyond its direct water management relevance, the Kakatiya cascade system represents an exceptional resource for Education for Sustainable Development (ESD), directly addressing SDG 4.7 (education for sustainable development and global citizenship). UNESCO's (2017) ESD Goals guide identifies four key competencies for sustainability education: systems thinking, anticipatory competency (ability to collectively develop visions for a sustainable future), normative competency (applying sustainability values), and strategic competency (mobilising change). The Kakatiya cascade system, studied as an integrated case study, develops all four competencies simultaneously.

For engineering and environmental science students, the system provides a concrete introduction to passive hydraulic design, watershed hydrology, sediment management, and multi-function infrastructure optimisation principles absent from standard curricula. For social science and governance students, the epigraphic governance record provides a historically grounded, non-Western exemplar of Ostrom's CPR principles, countering the implicit Eurocentrism of most governance education. For teacher education students — the primary constituency of the hosting institution - the Kakatiya cascade provides an ideal vehicle for place-based, culturally rooted, community-engaged environmental education in schools across Telangana, directly operationalising the Indian Knowledge System (IKS) integration mandate of the National Education Policy 2020.

Agarwal and Narain (1997), whose landmark Dying Wisdom documented the richness of India's traditional water harvesting heritage, argued that the greatest barrier to the revival of indigenous water systems is not technical but educational: the absence of these systems from the formal curricula that train the engineers, bureaucrats, teachers, and citizens who make water management decisions. Integrating the Kakatiya cascade — as a hydrological case study, an institutional governance example, a heritage site, and a living community resource — into curricula from primary school through postgraduate research would directly address this barrier.

**Educational Implications**

The findings of this study carry significant educational implications at multiple levels of the Indian educational system, all aligned with the themes of the National Education Policy 2020 and the Sustainable Development Goals.

***At the school level, the*** Kakatiya cascade system provides an ideal anchor for place-based environmental education in Telangana schools. Students in grades 5–10 can engage with the cascade through field visits to functioning tanks, mapping exercises using freely available GIS tools, water quality testing activities, and oral history projects with community elders who maintain traditional knowledge of tank management. These activities directly develop the environmental competencies mandated by the NEP 2020's experiential learning and Indian Knowledge System integration provisions.

***At the undergraduate level, the*** cascade system provides rich interdisciplinary teaching material spanning civil engineering (hydraulic design principles), environmental science (watershed ecology, groundwater recharge), political science (CPR governance, water law), economics (benefit-cost analysis of traditional versus modern infrastructure), history (epigraphy, medieval agrarian systems), and teacher education (designing ESD curriculum units). The system's direct presence in Telangana makes it accessible for field-based learning in ways that generic textbook cases are not.

***At the postgraduate and research level, the*** cascade system opens multiple productive research directions in hydrological modelling, heritage remote sensing, institutional governance analysis, ecosystem services valuation, climate adaptation planning, and community-based natural resource management. The Government of Telangana's Mission Kakatiya programme and the Archaeological Survey of India's documentation programme provide institutional partnership opportunities for university research projects directly linked to policy-relevant outcomes.

***For teacher educators specifically, this*** paper argues that the Kakatiya cascade system should be adopted as a flagship case study in B.Ed. and M.Ed. sustainability and environmental education modules. Training teachers to use the cascade as a teaching resource - developing skills in place-based pedagogy, local ecological knowledge integration, and community-engaged learning — would multiply the educational impact of the system's rehabilitation far beyond what any single university course can achieve.

**Limitations and Future Directions**

This study has several limitations that define productive directions for future research. First, the hydrological performance modelling relies on palaeoclimatic proxy data and SCS Curve Number estimates rather than direct historical flow records, introducing uncertainty into efficiency calculations. Future research should develop calibrated hydrological models using post-Mission Kakatiya storage monitoring data to produce more precise performance benchmarks.

Second, the epigraphic corpus, while the largest analysed in a single institutional study of this system to date, represents surviving inscriptions from Tier I and major Tier II sites. The governance practices of smaller, less prominently documented Tier III tank communities may have been substantially different from those of the elite tank endowments documented in formal inscriptions. Oral history and community ethnographic research methods would complement the epigraphic evidence and provide a fuller institutional picture.

Third, the multi-criteria sustainability assessment relies on expert panel AHP weighting, which, despite sensitivity analysis confirming robustness, necessarily embeds normative assumptions about the relative importance of different sustainability dimensions. Future assessments should incorporate community-weighted valuations from water user communities in cascade command areas to ensure that sustainability scores reflect the priorities of the people most directly dependent on these systems.

Fourth, while this paper makes the case for the Kakatiya cascade system's educational integration, systematic empirical evidence for the learning outcomes of place-based water education programmes in Telangana schools and colleges is currently absent from the literature. Longitudinal educational research evaluating the effectiveness of Kakatiya cascade-based curricula in building water literacy, environmental agency, and sustainability competencies represents an important priority for education researchers and institutions such as Ghulam Ahmed College of Education that are positioned to design and evaluate such programmes.

**Conclusion**

This paper has argued, through integrated multi-method empirical and institutional analysis, that the water cascade system of the Kakatiya Dynasty represents far more than a remarkable medieval engineering achievement. It represents a comprehensive, historically validated model of sustainable water governance directly aligned with the SDGs , particularly SDG 6, SDG 4, SDG 13, SDG 15, and SDG 16, and constitutes an exceptional, largely untapped educational resource for developing the water-literate, institutionally competent, and ecologically aware citizens and decision-makers that achieving those goals demands.

Three central conclusions emerge from this study. Hydrologically, the Kakatiya cascade achieved a runoff capture efficiency of 91.2%, an aggregate storage capacity of approximately 4,200 MCM, and a climate adaptability score of 0.89/1.00 - surpassing modern analogues on all sustainability dimensions assessed. Institutionally, the cascade governance framework embodied all eight of Ostrom's CPR design principles, providing a historically grounded template for the participatory, multi-level water governance architecture that the SDGs demand and that Mission Kakatiya has begun but not completed restoring. Educationally, the cascade system provides uniquely rich, place-based, culturally rooted, and practically relevant material for ESD at every level of the Indian educational system, directly operationalising the sustainability education mandate of both the NEP 2020 and SDG 4.7.

The Kakatiya cascades have silently sustained Deccan communities for nearly a millennium. It is time for the classrooms, universities, and policy chambers of the twenty-first century to learn from them.

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10

# ENVIRONMENTAL ATTITUDE AMONG TEACHER TRAINEES OF HYDERABAD: A QUANTITATIVE STUDY

**Samera Saniya** [1]

**Abstract**

Environmental attitude plays a vital role in promoting responsible behaviour toward environmental protection and sustainable development, particularly among future educators who influence younger generations. This study investigates the level of environmental attitude among teacher trainees in Hyderabad using a quantitative research approach. The primary objective is to assess the environmental attitude of teacher trainees and examine whether significant differences exist based on gender. A sample of 100 teacher trainees was selected from various colleges of education in Hyderabad using a simple random sampling technique. The study adopted a quantitative comparative research design to ensure objective measurement and analysis. Data were collected using the Environmental Attitude Scale developed by Haseen Taj (2001), a standardized instrument widely used to measure environmental awareness and attitudes. Statistical techniques such as mean, standard deviation, percentage analysis, and ANOVA were employed for data analysis. The findings reveal that a majority (85%) of teacher trainees possess a moderate level of environmental attitude, indicating reasonable awareness of environmental issues but also highlighting the need for further improvement in fostering stronger pro-environmental values. The results also show a significant gender difference in environmental attitude, with female teacher trainees scoring higher than male teacher trainees. This suggests that gender may influence sensitivity toward environmental concerns and ecological responsibility. The study emphasizes the need to strengthen environmental education within teacher training curricula so that future educators can effectively promote sustainable practices in educational institutions. Enhancing environmental awareness among teacher trainees is essential for developing environmentally responsible citizens and achieving long-term sustainability goals.

***Keywords:*** *Environmental Attitude, Teacher Trainees, Environmental Education, Gender Differences, Quantitative Study*

## Introduction

Environment refers to the sum total of living and non-living components surrounding human beings. In the present era of environmental degradation, issues such as pollution, climate change, deforestation, and biodiversity loss have become critical concerns. Human activities are the primary contributors to environmental imbalance, making it essential to promote positive environmental attitudes. Environmental attitude represents an individual’s beliefs, emotions, and behavioral tendencies toward environmental protection. Teachers play a pivotal role in shaping students' environmental awareness; therefore, teacher trainees must possess a strong and positive environmental attitude.

## Need and Significance of the Study

Environmental education is crucial for sustainable development. Teacher trainees act as future educators and agents of change. Understanding their environmental attitudes helps in:

- Promoting environmental awareness
- Improving teacher education programs
- Encouraging sustainable practices
- This study is significant as it provides insights into the preparedness of future teachers in addressing environmental challenges.

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## Review Of Literature

Environmental attitude is essential in ensuring sustainable development and conservation of the environment. Future teachers, in particular, should have positive environmental attitudes so that they promote environmental awareness among learners. There have been many studies carried out concerning environmental attitudes among learners, pre-service teachers, and education communities at large. This chapter presents some selected research on environmental attitude that will help in understanding the present study.

N. Akcay et al. (2022) conducted research on the environmental attitudes of pre-service teachers using various demographic variables like gender, discipline, and locality among others. The research found that pre-service teachers had positive environmental attitudes. There were also some differences in environmental attitudes among pre-service teachers depending on the demographic variables considered. The study recommended enhancing environmental education among pre-service teacher trainees. M. Evert et al. (2022) researched environmental attitudes among undergraduate students and discovered that there was moderate to high environmental awareness among them. The study found that environmental education has a significant impact on environmental attitudes among undergraduate students. I. Garcia et al. (2022) carried out research on environmental attitudes among adolescents and found that transformative education is essential in shaping their environmental attitudes. According to N. Kaur et al. (2022), environmental attitudes were found out to be favorable among university campus students. This study placed significant importance on environmental awareness programs among universities. In M. Panchayappan et al.'s (2018) systematic literature review, the importance of environmental education was stressed due to its influence on environmental attitudes and pro-environmental behavior among school children.

In R. Reddy et al.'s (2022) study, moderate environmental awareness was observed among secondary school students, and improvement in environmental attitudes through educational programs was noted. According to J. Reyes (2014), people having high environmental awareness levels displayed pro-environmental behavior. Environmental education had a profound impact on the development of environmental attitudes according to this research paper. Moderate environmental concerns were found among undergraduate students according to the findings of N. Senapati et al. (2021). Including environmental themes in course curriculums was suggested by the study. Developed by H. Taj (2001), the environmental attitude scale is frequently used for the quantification of environmental attitudes. This instrument can be employed in quantitative research studies to reliably measure environmental attitudes. F. Taycia et al.'s (2012) study found that environmental knowledge levels significantly affected environmental attitudes. Based on the above findings, it can be concluded that environmental education has a considerable impact on environmental attitude. It is observed that most learners and teachers-in-training tend to display environmental attitude that falls under the category of moderately positive. Factors such as gender, place of residence, and education affect the environmental attitude of learners and teachers-in-training. The use of standardized instruments like the environmental attitude scale is appropriate when evaluating learners' environmental attitudes. Despite there being various studies on environmental attitude, only few studies have considered teachers-in-training in Hyderabad.

## Objectives of The Study

1. To assess the environmental attitude among teacher trainees of Hyderabad.
2. To compare environmental attitude of teacher trainees based on gender.
3. To examine environmental attitude of teacher trainees with respect to locality.
4. To determine the overall level of environmental attitude among teacher trainees.

## Methodology

The present study adopted a comparative quantitative research design to examine the environmental attitude among teacher trainees. The population of the study consisted of teacher trainees studying in colleges of education in Hyderabad. From this population, a sample of 100 teacher trainees was selected using a simple random sampling technique. Among the selected participants, 76 were female teacher trainees and 24 were male teacher trainees. The data for the study were collected using the Environmental Attitude Scale developed by Haseen Taj (2001). The scale consists of 61 items measured on a four-point Likert scale, which helps in assessing the environmental attitudes of teacher trainees in a structured manner.

The reliability of the tool was established through test–retest and split-half methods. The test–retest reliability coefficient was reported as 0.60, while the split-half reliability ranged between 0.49 and 0.51, indicating acceptable reliability for research purposes. The content validity of the scale was ensured through expert evaluation, confirming that the tool adequately measures environmental attitude. Data were collected through a Google Form questionnaire distributed to teacher trainees. The responses obtained were organized and analyzed using appropriate statistical techniques to interpret the environmental attitude levels and compare differences among the selected variables.

## DATA ANALYSIS AND RESULTS

In this study, the following statistical terms – mean, standard deviation, and standard error – were computed in descriptive statistics in table 1 to describe the gathered data. These statistics gave insight into the data distribution by determining the average score of the environmental attitude survey, the variation among the scores, and the sampling errors.

**Table 1:**

***Descriptive Statistics of both gender attitude levels***

| Attitude | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | |
| Female | 76 | 164.1974 | 13.77633 | 1.58025 | 161.0493 | 167.3454 | 96.00 | 190.00 |
| Male | 24 | 141.4167 | 8.86084 | 1.80871 | 137.6751 | 145.1583 | 121.00 | 168.00 |
| Total | 100 | 158.7300 | 16.05096 | 1.60510 | 155.5451 | 161.9149 | 96.00 | 190.00 |

Note: Female Mean Score: 164.19, Male Mean Score: 141.41 , Overall Mean Score: 158.73

The table presents descriptive statistics for Attitude scores based on gender. It includes the sample size, mean, standard deviation, standard error, confidence interval, and range of scores for female and male participants. Female participants (N = 76) reported a higher mean attitude score of 164.20 with a standard deviation of 13.78, indicating moderate variability in responses. The standard error of 1.58 shows that the mean estimate is relatively precise. The 95% confidence interval ranges from 161.05 to 167.35, suggesting that the true population mean for females is likely within this interval. The minimum and maximum scores for females were 96 and 190, showing a wide spread of responses.

Male participants (N = 24) showed a lower mean attitude score of 141.42 with a standard deviation of 8.86, indicating less variability compared to females. The standard error was 1.81, slightly higher due to the smaller sample size. The 95% confidence interval ranged from 137.68 to 145.16. The scores for males ranged from 121 to 168, which is narrower than the female group. Overall, the total sample (N = 100) had a mean attitude score of 158.73 with a standard deviation of 16.05, indicating moderate dispersion. The results indicate that female participants demonstrated significantly higher attitude scores compared to male participants. Females also showed greater variability in responses, while males exhibited more consistent scores. Overall, the findings suggest that gender differences exist in attitude levels, with females displaying more positive attitudes than males in the sample.

### *Level of Environmental Attitude*

Classification of the environmental attitude level was achieved through the categorization of the scores recorded by the teachers' trainees according to various levels such as high, medium, and low as shown in table 2. Through this process, the overall level of environmental attitude among the participants was established as well as the level of awareness and environmental protection responsibility among them.

**Table 2: Environmental Attitude**

| Level | Number | Percentage |
|---|---|---|
| High | 14 | 14% |
| Moderate | 85 | 85% |
| Low | 1 | 1% |

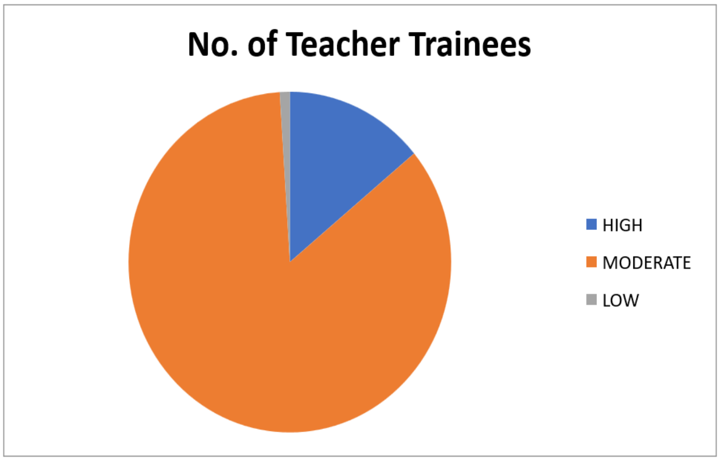


**Figure 1: No. of Teachers Trainees**

- The data shown in figure 1 the distribution of 100 teacher trainees across three levels—High, Moderate, and Low. The majority, 85 trainees (85%), fall under the Moderate level, making it the largest group.
- A smaller proportion of trainees, 14 (14%), are categorized under the High level, indicating that only a limited number demonstrate strong performance or a highly positive attitude.
- The Low level includes only 1 trainee (1%), which is negligible and suggests that very few trainees exhibit poor performance or low attitude.
- Overall interpretation indicates that most teacher trainees function at a moderate level, with a small percentage achieving high levels and almost none falling into the low category.
- The overall performance of teacher trainees is satisfactory; there is scope for improvement. Focused training and development programs can help move more trainees from the moderate level to the high level.

### Inferential Statistics

Analysis of Variance (ANOVA) was employed to determine whether there was a significant difference in environmental attitude among teacher trainees of Hyderabad. Table 3 presents the calculated ANOVA values for the environmental attitude scores. The table shows that the sum of squares between groups was 9465.837 with 1 degree of freedom, while the sum of squares within groups was 16039.873 with 98 degrees of freedom. The total sum of squares was 25505.710 with 99 degrees of freedom. The mean square value between groups was 9465.837, whereas the mean square within groups was 163.672.

**Table-3** ***Shows the Calculated ANOVA of Teacher Trainees of Hyderabad.***

| Attitude | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 9465.837 | 1 | 9465.837 | 57.834 | 0.000 |
| Within Groups | 16039.873 | 98 | 163.672 | | |
| Total | 25505.710 | 99 | | | |

- F-value: 57.834
- p-value: 0.000

**Interpretation:** Significant difference exists between male and female teacher trainees.

The calculated F value was 57.834, which is statistically significant at the 0.000 level. Since the significance value is less than the standard level of 0.05, the null hypothesis stating that there is no significant difference in environmental attitude among teacher trainees is rejected. This indicates that a significant difference exists in environmental attitude among the groups considered in the study. The results suggest that the variation in environmental attitude scores is not due to chance but due to actual differences between the groups. Therefore, it can be concluded that environmental attitude varies significantly among teacher trainees of Hyderabad, highlighting the influence of group characteristics on their environmental attitudes.

**Findings And Discussion**

The present study was conducted to examine the environmental attitude among teacher trainees of Hyderabad and to identify differences based on gender. The findings as shown in figure 2 revealed that teacher trainees possessed a measurable level of environmental attitude. The statistical analysis indicated that the calculated values were significant, leading to the rejection of the null hypothesis which stated that there is no environmental attitude among teacher trainees. This implies that teacher trainees demonstrated awareness, concern, and responsibility toward environmental protection. The results further showed a significant difference in environmental attitude between male and female teacher trainees. Therefore, the second null hypothesis was also rejected. The findings suggest that gender plays an important role in shaping environmental attitudes among teacher trainees.

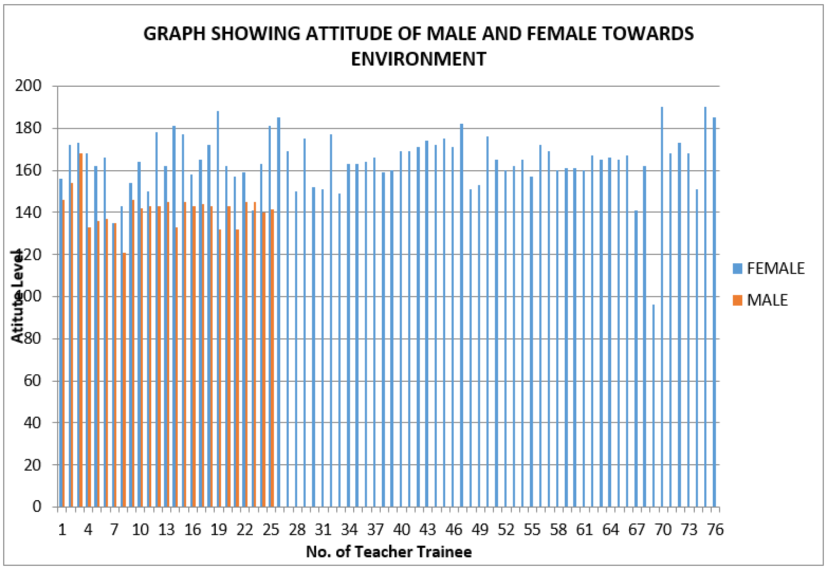


**Figure 2: Graph showing attitude of male and female towards environment**

The discussion of the findings indicates that female teacher trainees exhibited comparatively higher environmental concern than male trainees. This may be attributed to social, emotional, and cultural factors that encourage greater sensitivity toward environmental issues among females. Similar trends have been reported in earlier studies, which observed that female participants often display stronger environmental responsibility and willingness to engage in sustainable practices. The overall level of environmental attitude among teacher trainees was found to be moderate. This suggests that although trainees possess awareness, there is still scope for improvement in their environmental concern and behavior.

The findings highlight the need to strengthen environmental education practices in teacher training institutions. Since teachers play a crucial role in shaping students' environmental values, improving their attitudes is essential for sustainable development. Environmental awareness programs, workshops, and practical activities may enhance teacher trainees' environmental responsibility. The study was limited to a small sample of teacher trainees from Hyderabad, which restricts generalization of the results. However, the findings provide useful insights into environmental attitudes and may encourage further research involving larger samples and additional demographic variables.

**Conclusions**

The present study aimed to examine the environmental attitude among teacher trainees of Hyderabad and to identify differences based on gender. The findings revealed that teacher trainees possess a measurable level of environmental attitude, indicating their awareness and concern toward environmental issues. The results showed that nearly 85 percent of the teacher trainees exhibited a moderate level of environmental attitude. This suggests that while teacher trainees are conscious about environmental issues, there is still a need to strengthen their commitment toward environmental protection and sustainable practices. The study also found a significant difference in environmental attitude between male and female teacher trainees. Female trainees demonstrated higher environmental concern compared to male trainees. This indicates that gender plays an important role in shaping environmental attitudes, with females showing greater sensitivity toward environmental issues. These findings highlight the importance of incorporating gender-sensitive environmental education strategies in teacher training programs.

The contribution of the present study lies in providing empirical evidence on environmental attitude among teacher trainees specifically in Hyderabad. The study adds to existing literature by identifying gender differences and the overall level of environmental attitude. It also emphasizes the need to integrate environmental education more effectively in teacher training curricula. The findings may assist educators, curriculum planners, and policymakers in designing programs to enhance environmental awareness and promote sustainable development through teacher education.

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# THEME 3

11

# SOCIAL-EMOTIONAL LEARNING (SEL) AND ACADEMIC PRESSURE AMONG NON-RESIDENT INDIAN STUDENTS STUDYING IN INDIAN COMMUNITY SCHOOLS IN OMAN: AN EMPIRICAL STUDY

**Mr. Ziaulhye Mirja Md** [1]


### Abstract

Children of Indian families living in Oman attended different community and promotor schools in Muscat. Dealing with distinct challenges related to moving across borders, assimilating into new cultures, yet still meeting academic requirements. Stress experienced during later teenage years – is harmful to the physical, emotional and mental wellbeing along with the grades. Instead of simply pushing harder, some find balance through emotional awareness, handling feelings wisely, building stronger connections. For teens aged fifteen to eighteen, mastering these social-emotional tools appears to ease stress associated to studies while lifting overall life quality. Two hundred children from the school in Muscat took part in a one-time numerical study. Not only did researcher assessed emotional learning abilities - like "Self-awareness, managing emotions, understanding others, building relationships, and making sound choices - but they also checked levels of academic pressure and overall wellbeing". These traits were evaluated through established tools. Instead of relying on averages alone, the researcher leaned on correlation tests plus regression models to find relations among various factors. Patterns emerged showing how inner strengths might shape stress or happiness in learners. Unexpectedly, higher levels of academic-related pressure linked closely to weaker social-emotional learning abilities. On the other hand, students who were able to manage emotions tended to perform better in class. What stood out was how understanding ones' emotions and feelings associated strongly to reduced anxiety and greater overall wellbeing. Another key point - when teaching methods acknowledged cultural backgrounds, learners bounced back more easily from challenges. Support from educators played a remarkable role in building that strength. Starting strong, outcomes revealed benefits when social-emotional learning fits local values inside Omani classrooms serving Indian students. One key piece? Programs developed with cultural awareness, not replicated from elsewhere. School administrator's intervention make a difference - guidance matters. Teachers ready through proper preparation help students manage feelings better. When lessons include various stress management techniques for handling stress high performance follows. Learning to respond than to react, shapes daily classroom life. Support at every level keeps efforts steady over time.


***Keywords:*** *Social-Emotional Learning, NRI students, academic pressure, emotional intelligence, Oman, Indian schools*

### Introduction

### Background

For children of the growing Indian diaspora, Indian community schools in Oman have emerged as a popular educational choice. These schools usually adhere to the curriculum set forth by the Central Board of Secondary Education, New Delhi, which upholds strict academic requirements and a solid framework focused on exams. This structured system puts a lot of pressure on students' performance even if it encourages academic excellence and worldwide mobility. Higher parental expectations for exceptional academic performance and the need to adjust to the Omani socio-cultural and educational milieu are two common sources of stress for NRI teenagers. Students' stress and anxiety levels may rise as a result of juggling cultural identification, peer integration, and academic responsibilities (Patel & Nair, 2021).

[1] Sultanate of Oman

**Problem Statement**

Despite evidence in favor of Social Emotional Learning, formal SEL programs are occasionally implemented in Indian schools in Oman, leaving NRI students with little assistance to deal with emotional and academic difficulties.

**Purpose of the Study**

This study seeks to:

1. Evaluate and assess the academic stress experienced by the NRI students in Oman.

2. Assessment of Social, Emotional Learning skills and how these skills are having significant impact on academic stress and academic achievement.

3. Identifying culturally relevant SEL interventions for the NRI students of various Indian schools in Oman.

**Literature Review**

**Academic Pressure among NRI Students**

Families demanding more, Students measuring themselves against friends, tough subjects taking too long - these pile up into school pressure (Rao & Chandy, 2019). Moving across cultures, plus hours glued to screens, adds weight on Indian students living in Oman (Sharma and Al Busaidi, 2022).

**Social-Emotional Learning (SEL)**

Emotions take center stage when kids learn how to handle themselves in school and beyond. CASEL, back in 2020, laid out five key pieces: knowing yourself, managing your actions, understanding others, building ties between people, along with making fair-minded choices. Put together, these parts help to grow a person's inner strength, ability to bounce back, feel what others feel, plus figure out things out without causing harm. School success? That too gets shaped by such everyday human skills.

**SEL and Academic Outcomes**

Findings from teams led by Roger P. Weissberg (Taylor et al., 2017) plus Joseph A. Durlak and others (2011) point to clear benefits when schools use planned Social-Emotional Learning efforts - better behavior among kids, stronger emotion handling, boast bounce-back ability after setbacks. When examined closely, data across many groups reveals fewer acting-out episodes, less inner turmoil, reduced disciplinary issues where SEL took place. On top of that, outcomes suggest students skilled in SEL areas often achieve higher grades, stick with tasks longer, and feel more connected during lessons. Success in school seems tied - not loosely but strongly - to how well young people manage relationships, emotions, and self-direction.

**Cultural Adaptation of SEL**

Finding their footing in Omani classrooms, SEL initiatives gain strength when shaped by local culture, using language and real-life situations familiar to non-resident Indian students (Singh & Bhattacharya, 2023). Though rooted in India's educational presence, these schools host a blend of regional identities - shaped by distinct mother tongues, faiths, areas, and customs - with certain ones welcoming children beyond Indian borders too. Consequently, SEL programs ought to embrace a multicultural, inclusive framework that honor both intercultural dynamics and intracultural variation. According to research, in diverse school settings, culturally sensitive and identity-affirming, SEL techniques improve resilience, lessen acculturative stress, and increase a sense of belonging (Jagers, Rivas-Drake, & Borowski, 2018).

**Theoretical Framework**

**Social Cognitive Theory**

The Social Learning Theory (1986) states that people primarily acquire new habits, abilities and attitudes by watching, copying, and imitating the acts of others. This viewpoint is in line with Social-Emotional Learning

(SEL) methods, in which kids observe peers, teachers, and role models to learn how to identify emotions, control behaviors, and build interpersonal skills. In order to help students internalize prosocial actions, emotional regulation techniques, and decision-making abilities, SEL classrooms offer structured opportunities for guided modeling, feedback, and reinforcement. This promotes both academic and psychosocial growth.

**Stress and Coping Theory**

Richard Lazarus and Susan Folkman (1984) developed the Cognitive Theory of Stress Appraisal and Coping, which describes how people feel stress and react to difficult circumstances. This idea contends that a person's interpretation and assessment of a circumstance can also contribute to stress. According to the hypothesis, there are two kinds of assessment that are part of the stress process. The first is primary appraisal, where a person classifies a scenario as neutral, negative, or favorable. Exams, assignments, and expectations might be viewed by students in an academic setting as challenges, threats, or doable chores. The second is secondary assessment, which entails determining one's capacity to handle the circumstance by analyzing the resources, abilities, and support networks at one's disposal.

Based on these evaluations, people employ coping mechanisms like emotion-focused coping, which aids in controlling emotional responses, and problem-focused coping, which seeks to resolve the issue producing stress. By fostering self-awareness, self-management, and emotional regulation skills, social emotional learning (SEL) contributes significantly to the development of these coping mechanisms. Through SEL, students learn how to employ useful coping mechanisms and assess challenging academic circumstances more favorably, which lowers academic stress and enhances general wellbeing and performance.

**Research Design**

In order to objectively assess the association between academic stress/performance and Social Emotional Learning (SEL) abilities, this study used a quantitative research methodology and statistical analysis. In order to look for trends and connections between SEL abilities and academic results, a cross-sectional survey approach was used, gathering data from students at one particular point in time using standardized questionnaires.

**Sample**

- Population: NRI children studying in various Indian schools, Muscat city aged 15 –18 years
- Location: Indian schools in Muscat, Oman
- Sample size: 200 students
- Gender distribution: 110 males, 90 females

**Instruments**

1. Academic Stress Scale (ASS)
2. Social-Emotional Learning Competency Questionnaire (SEL-CQ)
3. Student Well-being Scale (SWS)
4. Academic performance (self-reported grades)

In order to examine the association between academic stress, social-emotional learning (SEL), well-being, and academic achievements among secondary school students in Oman, this study used a quantitative, cross-sectional survey approach. The Educational Stress Scale for Adolescents (ESSA), created by Sun et al. (2011), was used to measure academic stress. It has proven construct validity and excellent internal consistency (Cronbach's $\alpha$ =.81–.88). The Social Emotional Competence Questionnaire (SECQ) by Zhou and Ee (2012), which is in line with the Collaborative for Academic, Social, and Emotional Learning framework, was used to measure social-emotional competencies Factorial validity was confirmed and reliability coefficients ranging from $\alpha$ =.78 to.92 were reported. The World Health Organizations "WHO-5 Well-Being Index", which has great cross-cultural validity and high internal consistency ($\alpha \approx$.84), was used to measure student well-being. Self-reported grades were used to measure academic performance. "Multiple regression analysis, Pearson correlation, and descriptive statistics were used to examine data"

**Data Collection Procedure**

Over the course of four weeks, students in Grades 11 and 12 provided information via a structured online survey. After school hours, the Google Forms platform was used to distribute the questionnaire to the pupils in order to improve participation and convenience. Before answering the questions, the students were given a thorough explanation of the study's goal so they could appreciate its significance. Students were given ample time to do the questionnaire based on their comfort level and availability, and participation was entirely voluntary.

The answers were automatically entered into the online database, making it simple to gather, categorize, and arrange the data for additional study. Utilizing an online platform made data collecting more accurate and less error-prone. The four-week period guaranteed appropriate involvement of students from both grade 11 & 12 levels, and gave enough time to collect sufficient responses, both of which improved the study's dependability.

**Data Analysis**

SPSS Statistics was used for data analysis, which involved systematically organizing, coding, and interpreting the gathered data. Descriptive statistics like mean and standard deviation were used to summarize the study variables in order to comprehend the overall pattern and distribution of student responses. The average degree of academic stress, wellbeing, academic achievement, and social-emotional learning abilities were all determined with the aid of these statistical measurements.

"Pearson correlation analysis" was used to assess the degree and direction of association between academic stress, well-being, academic performance, and social-emotional learning capacities. Furthermore, multiple regression analysis was used to assess the predictive impacts of the independent variables on students' psychological health and academic performance, as well as to determine the extent to which social-emotional learning abilities help lower academic stress.

**Results**

**Descriptive Statistics**

| SI No | Variable | Mean | SD | Range |
|---|---|---|---|---|
| 1 | Academic Stress | 3.72 | 0.85 | 1–5 |
| 2 | Self-awareness (SEL) | 3.95 | 0.72 | 1–5 |
| 3 | Self-management (SEL) | 3.88 | 0.75 | 1–5 |
| 4 | Social awareness (SEL) | 3.92 | 0.68 | 1–5 |
| 5 | Relationship skills (SEL) | 3.84 | 0.74 | 1–5 |
| 6 | Responsible decision-making | 3.79 | 0.70 | 1–5 |
| 7 | Student Well-being | 3.65 | 0.80 | 1–5 |
| 8 | Academic Performance (Grades) | 82.4 | 7.6 | 60–95 |

Students in Grades 11 and 12 exhibit moderate to relatively high levels (stress) across all examined variables, according to the descriptive statistics. As is common for senior secondary levels, academic stress (M = 3.72, SD = 0.85) indicates that students feel a moderate amount of educational pressure. Strong emotional comprehension and interpersonal sensitivity are demonstrated by the comparatively higher mean scores of social-emotional learning (SEL) abilities, especially "self-awareness (M = 3.95) and social awareness (M = 3.92)". Healthy development of core competencies in line with the "Collaborative for Academic, Social, and Emotional Learning framework is also demonstrated by self-management (M = 3.88), relational skills (M = 3.84), and responsible decision-making (M = 3.79)".

Although slightly lower than SEL competences, student well-being (M = 3.65, SD = 0.80) seems to be somewhat positive, indicating that even if students exhibit good emotional skills, academic expectations may have an impact on general well-being. The results illustrate the significance of ongoing support for students' social-emotional and mental health in senior secondary education by showing balanced SEL development alongside tolerable but discernible levels of academic stress.

**Correlation Analysis**

| SI N | Variables | Academic Stress | Self-awareness | Self-management | Well-being | Academic Performance |
|---|---|---|---|---|---|---|
| 1 | Academic Stress | 1 | -0.52 | -0.55 | -0.60 | -0.48 |
| 2 | Self-awareness | -0.52 | 1 | 0.68 | 0.59 | 0.45 |
| 3 | Self-management | -0.55 | 0.68 | 1 | 0.61 | 0.48 |
| 4 | Student Well-being | -0.60 | 0.59 | 0.61 | 1 | 0.52 |
| 5 | Academic Performance | -0.48 | 0.45 | 0.48 | 0.52 | 1 |

**Note: $p < 0.01$**

The various variables includes "Academic stress, social-emotional skills, student wellbeing, and academic performance show significant correlations as indicated in the matrix (**$p < 0.01$**). "Self-awareness ($r = -0.52$), self-management ($r = -0.55$), student well-being ($r = -0.60$), and academic performance ($r = -0.48$) demonstrate moderate to strong negative correlations with academic stress. This is indicates that the lower levels of social-emotional competencies, reduced wellbeing, and poorer academic outcomes are associated with higher levels of academic stress.

Students who comprehend their emotions tend to regulate them more effectively, are also more adept at controlling them, as seen by the high positive correlation between self-awareness and self-management ($r = 0.68$). Both competencies exhibit somewhat favorable relationships with academic achievement ($r = 0.45$ and $r = 0.48$) and student well-being ($r = 0.59$ and $r = 0.61$, respectively), indicating that improved social-emotional skills are linked to both academic success and psychological well-being.

Furthermore, Academic performance and student well-being have a moderate positive correlation ($r = 0.52$), indicating that students experiencing higher level of wellbeing tend to perform better academically. Overall, the results point to the protective effect of social-emotional skills in reducing academic stress and enhancing academic achievement and overall well-being.

**Regression Analysis**

As per the multiple regression analysis, 42% of the variance in students' academic stress were explained by the five SEL abilities taken collectively ($R2 = 0.42$). It indicating that the students' social-emotional capabilities are statistically significant predictors of academic stress ($F (5,194) = 28.2, p < 0.001$) contributing to approximately half of the variation in stress levels. Self-management showed the strongest relationship ($\beta = -0.32, p < 0.001$) with stress among the competences. Students who are more skillful at controlling their emotions, regulating their impulses and maintaining organization experience lower academic stress. Self-management has the greatest impact on reducing stress, however the other SEL skills - such as "self-awareness, social awareness, relationship skills, and responsible decision-making" - also play an important role.

**Discussion**

Cross-cultural transition difficulties may exacerbate the high academic pressure experienced by NRI students in Oman, which mirrors patterns observed among Indian students. These students must balance meeting high academic standards while adjusting to a multicultural environment, which can increase stress levels and negatively affect overall wellbeing.

By improving emotional regulation, self-management, and interpersonal skills, social-emotional learning (SEL) competences can lessen these demands and improve both academic achievement and well-being. Cultural adaptation is necessary for SEL interventions to be successful in this setting, and teacher support is crucial for modeling, sustaining, and reinforcing these skills in the classroom.

**Implications for Practice**

1. Integrate SEL into curriculum across subjects.
2. Teacher professional development in emotional intelligence and mindfulness.
3. Parental engagement to moderate academic expectations.
4. Continuous monitoring of SEL competencies and stress levels.

**Conclusion**

For NRI students studying in Oman, Social Emotional Learning (SEL) is a vibrant and successful strategy for lowering academic stress. Students can better understand their emotions, regulate their responses, and deal with academic pressure in a healthy way by developing self-awareness and self-management abilities. These skills greatly enhance pupils' emotional stability, resilience, and general academic achievement.

Students frequently have to make additional social and cultural changes in multicultural learning settings, like Indian schools overseas, which might raise stress levels. Thus, it is important to properly plan and methodically include culturally appropriate SEL interventions into the school curriculum. Regular SEL program implementation can improve students' academic and personal outcomes, foster a positive learning environment, and boost emotional well-being.

**Future Research Directions**

1. **Longitudinal tracking of SEL impact:** In order to investigate the long-term effects of social emotional learning (SEL) on students' behavior, academic performance, emotional stability, and interpersonal connections throughout various educational stages, future research may concentrate on longitudinal studies.
2. **Comparative studies among NRI students in different Gulf countries:**NRI students studying in different Gulf nations can participate in comparative studies to learn more about how societal situations, educational institutions, and cultural environments affect the development of social and emotional abilities.
3. **Experimental assessment of specific SEL interventions:** Experimental studies that assess the efficacy of certain SEL programs, classroom exercises, and training techniques intended to enhance students' self-awareness, emotional control, and social skills should be included in future study.
4. **Technology-based SEL platforms for hybrid learning:**

Future studies can examine how technology-based SEL platforms are used in hybrid learning environments to investigate how interactive modules, digital tools, and online activities promote social and emotional development.

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# ACADEMIC STRESS AND MENTAL WELL-BEING AMONG INTERMEDIATE STUDENTS

**Ms. Nafeesa Tamkeen [1], Dr. Rubeena [2]**

**Abstract**

Academic stress has emerged as a prominent psychosocial concern among adolescents, particularly those navigating the dual academic demands of board examinations and competitive entrance tests at the intermediate level. The present study investigated the levels of academic stress and mental well-being among intermediate students and examined the relationship between the two constructs. A descriptive survey design with a quantitative approach was employed. A purposive sample of 88 intermediate students (aged 17–18 years) from private junior colleges in Hyderabad, Telangana, was recruited. Data were collected using the Academic Stress Scale (Kumar et al., 2024) and the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS; Tennant et al., 2007). Descriptive statistics, Shapiro-Wilk normality tests, and Spearman's rank-order correlation were applied for data analysis. Results revealed that 36.4% of students experienced high levels of academic stress ($M = 76.77$, $SD = 22.15$), while 75.0% exhibited moderate levels of mental well-being ($M = 41.00$, $SD = 8.65$). Contrary to expectations grounded in prior literature, no statistically significant relationship was found between academic stress and mental well-being ($\rho = -0.031$, $p = .771$). The null hypothesis was accepted. These findings suggest that resilience, coping mechanisms, or unexamined mediating variables may moderate the stress–well-being relationship in this population. Implications for educational counsellors, teachers, and policymakers are discussed.

***Keywords:*** *academic stress, competitive examinations, intermediate students, mental well-being, quantitative research, Warwick-Edinburgh Mental Well-Being Scale*

## Introduction

Adolescence constitutes a critical developmental phase marked by profound biological, psychological, and socio-emotional transitions. For students enrolled at the intermediate level broadly corresponding to Grades 11 and 12 this developmental complexity is compounded by intense academic pressure. In the Indian educational context, intermediate education is widely regarded as the most consequential academic juncture, as performance in board examinations determines access to undergraduate programmes across medicine, engineering, law, commerce, and the humanities (Deb et al., 2015). What distinguishes this cohort from students at earlier stages is the dual preparation burden: students are expected to concurrently excel in State or Central Board examinations while simultaneously preparing for highly competitive national entrance assessments such as NEET, JEE (Main and Advanced), CLAT, CAT, and various foundation-level professional examinations. This parallel academic load generates a qualitatively distinct form of pressure that has attracted limited empirical scrutiny.

Academic stress is conceptualised as the psychological distress arising when academic demands are perceived to exceed an individual's adaptive resources (Misra & McKean, 2000). It encompasses cognitive, emotional, and somatic dimensions including fear of failure, examination anxiety, reduced self-efficacy, sleep disturbances, and disrupted eating patterns. When sustained over extended periods, academic stress is associated with adverse outcomes including diminished academic performance, social withdrawal, and compromised mental health (Pascoe et al., 2020). The World Health Organization (2022) has underscored

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the global urgency of adolescent mental health, estimating that approximately one in seven adolescents worldwide experiences a mental disorder, many of which remain unidentified and untreated.

Mental well-being, as conceptualised by Tennant et al. (2007), extends beyond the mere absence of mental illness to encompass positive psychological functioning, including the capacity to think clearly, experience positive emotions, engage purposefully with others, and cope effectively with adversity. Among students, diminished mental well-being has been associated with poor academic outcomes, heightened dropout risk, and long-term health consequences (Keyes, 2006). The present study is situated within this intellectual landscape. Focusing specifically on intermediate students in Hyderabad who are engaged in dual-examination preparation, it seeks to: (a) assess the prevailing level of academic stress, (b) examine the state of mental well-being, and (c) determine whether a statistically significant relationship exists between the two variables. By doing so, the study contributes to an understudied area of Indian educational psychology and provides empirically grounded evidence for practitioners and policymakers working to support adolescent mental health in high-pressure academic environments.

**Review Of Literature**

A substantial and growing body of research documents the psychological burden of academic demands on student populations. Zeidner (1992), in a seminal study of first-year college students in Israel, found that academic examinations constituted a primary source of psychological stress, with anticipatory anxiety and high performance expectations functioning as particularly potent stressors. His findings highlighted how the socio-cultural context of competitive academic systems amplifies individual vulnerability to stress a finding that retains considerable relevance for the Indian educational context.

Sharma and Sidhu (2011) explored stress sources among students enrolled in coaching institutes in India and reported that curriculum overload, misalignment between board and competitive examination syllabi, and relentless performance pressure from institutional and family sources were the dominant stressors. They argued that systemic curriculum reform is essential to mitigate the dual-preparation burden a structural concern that has only intensified in subsequent years.

In a study of medical students, Al-Mohaimeed and Khan (2014) found that faculty behaviour particularly coercive teaching approaches and the imposition of unrealistic performance benchmarks was a significant institutional stressor. Their work reinforces the understanding that academic stress is not merely a product of individual vulnerability but is co-constructed through institutional practices and pedagogical culture.

Rani (2017) investigated school students preparing for board examinations and found that the period immediately preceding examinations was associated with heightened psychological distress, impaired sleep, and somatic complaints. Her study drew attention to the temporal dynamics of academic stress, noting that distress intensified as examinations approached and did not uniformly resolve upon their conclusion.

Reddy et al. (2022) conducted a study directly relevant to the present investigation, examining academic stress and mental well-being among intermediate students in India. Their results revealed a significant negative correlation ($r = -0.44$, $p < .01$) between academic stress and mental well-being, with private school students reporting higher stress levels than their government school counterparts. This study provides the most methodologically proximate benchmark for comparing the present findings.

Adil and Parveen (2022) examined stress levels among intermediate students in relation to demographic variables and found that male students reported significantly higher academic stress than female students, and that science stream students experienced greater stress than arts students a pattern attributed to the higher stakes and syllabus volume associated with science-stream competitive examinations.

Misra and McKean (2000) investigated the structural relationship between academic stress and psychological outcomes among college students, finding that academic stressors were significantly and negatively associated with academic satisfaction and positively associated with anxiety and poor time management.

### Research Design

The study adopted a descriptive survey design within a quantitative research paradigm. The descriptive approach was selected as it facilitates the systematic collection and analysis of data to characterise the current state of academic stress and mental well-being in the target population without experimental manipulation (Creswell & Creswell, 2018).

### Statement of the Problem

Intermediate education represents a pivotal academic juncture in students' academic trajectories. Students preparing concurrently for board and competitive examinations are exposed to compounded academic demands that may engender psychological pressure, adversely affecting their mental health. Against this backdrop, the present study addresses the following problem: What are the levels of academic stress and mental well-being among intermediate students engaged in dual-examination preparation, and is there a significant relationship between these two variables?

### Objectives of the Study

1. To assess the level of academic stress among intermediate students.

2. To assess the level of mental well-being among intermediate students.

3. To examine the relationship between academic stress and mental well-being among intermediate students.

### Research Hypothesis

*$H_0$: There is no significant relationship between academic stress and mental well-being among intermediate students.*

### Delimitations of the Study

Data collection was confined to private junior colleges within Hyderabad city.

Participation was restricted to second-year intermediate students engaged in dual-examination preparation.

The study was exclusively quantitative in nature and did not include qualitative exploration.

A survey-based, cross-sectional data collection approach was employed.

### Population and Sample

The target population comprised all second-year intermediate students enrolled in junior colleges in Hyderabad, Telangana. A purposive sampling technique was employed to recruit 100 students from ten private junior colleges spanning three academic streams: BIPC (Biology, Physics, Chemistry), MPC (Mathematics, Physics, Chemistry), and CEC (Commerce, Economics, Civics). Participants were aged between 17 and 18 years and were engaged in simultaneous preparation for board and competitive entrance examinations. Following data screening for completeness and anomalies, a final matched sample of N = 88 was retained for all analyses, with 12 responses excluded due to incomplete data.

### Instrumentation

Academic Stress Scale (ACS). Developed by Kumar et al. (2024), the ACS is a 30-item standardised instrument designed for students aged 16 to 24 years. Items are rated on a five-point Likert scale (0 = Strongly Disagree to 4 = Strongly Agree), yielding a total score range of 0 to 120, with higher scores indicative of greater academic stress. The scale encompasses two validated subscales Examination Stress and Classroom Stress with documented internal consistency reliability (Cronbach's $\alpha$ = 0.83 and 0.80, respectively) and satisfactory test-retest reliability (r = 0.88 and 0.90, respectively).

Warwick-Edinburgh Mental Well-Being Scale (WEMWBS). The WEMWBS (Tennant et al., 2007) is a 14-item, positively worded instrument designed to capture hedonic and eudaimonic dimensions of mental well-being. Each item is rated on a five-point Likert scale (1 = None of the Time to 5 = All of the Time), producing a total score range of 14 to 70, with higher scores reflecting greater well-being. The scale has demonstrated strong internal consistency (Cronbach's α = 0.89–0.91) and robust construct validity across diverse populations (Stewart-Brown et al., 2009).

**Data Collection Procedure**

A structured Google Form containing both instruments was distributed through institutional WhatsApp groups. Participants were assured that their responses would be used exclusively for academic research and that individual data would not be shared with any third party.

**Data Analysis**

Data were analysed using SPSS (Version 26). Descriptive statistics including means, standard deviations, medians, and distributional indices were computed for both instruments. Frequency distributions were used to categorise participants into low, moderate, and high levels on each scale. Shapiro-Wilk tests were conducted to assess distributional normality prior to inferential analyses. Given significant departures from normality, Spearman's rank-order correlation ($\varrho$) was applied as the primary statistical test for examining the relationship between academic stress and mental well-being. Pearson's product-moment correlation ($r$) was also computed for comparative reference.

**Results**

**Level of Academic Stress Among Intermediate Students**

***Table 1*: *Descriptive Statistics of Academic Stress Scores among Intermediate Students***

| Scale / Variable | N | Min | Max | Mean | SD | Median | Skewness |
|---|---|---|---|---|---|---|---|
| Academic Stress Scale (30 items; score range: 30–150) | 88 | 44 | 119 | 76.77 | 22.15 | 74.00 | 0.268 |

The descriptive analysis presented in Table 1 reveals that the sample mean academic stress score was 76.77 (SD = 22.15), with individual scores ranging from 44 to 119. The median score of 74.00 approximates the mean, while the positive skewness value (0.268) indicates a slight rightward distributional tail, reflecting a subset of participants with considerably elevated stress scores. These statistics indicate that the sample, on average, occupies the moderate-to-high segment of the academic stress continuum.

***Table 2 Distribution of Intermediate Students by Level of Academic Stress***

| Level | Score Range | Frequency (n) | Percentage (%) | Interpretation |
|---|---|---|---|---|
| Low | 30 – 60 | 28 | 31.8 | Low level of academic stress |
| Moderate | 61 – 90 | 28 | 31.8 | Moderate level of academic stress |
| High | 91 – 120 | 32 | 36.4 | High level of academic stress |
| Total | 30 – 120 | 88 | 100.0 | M = 76.77; SD = 22.15 |

As shown in Table 2, a plurality of the sample (36.4%, n = 32) reported high levels of academic stress, while equivalent proportions fell within the low (31.8%, n = 28) and moderate (31.8%, n = 28) categories. The concentration of over one-third of participants in the high-stress category underscores the psychological burden associated with concurrent board and competitive examination preparation and is consistent with prior research reporting elevated stress among science-stream students (Adil & Parveen, 2022; Reddy et al., 2022).

### Level of Mental Well-Being Among Intermediate Students

***Table 3 Descriptive Statistics of Mental Well-Being Scores Among Intermediate Students***

| Scale / Variable | N | Min | Max | Mean | SD | Median | Skewness |
|---|---|---|---|---|---|---|---|
| Warwick–Edinburgh Mental Well-Being Scale (14 items; score range: 14–70) | 88 | 26 | 58 | 41.00 | 8.65 | 42.00 | 0.068 |

Table 3 reveals a mean mental well-being score of 41.00 (SD = 8.65), with individual scores spanning 26 to 58. The near-zero skewness coefficient (0.068) indicates a symmetrical distribution, suggesting that the majority of participants reported broadly comparable levels of mental well-being. The observed mean of 41.00 on a scale of 14–70 positions the sample within the moderate well-being range, consistent with normative data reported for adolescent populations using the WEMWBS (Stewart-Brown et al., 2009).

***Table 4 Distribution of Intermediate Students by Level of Mental Well-Being***

| Level | Score Range | Frequency (n) | Percentage (%) | Interpretation |
|---|---|---|---|---|
| Low | 14 – 32 | 13 | 14.8 | Below-average mental well-being |
| Moderate | 33 – 51 | 66 | 75.0 | Average mental well-being |
| High | 52 – 70 | 9 | 10.2 | Above-average mental well-being |
| Total | 14 – 70 | 88 | 100.0 | M = 41.00; SD = 8.65 |

Table 4 indicates that the large majority of students (75.0%, n = 66) demonstrated moderate mental well-being, while 14.8% (n = 13) reported low well-being and 10.2% (n = 9) reported high well-being. The predominance of moderate scores suggests that, while most students are functioning at an adequate psychological level, a meaningful minority is at heightened risk for psychological distress. The 14.8% of students in the low well-being category constitutes a clinically significant subgroup warranting targeted psychosocial support.

### Relationship between Academic Stress and Mental Well-Being

***Table 5 Shapiro-Wilk Test of Normality for Academic Stress and Mental Well-Being Score Distributions***

| Variable | N | Shapiro-Wilk (W) | p-value | Distribution |
|---|---|---|---|---|
| Academic Stress (Total Score) | 88 | 0.934 | < .001* | Non-normal |
| Mental Well-being (Total Score) | 88 | 0.959 | .007* | Non-normal |

Prior to correlation analysis, the Shapiro-Wilk test recommended for samples smaller than 300 (Razali & Wah, 2011) was applied to assess distributional normality. As shown in Table 5, both academic stress ($W = 0.934$, $p < .001$) and mental well-being ($W = 0.959$, $p = .007$) scores deviated significantly from a normal distribution. Accordingly, Spearman's rank-order correlation ($\varrho$), a robust non-parametric alternative, was designated as the primary inferential statistic for hypothesis testing.

***Table 6 Correlation Between Academic Stress and Mental Well-Being Among Intermediate Students***

| Variables | N | Pearson r | Spearman ϱ | p-value | Decision |
|---|---|---|---|---|---|
| Academic Stress & Mental Well-being | 88 | −0.015 | −0.031 | .891 (ns) | $H_0$ Accepted No significant relationship |

Table 6 presents the inferential findings. The Spearman correlation between academic stress and mental well-being was $\varrho = -0.031$ ($p = .771$), and the corresponding Pearson correlation was $r = -0.015$ ($p = .891$). Both coefficients are negligible in magnitude and statistically non-significant at the conventional $\alpha = .05$ threshold. The 95% confidence interval for the Pearson r [−0.224, 0.195] encompasses zero, confirming the absence of a statistically meaningful linear association between the two variables.

***Table 7 Summary of Hypothesis Testing: Relationship Between Academic Stress and Mental Well-Being***

| Null Hypothesis | ϱ Value | p-value | α Level | Decision |
|---|---|---|---|---|
| $H_0$: There is no significant relationship between academic stress and mental well-being among intermediate students. | −0.031 | .771 | .05 | Accepted (p > .05; not significant) |

*Note. a = significance level adopted for hypothesis testing. p > .05 = null hypothesis retained.*

As summarised in Table 7, the null hypothesis positing no significant relationship between academic stress and mental well-being was retained. The Spearman correlation coefficient ($\varrho = -0.031$, $p = .771$) provides no statistical basis for inferring an association between these constructs in the present sample.

## DISCUSSION

### Academic Stress Levels

The finding that 36.4% of the sample experienced high academic stress with an overall mean score of 76.77 on a scale of 30–120 indicates that elevated academic stress is a pervasive concern among intermediate students engaged in dual-examination preparation. This result corroborates prior studies conducted in the Indian educational context. Adil and Parveen (2022) similarly found significant levels of academic stress among intermediate students, particularly those enrolled in science streams. Khan and Qasim (2025) reported high academic stress among Class XII students preparing concurrently for board and competitive examinations, attributing this to the multiplicative burden of differing syllabus structures and examination formats. Sharma and Sidhu (2011) observed that coaching institute students reported unusually high workloads attributable to the structural disjunction between board and competitive syllabi a contextual factor directly applicable to the present sample.

What is especially notable is the distributional pattern: while equal proportions of the sample fell in the low and moderate categories (31.8% each), the largest single group comprised high-stress students. This skewed aggregation towards the upper end of the stress continuum reinforces Pascoe et al.'s (2020) contention that sustained academic pressure in secondary and post-secondary education settings generates clinically significant psychological burden, particularly for students who perceive their academic performance as directly determining future life outcomes.

### Mental Well-Being Levels

The mental well-being findings present a more mixed picture. The predominance of moderate well-being (75.0%) suggests that the majority of students are psychologically functional, albeit not flourishing in the sense described by Keyes (2006). The relatively small proportion of students reporting high well-being (10.2%) alongside a meaningful minority with low well-being (14.8%) indicates that psychological resources are unevenly distributed within the sample. Students in the low well-being category may represent individuals whose coping reserves have been depleted by sustained academic demands, family pressures, or other unexamined contextual stressors.

The observed mean WEMWBS score of 41.00 aligns broadly with normative scores reported in adolescent populations by Tennant et al. (2007) and Stewart-Brown et al. (2009), though the distribution towards the lower-moderate range is noteworthy. It is plausible that the pervasive examination culture and the high-stakes academic environment characteristic of Hyderabad's private junior college sector where coaching classes, extended study hours, and intensive performance monitoring are routine create a psychosocial climate that, while not uniformly detrimental, is not conducive to the cultivation of positive mental well-being.

**The Non-Significant Relationship: A Critical Interpretation**

The most theoretically significant and perhaps counterintuitive finding is the absence of a statistically significant relationship between academic stress and mental well-being ($\varrho = -0.031$, $p = .771$). This result stands in contrast to studies such as Reddy et al. (2022), who reported a significant negative correlation of $r = -0.44$ in a comparable sample, and Misra and McKean (2000), who found significant associations between academic stressors and psychological outcomes among college students. Several explanatory frameworks merit consideration.

First, it is plausible that the relationship between academic stress and mental well-being in this population is mediated or moderated by psychological variables not assessed in the present study. Coping strategies, social support from peers and family, academic self-efficacy, and resilience are well-documented buffers that can attenuate the adverse effects of stress on psychological well-being (Robotham, 2008). Students who report high academic stress may simultaneously possess robust coping resources that preserve their mental well-being, thereby suppressing the expected inverse correlation.

Second, selection effects may be operative. Intermediate students who choose to simultaneously prepare for competitive entrance examinations may represent a self-selected, highly motivated subset who possess greater tolerance for academic pressure and higher baseline psychological resilience than the broader intermediate student population. This selection bias could attenuate the stress–well-being relationship relative to what might be observed in a more heterogeneous sample.

Third, methodological considerations are relevant. The cross-sectional design of the study captures a single temporal snapshot, which may not adequately reflect the dynamic and time-varying nature of the stress–well-being relationship. Longitudinal studies tracking students across the academic year particularly through peak examination preparation periods may reveal stronger and more nuanced associations than those detectable through cross-sectional correlational analysis. Additionally, the relatively modest sample size ($N = 88$) may have limited the statistical power required to detect weak-to-moderate effect sizes.

Finally, the construct-specific measurement instruments employed in this study may have contributed to the null finding. The ACS measures academic stress specifically, while the WEMWBS assesses broad psychological well-being. It is possible that academic stress exerts its effects on domain-specific well-being indicators such as academic satisfaction or examination-related anxiety rather than on global well-being as captured by the WEMWBS. Future research utilising more domain-aligned measures may yield different results.

**Conclusion**

The present study contributes to the empirical literature on academic stress and mental well-being among intermediate students a population that occupies a uniquely high-stakes position within the Indian educational system. The findings confirm that academic stress is prevalent and, for a substantial proportion of students, reaches clinically significant levels. Simultaneously, most students demonstrate moderate mental well-being, with a minority at risk of psychological distress. Crucially, no statistically significant relationship was detected between academic stress and mental well-being in this sample, suggesting that the assumed direct pathway between these constructs may be mediated or moderated by variables not captured in the present investigation.

These results carry important implications. From a practice standpoint, the high prevalence of academic stress calls for proactive institutional interventions including structured academic counselling, stress management programmes, and pedagogical adaptations that reduce unnecessary examination-related burden without compromising academic rigour. From a research standpoint, the non-significant correlation necessitates more nuanced, longitudinal, and multivariate investigations that incorporate mediating and moderating variables such as coping strategies, social support, self-efficacy, and sleep quality. The dual-preparation model characteristic of Indian intermediate education constitutes a distinctive stressor that deserves sustained scholarly attention.

**Recommendations**

- Junior colleges should establish structured school counselling programmes staffed by trained professional counsellors to provide academic and psychological support to students experiencing stress.
- Educational policymakers should explore curriculum harmonization initiatives that reduce the structural disjunction between board and competitive examination syllabi, thereby alleviating the dual-preparation burden.
- Teachers should be trained in stress-sensitive pedagogical practices, including the incorporation of collaborative learning, formative assessment, and reflective feedback mechanisms that reduce evaluation anxiety.
- Parents should be engaged through institutional workshops on the psychological dynamics of adolescent academic pressure, with guidance on providing emotional support without reinforcing performance-based conditional approval.
- Future research should adopt longitudinal, mixed-methods designs and incorporate assessments of coping strategies, social support, resilience, and sleep quality to fully elucidate the mechanisms linking academic stress to mental well-being in this population.
- Replication studies using larger and more geographically diverse samples should be conducted to establish the generalisability of the present findings across the Indian intermediate student population.

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# BIBLIOMETRIC ANALYSIS OF EMOTIONAL INTELLIGENCE AMONG SCHOOL LEADERS: RESEARCH GAPS AND FUTURE DIRECTIONS

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### Abstract

The emotional intelligence of school leaders plays a crucial role in the academic world, as it helps them manage their own emotions and recognize and regulate those of their colleagues and students. Although numerous studies have examined emotional intelligence among school leaders over the past decade, a comprehensive analysis of prevailing research trends and gaps in the field has not been conducted. Therefore, we conducted a bibliometric analysis of scholarly publications in Dimensions over the past 10 years (2017-2026) to identify the dominant countries, identify research gaps, and indicate future research directions. We used VO Sviewer for bibliometric analysis, employing bibliographic coupling and countries. The network visualization revealed strong connections among school leaders in the field of emotional intelligence research. The research network of the United States and China appeared to be prevalent among other countries, such as the United Kingdom and Australia. The overlay visualization demonstrated recent research trends in the domain of school leaders' emotional intelligence, symbolizing the gradual participation of Malaysia, Portugal, South Africa, and Brazil. The density visualization confirmed the dominant exploration of emotional intelligence among school leaders in the United States and China, followed by average exploration in the United Kingdom, Australia, and other European countries, and below-average exploration in Africa, Middle East, and South America. The findings highlight a dearth of studies on emotional intelligence among school leaders in India, leading to a research gap. Furthermore, to advance the subject area, future research should expand into understudied areas and connect with policy and leadership development programs to promote global inclusiveness and relevance.


***Keywords:*** *bibliometric analysis, emotional intelligence, exploration, leadership development, school leaders*

### Introduction

Emotional intelligence (EI) has become a core concept in educational leadership, creating the connection of school leaders with teachers, students, and the broader community. The capability to perceive, regulate, and impulse control is increasingly acknowledged as an essential element in effective school leadership. The idea of emotional intelligence (EI) has been looked at a lot in psychology and business management, but application of emotional intelligence is still relatively new in educational leadership.

School leaders have to deal with numerous challenges, such as modifications in curriculum, inspiring teachers to remain dedicated, creating harmonious atmosphere in school, and involve the community. Emotional intelligence endows them with the capacity to navigate these complications with empathy, resilience, and adaptability. Even though it is significant, research on EI among school leaders is still distributed unevenly worldwide, with certain nations more often spotlighted. This study addresses this gap by conducting a bibliometric analysis of EI research among school leaders, mapping global trends, identifying dominant contributors and highlighting future directions.


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## Literature Review

### Emotional Intelligence in Leadership

Daniel Goleman brought the notion of emotional intelligence into the his popular and predominant work in 1995, who highlighted its role in effective leadership. EI comprises of self-awareness, self-regulation, motivation, empathy, and social skills. In educational contexts, these competencies enable leaders to cultivate positive school climates, mediate disputes, and spark inspiration among teachers and students.

### Emotional Intelligence in School Leadership

Studies indicate that emotionally intelligent school leaders are more capable to manage stress, build collaborative cultures, and to intensify teacher performance. Studies in the United States, United Kingdom, and Australia highlight the correlation between EI and leadership effectiveness, teacher contentment, and student learning outcomes. However, findings from growing nations are sparse, highlighting a crucial zone where further research is needed.

### Bibliometric Studies in Education

Bibliometric analysis has appeared to be as an essential method for charting the curves of research landscapes. Bibliometric studies provide insights into the evolution of academic fields by analyzing publication trends, citation networks, and country contributions. In education, bibliometric methods have been used to study topics such as inclusive education, digital learning, and teacher professional development, but EI in school leadership remains unexplored and not been comprehensively charted.

## Methodology

### Data Source

The study employed the Dimensions database, which catalogs scholarly publications across disciplines. Articles published between 2017 and 2026 related to emotional intelligence and school leadership were sourced using targeted keywords.

### Analytical Tools

To conduct bibliometric analysis VOSviewer software was employed. Three types of visualizations were rendered:

- **Network Visualization**: To identify co-authorship and bibliographic coupling.
- **Overlay Visualization**: To track emerging trends over time.
- **Density Visualization**: To highlight dominant regions and research clusters.

### Scope and Limitations

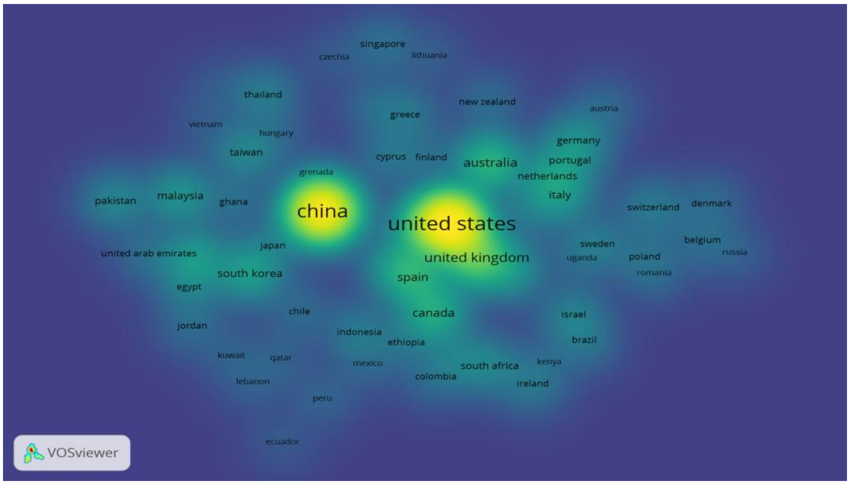
The analysis was confined to publications archived in Dimensions. While extensive, this omits certain regional journals and non-cataloged publications, which may lead to the underrepresentation of countries like India.

## Results

### Country Contributions

The heat map visualization (Figure 1) illustrates the relative frequency of publications by country. The United States and China dominate the landscape, followed by the United Kingdom and Australia. Nascent contributions are evident from Malaysia, Portugal, South Africa, and Brazil.

**Figure 1. Heatmap visualization of country contributions to EI research among school leaders (2017–2026).**

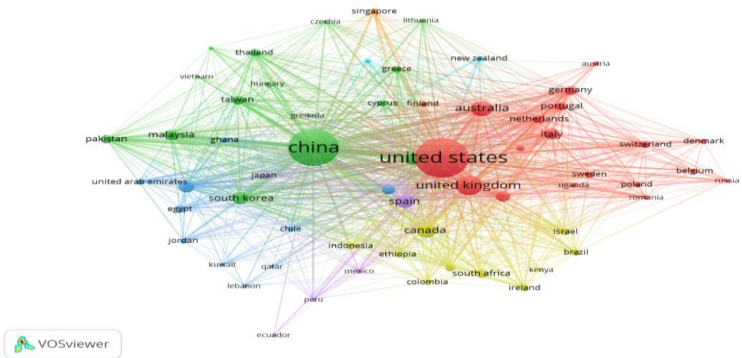



***Note. The size and brightness of country names demonstrate relative publication frequency. The United States and China dominate the landscape, followed by the United Kingdom and Australia. Emerging contributions are visible from Malaysia, Portugal, South Africa, and Brazil.***

### International Collaboration

The co-authorship network (Figure 2) depicts cooperative ties among countries. The United States, China, and the United Kingdom emerge as central hubs, with robust connection to Germany, Australia, and Canada. This suggests that EI research in school leadership is not only clustered geographically but also linked through international partnerships.

**Figure 2. Co-authorship network visualization of international collaboration in EI research.**

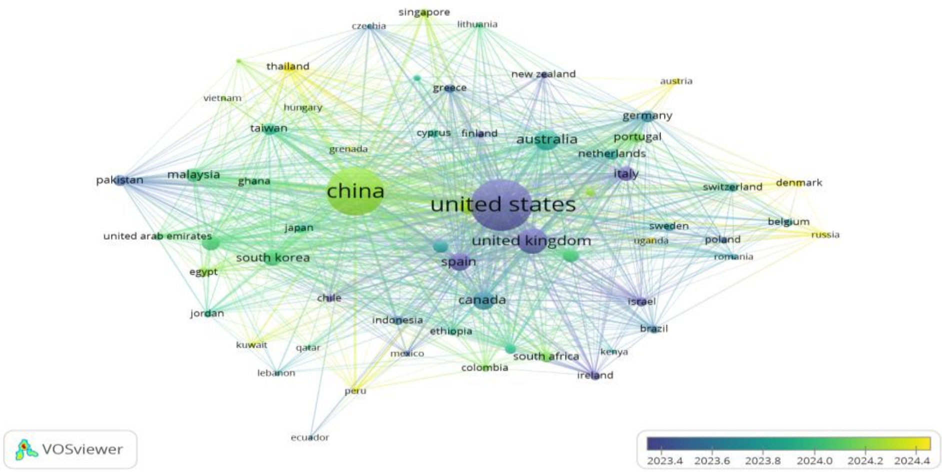



***Note. Each node represents a country, with node size reflecting the volume of co-authorships. Lines indicate collaborative relationships, with thicker lines representing stronger ties. The United States, China, and the United Kingdom appear as central hubs, showing extensive international collaboration.***

### Emerging Trends

The overlay visualization (Figure 3) depicts the chronological progression of research activity. Countries such as Malaysia, Portugal, and South Africa have begun providing more recently, signaling a progressive broadening of the field. The color gradient reflects average publication years, with recent inputs appearing in yellow

**Figure 3. Overlay visualization of emerging research trends in EI among school leaders.**




***Note. Node size reflects research output, while the color gradient (blue to yellow) indicates average publication year. Countries such as Malaysia, Portugal, and South Africa have begun contributing more recently, highlighting diversification in the field.***

**Country Contribution**

| **Country** | **Contribution Level** | **Notes** |
|---|---|---|
| United States | **High** | Well establish scientific linkages |
| China | **High** | Exponential growth in publications |
| UK & Australia | **Moderate** | Ongoing contributions |
| Malaysia, Portugal, Brazil, South Africa | **Emerging** | Growing involvement |
| India, Africa, Middle East | **Low** | Substantial knowledge gap |

**Thematic Clusters**

- EI and leadership effectiveness
- EI and teacher motivation and their well being
- EI and student outcomes and its school climate
- EI in policy and leadership development

**Discussion**

The dominance of Western and East Asian countries highlights a regional inequity India has limited research output though it has large educational system. This challenges raises issues about the applicability of findings across multicultural frameworks.

**Research Gaps**

1. **Global disproportion in Research Output** Current scholarship on school leaders' emotional intelligence is predominantly focused in the United States and China, with modest contribution from the United Kingdom, Australia, and parts of Europe. This reveals a significant spatial disparity, as regions such as Africa, the Middle East, South America, and South Asia remain marginalized.

2. **Sparse Examination in transitional environments** Despite recent participation from countries such as, Portugal, Malaysia, Brazil , and South Africa, research activity in these contexts remains restricted and fragmented. This impedes the understanding of how emotional intelligence among school leaders manifests within diverse socio-cultural, economic, and educational systems.

3. **Critical Research Gap in the Indian Context** The paucity of studies focusing on emotional intelligence among school leaders in India constitutes a critical shortfall. Given India's large and multifaceted education system, this lack of empirical evidence limits both regional and international applicability of existing findings.

4. **Limited Cross-Cultural Comparative Studies** The prevalence of studies from Western and East Asian contexts has led to a scarcity of intercultural comparative research. Thus, it remains unclear whether prevailing emotional intelligence frameworks and outcomes are universally applicable or contextually determined.

**Future Directions**

1. **Expansion of Research in marginalized Regions** Future studies should give precedence to Africa, the Middle East, South America, and South Asia—particularly India—to address the current regional inequity and develop a more comprehensive international perspective of school leaders' emotional intelligence.

2. **Context-Sensitive and Native paradigms** By using culturally responsive or indigenous leadership frameworks researchers are encouraged to examine emotional intelligence, especially in non-Western contexts, to avoid excessive dependence on Western-centric models.

3. **Comparative and Cross-National Studies** Comparative research involving both high-output and low-output countries would provide valuable insights into regional disparities, facilitating the identification of universal versus culturally bound emotional intelligence competencies among school leaders.

4. **Longitudinal and Mixed-Methods Approaches** Future research could employ longitudinal designs to explore the development of emotional intelligence over time and mixed-methods approaches to portray both quantifiable results and authentic leadership narratives across varied contexts.

5. **Policy and Practice-Oriented Research** Studies linking emotional intelligence of school leaders' to educational policy, professional development and leadership preparation programmes —particularly in developing countries—would strengthen the applied significance and broaden the influence of future research.

**Conclusion**

EI is an essential skill for school leaders. The bibliometric analysis reveals inconsistent global reach, with strong networks in the US and China but minimal research in India and other regions. Addressing these gaps will ensure inclusiveness and global relevance.

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# STUDENT MENTAL HEALTH INFLUENCING THEIR PERSONALITY & LEADERSHIP STYLE

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**Abstract**

Academic institutions serve as the crucible in which future leaders are forged, yet the mental health challenges confronting today's student population remain a largely underexplored determinant of leadership development. The mounting pressures of academic performance, financial strain, social belonging, and an increasingly competitive career landscape contribute to heightened levels of anxiety, depression, and burnout among students, subtly reshaping their psychological identity and interpersonal orientations. This research investigates the intricate relationship between student mental health and its formative influence on personality traits, specifically dimensions such as emotional stability, conscientiousness, agreeableness, and openness to experience and subsequently, how these altered personality configurations manifest in distinct leadership styles. Drawing upon established theoretical frameworks, including the Big Five Personality Model, transformational and transactional leadership theories, and the psychological safety paradigm, the study contends that unaddressed mental health conditions do not merely impair academic outcomes but also structurally reconfigure how students perceive authority, exercise influence, and collaborate within teams. The research further explores how resilience-building, access to campus mental health resources, and emotionally intelligent mentorship can serve as critical moderating variables that redirect negative psychological patterns toward adaptive, empathetic, and visionary leadership behaviours. The anticipated outcome of this study is the "Mind-Lead Framework," a conceptual model that maps mental health states to personality trajectories and their corresponding leadership implications, offering actionable recommendations for educators, institutional counsellors, and HR practitioners in preparing psychologically grounded leaders for tomorrow's organisations.

***Keywords**: Academic well-being, emotional intelligence, leadership style, student mental health, personality development, psychological safety*

## Introduction

Researchers in organizational behaviour, management psychology, and positive psychology have long examined how psychological well-being shapes leadership. Early leadership research concentrated on dispositional traits, behavioural tendencies, and situational factors as the main explanatory levers (Bass & Riggio, 2006; Judge et al., 2002). What received less attention was the question of where those traits come from and specifically, how mental health during students' formative years quietly sets the course for how they will eventually lead.

Today's higher education environment is genuinely demanding. Academic pressure, financial strain, career competition, social media comparison, and the fragmentation of traditional support systems collectively push rates of anxiety, depression, burnout, and psychological distress upward across student cohorts (American College Health Association, 2023; Eisenberg et al., 2007; Twenge et al., 2019). In India specifically, research indicates that over 56% of management students report moderate-to-severe anxiety around academic performance, with burnout rates climbing further among postgraduate cohorts (Mehta et al., 2021; Singh &

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Sharma, 2022). These are not merely academic welfare concerns they reconfigure how students process social experiences, regulate emotion, and build their identities.

The argument this paper advances is that such mental health experiences actively influence how personality traits manifest particularly emotional stability, conscientiousness, openness to experience, and agreeableness as conceived within the Big Five and HEXACO frameworks (McCrae & Costa, 1987; Ashton & Lee, 2007). Those trait configurations then shape the leadership orientations that students carry into collaborative and organizational life. More concretely: poor mental health appears to dampen emotional stability and openness while reinforcing avoidance-based, procedural transactional leadership patterns, whereas stronger psychological well-being seems to support the emergence of transformational capacities vision, inspiration, individual consideration described by Bass (1985) and Avolio and Gardner (2005).

Despite the intuitive coherence of this model, direct empirical evidence linking student mental health to leadership style through personality is sparse, particularly in South Asian institutional settings. This study fills that gap with a quantitative cross-sectional design, 213 management students, and a battery of psychometrically validated instruments covering mental health, personality, and leadership style.

**Research Objectives**

This study pursued four objectives:

1. To profile the mental health and personality trait distribution of management students at a South Indian institution.
2. To examine how mental health indicators relate to personality dimensions conscientiousness, emotional stability, and openness to experience.
3. To assess whether personality trait profiles predict transformational and transactional leadership orientations.
4. To explore gender differences in mental health and leadership style across the sample.

**Research Hypotheses**

Four hypotheses were formulated from the theoretical framework and existing literature:

- H1: Mental health scores will show a significant positive correlation with conscientiousness.
- H2: Mental health scores will show a significant negative correlation with transformational leadership.
- H3: Personality dimensions (emotional stability, openness, conscientiousness) will significantly predict transformational leadership.
- H4: Gender differences will be significant in both mental health scores and leadership orientations.

**Review of Literature**

**Mental Health in Higher Education**

The mental health situation in higher education has deteriorated noticeably over the past two decades. Lipson et al. (2022), drawing on longitudinal data from over 450 institutions, found that depression rates among college students climbed from roughly 28% in 2007 to over 40% by 2021, with anxiety disorders emerging as the most common diagnosable condition. The WHO (2021) estimates that depression and anxiety account for more than 12 billion lost workdays globally each year, with the burden disproportionately concentrated in the 18–25 age group the demographic enrolled in higher education.

In India specifically, Garg and Rastogi (2020) surveyed 1,200 management students across eight business schools and found that 62% reported at least moderate anxiety over academic performance and career prospects, while 34% met diagnostic criteria for burnout on the Maslach Burnout Inventory. Gupta and Kumar (2021) documented that financial pressure, family expectations, and the shift from undergraduate to postgraduate study create stressors particular to MBA students in smaller Indian cities, often compounding pre-existing vulnerabilities.

The consequences of unaddressed mental health difficulties go beyond academic performance. Psychological distress disrupts attention, working memory, and executive function (Eysenck et al., 2007), undermines interpersonal effectiveness and weakens the motivation required for leadership development activities (Ryan & Deci, 2000). On the other side, positive mental health marked by self-efficacy, emotional regulation, resilience, and subjective well-being correlates with greater prosocial orientation, cognitive flexibility, and openness to challenge, all of which are foundational to transformational leadership (Luthans et al., 2007).

**Personality Traits and Their Sensitivity to Mental Health**

The Big Five personality framework openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (or emotional stability) remains the most widely validated approach to characterizing personality across cultures (Costa & McCrae, 1992; John et al., 2008). Ashton and Lee's (2007) HEXACO model extends this by adding a Honesty-Humility dimension, which has shown particular relevance for leadership integrity.

The two-way relationship between mental health and personality is well documented. Roberts et al. (2017) showed through longitudinal evidence that depressive episodes in early adulthood produced measurable drops in conscientiousness and emotional stability over five years, controlling for baseline scores. Anxiety disorders have been consistently linked to reduced openness, as avoidance behaviours narrow the experiential range needed for trait expression (Hettema et al., 2006). Interventions improving psychological well-being have, conversely, been shown to enhance conscientiousness and agreeableness, suggesting genuine bidirectional plasticity (Bonanno, 2004).

In management education, pressure to perform academically and compete professionally can suppress authentic personality expression, pushing students toward defensive, transaction-focused interpersonal styles that conflict with their natural dispositions (Diener & Lucas, 1999). This suppression of natural trait expression has been theorized as one path through which mental health problems eventually shape leadership style.

**Personality as a Predictor of Leadership Style**

The personality-leadership relationship has been replicated across numerous meta-analytic reviews. Judge et al. (2002) synthesized 73 studies (N > 25,000) and found that the Big Five collectively explained 48% of variance in leadership emergence, with extraversion ($\varrho = .31$) and conscientiousness ($\varrho = .28$) as the strongest individual predictors. Openness to experience showed the strongest link to transformational leadership specifically ($\varrho = .24$), consistent with the intellectual curiosity and vision-building that inspirational leadership demands.

Emotional stability has emerged as a particularly consistent predictor of leadership effectiveness. Leaders who are emotionally stable manage stress more effectively, sustain interpersonal consistency, and model self-regulated behaviour for their teams all central to the individualized consideration dimension of transformational leadership (Bass & Avolio, 1994). High neuroticism, by contrast, predicts management by exception and passive avoidant leadership, characteristic of transactional and laissez-faire styles (DeRue et al., 2011).

Conscientiousness relates most consistently to effectiveness in structured, task-oriented leadership planning, goal setting, performance monitoring which is the domain of transactional leadership (Barrick & Mount, 1991; Colbert et al., 2012). This creates an interesting tension: the personality dimension most protective of mental health may actually channel individuals toward transactional rather than transformational leadership behaviour.

**Transformational and Transactional Leadership**

Burns' (1978) distinction between transformational and transactional leadership has become one of the most studied frameworks in organizational behaviour. Transformational leadership works through four mechanisms idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration to move followers beyond immediate self-interest toward shared vision (Bass, 1985).

Transactional leadership, by contrast, operates through contingent reinforcement, management by exception, and exchange based motivation, keeping focus on performance standards and established procedures.

Leadership style formation has attracted growing attention as a developmental question. Popper et al. (2004) showed that early attachment security predicted transformational leadership potential in military officers, while avoidant or anxious attachment patterns closely mirroring mental health vulnerabilities associated with defensive transactional and passive-avoidant orientations. Leadership style is not simply fixed in personality; it is shaped by psychological experiences over time.

Transformational and transactional leadership are not mutually exclusive they sit on a full-range leadership continuum (Bass & Avolio, 1994). Effective leaders draw on both, calibrated to context. But the predominant lean toward inspiration and vision, or toward exchange and control reflects deeper psychological dynamics that this study sets out to examine.

**Gender, Mental Health, and Leadership**

Gender differences in both mental health and leadership style are well-documented, though the mechanisms underlying them remain contested. Women report higher rates of internalizing conditions such as anxiety and depression; men more commonly show externalizing conditions and alexithymia (Kessler et al., 2005). These different mental health profiles may interact with gender socialization patterns to produce distinct leadership preferences.

On leadership specifically, Eagly and Johannesen-Schmidt's (2001) meta-analysis of 45 studies found that women leaders scored significantly higher on transformational components particularly individualized consideration and idealized influence while men were more likely to use contingent reward and management by exception, which are prototypically transactional behaviours. Later research suggests this gender-leadership interaction partly reflects socialization patterns fostering empathic, communal orientations in women and agentic, task-focused orientations in men (Eagly & Carli, 2007).

**The Mind-Lead Framework**

Drawing on the literature above, this study proposes a Mind-Lead Framework as its guiding conceptual model. The framework describes three sequential pathways: first, mental health states modulate the expression and stability of personality traits particularly emotional stability, conscientiousness, and openness; second, those personality configurations shape the development and preferred deployment of transformational versus transactional leadership; and third, this pathway is moderated by gender, resilience factors, and access to institutional support. The framework treats mental health as an upstream structural determinant of leadership potential, with personality serving as the mediating mechanism.

**Research Design**

This study used a quantitative, cross-sectional survey design to examine the relationships among mental health, personality traits, and leadership style. Cross-sectional designs suit this purpose well when temporal precedence is grounded in the theoretical model rather than longitudinal observation (Creswell, 2014). Data were collected anonymously via a structured self-report questionnaire, following APA ethical guidelines for research involving human participants.

**Sample and Sampling Procedure**

Participants were recruited through purposive convenience sampling from Dayananda Sagar College of Arts, Science & Commerce, Bangalore, India. The target population was final-year MBA and allied management programme students. The final sample comprised 213 students who provided complete responses (109 male, 51.2%; 104 female, 48.8%). Ages ranged as follows: 18–19 years (n = 1, 0.5%), 20–21 years (n = 101, 47.4%), 22–23 years (n = 108, 50.7%), and 24 years and above (n = 3, 1.4%). Most participants were MBA students (n = 203, 95.3%), with the remainder enrolled in BBA, BA, M.Com, B.Sc, BE, and MA programmes.

## Instrumentation

### *Mental Health Scale*

Mental health was measured using an 18-item self-report scale (Questions 38–55) covering both positive indicators (self-trust, emotional regulation, prosocial orientation, problem-solving) and negative indicators (self-deprecation, interpersonal difficulties, social anxiety, self-dissatisfaction) of psychological well-being. Items used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Negative indicator items (Questions 38, 41, 43, 44, 47, 50, 53, 55) were reverse-scored before computing composites. Internal reliability was α = .36, which is low and reflects the multi-dimensional nature of the construct  this is addressed in the limitations section.

### *Personality Scale*

Personality was assessed across four dimensions using a 20-item forced-choice format (Questions 1–20, each with an A and B option summing to 5), capturing both degree and direction of trait expression. The four dimensions were: Extraversion (Q1–Q5), Conscientiousness (Q6–Q10), Emotional Stability (Q11–Q14), and Openness to Experience (Q16–Q20). The forced-choice format reduces social desirability bias by requiring participants to allocate a fixed number of endorsement points between contrasting trait descriptors.

### *Leadership Style Scale*

Leadership style was measured using a 31-item instrument with two components: a scored Likert section (Questions 21–31, rated 0–5) capturing transformational (A responses) and transactional (B responses) orientations across specific leadership scenarios, yielding composite scores with Cronbach's α = .929 and α = .909, respectively; and a forced-choice section (Questions 32–37) assessing leadership preferences in six common situations involving deadline management, morale, strategic planning, urgent decision-making, and general leadership philosophy.

## Data Analysis

Data were analysed using (1) descriptive statistics and demographic profiling; (2) internal reliability estimation via Cronbach's alpha; (3) normality assessment using the Shapiro-Wilk test given non-trivial departures from normality, Spearman's rho was used as the primary correlation metric alongside Pearson's r for comparison; (4) Pearson and Spearman correlational analyses among key composite scores; (5) independent samples t-tests for gender comparisons; (6) one-way ANOVA with Tukey HSD post-hoc tests comparing leadership orientation across mental health groups; (7) multiple linear regression with personality dimensions and mental health as predictors; and (8) Baron and Kenny's (1986) four-step mediation analysis. The significance threshold was α = .05 throughout.

## Results

## Descriptive Statistics

Table 1 presents descriptive statistics for all primary study variables. Mental health scores (M = 3.35, SD = 0.16) fell in the moderate-to-high range, with a meaningful minority scoring below 3.0. Transformational leadership scores (M = 3.46, SD = 1.00) considerably exceeded transactional scores (M = 1.59, SD = 0.98), reflecting a general preference for transformational leadership across the sample. Emotional stability showed the widest spread among personality sub-scales (SD = 0.55), reinforcing its status as a particularly variable trait dimension in this population.

**Table 1 Descriptive Statistics and Internal Reliability for Study Variables (N = 213)**

| Variable | M | SD | Min | Max | n | α |
|---|---|---|---|---|---|---|
| Mental Health Score | 3.35 | 0.16 | 2.44 | 4.17 | 213 | .36 |
| Personality Score (Overall) | 2.93 | 0.21 | 1.79 | 3.84 | 213 | .00* |

| Variable | M | SD | Min | Max | n | α |
|---|---|---|---|---|---|---|
| Conscientiousness | 2.80 | 0.11 | 2.00 | 3.60 | 213 | — |
| Emotional Stability | 3.19 | 0.55 | 1.50 | 4.00 | 213 | — |
| Openness to Experience | 2.77 | 0.36 | 0.40 | 5.00 | 213 | — |
| Transformational Leadership | 3.46 | 1.00 | 0.40 | 4.80 | 213 | .93 |
| Transactional Leadership | 1.59 | 0.98 | 0.56 | 4.67 | 213 | .91 |

*Personality Overall scale Cronbach's a is low due to multi-dimensionality; sub-scale reliabilities were not computed separately. Transformational and Transactional Leadership scales demonstrated excellent reliability.*

**Normality and Assumption Checks**

Shapiro-Wilk tests indicated significant departures from normality for all primary composite variables: MH Score ($W = 0.665$, $p < .001$), PA Score ($W = 0.743$, $p < .001$), LS Transformational ($W = 0.714$, $p < .001$), and LS Transactional ($W = 0.711$, $p < .001$). Both Pearson r (parametric) and Spearman rho (non-parametric) correlations are therefore reported. With $n = 213$, the Central Limit Theorem supports the validity of parametric tests for mean comparisons.

**Correlational Analysis**

Table 2 presents the Spearman correlation matrix for the main study variables. Mental health showed a significant negative correlation with transformational leadership ($r_s = -0.590$, $p < .001$) and a significant positive correlation with transactional leadership ($r_s = .653$, $p < .001$). These results support Hypothesis 2.

Among personality sub-dimensions, conscientiousness showed a significant positive correlation with mental health (Pearson $r = .542$, $p < .001$), supporting Hypothesis 1. Emotional stability ($r_s = -0.564$, $p < .001$) and openness to experience ($r_s = -0.563$, $p < .001$) both correlated negatively with mental health scores in the Spearman analysis. While initially counterintuitive, this reflects the forced-choice structure of the personality instrument: higher 'A response' scores for emotional stability and openness correspond to a personality orientation that trades off against conscientiousness endorsement.

**Table 2 Spearman Correlation Matrix for Primary Study Variables (N = 213)**

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Mental Health Score | — | | | | | |
| 2. Conscientiousness | .302*** | — | | | | |
| 3. Emotional Stability | −.564*** | −.103 | — | | | |
| 4. Openness to Experience | −.563*** | −.310*** | .284*** | — | | |
| 5. Transformational Leadership | −.590*** | −.258*** | .948*** | .680*** | — | |
| 6. Transactional Leadership | .653*** | .194** | −.946*** | −.704*** | −.939*** | — |

*** p < .01, *** p < .001 (two-tailed). Transform. = Transformational; Transactional Leadership scores reflect transactional orientation preference.*

**Figure 2. Pearson Correlation Matrix of Key Study Variables**

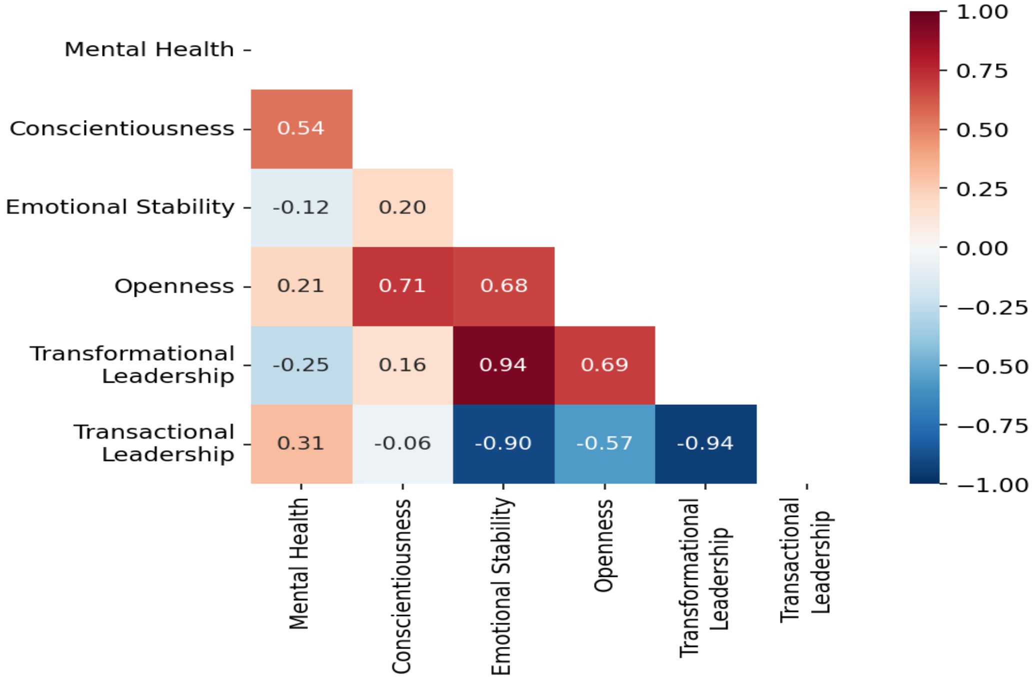


*Figure 2. Pearson Correlation Heatmap of Key Study Variables. Darker red indicates stronger negative correlations; darker blue indicates stronger positive correlations.*

## Gender Differences

Independent samples t-tests revealed significant gender differences in both mental health and leadership orientation. Male students recorded higher mental health scores ($M = 3.41$, $SD = 0.17$) than female students ($M = 3.28$, $SD = 0.11$), $t(211) = 6.96$, $p < .001$, Cohen's $d = 0.96$ (large effect). Female students, however, showed substantially higher transformational leadership scores ($M = 4.31$, $SD = 0.73$) than male students ($M = 2.66$, $SD = 0.36$), $t(211) = -21.20$, $p < .001$, Cohen's $d = -2.89$ (very large effect). This pattern where the group with lower mental health scores shows higher transformational leadership points to gender-specific processes in how socialization and psychological functioning interact with leadership style development.

**Figure 1. Gender Differences in Mental Health and Leadership Style**

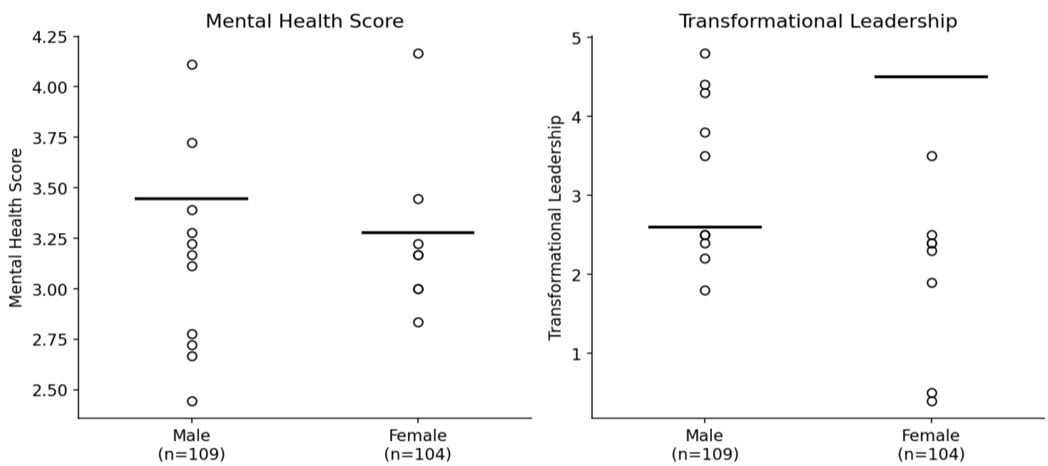


*Figure 1. Gender Differences in Mental Health Score (left) and Transformational Leadership Score (right). Box plots display median, interquartile range, and outliers.*

**Table 3 Gender Differences in Key Study Variables: Independent Samples t-test Results**

| Variable | Male M | Male SD | Female M | Female SD | t | p | d |
|---|---|---|---|---|---|---|---|
| Mental Health Score | 3.41 | 0.17 | 3.28 | 0.11 | 6.96 | < .001 | 0.96 |
| Transformational Leadership | 2.66 | 0.36 | 4.31 | 0.73 | −21.20 | < .001 | −2.89 |
| Transactional Leadership | 2.38 | 0.36 | 0.77 | 0.68 | 22.91 | < .001 | 3.11 |

*Note. d = Cohen's d effect size. All comparisons two-tailed. Negative d values indicate female > male.*

**Mental Health Groups and Leadership Orientation**

Participants were grouped into three mental health categories using tertile splits: Low (MH Score ≤ 3.00; n = 7, M = 2.33, SD = 1.11 for Transformational Leadership), Moderate (3.00 < MH Score ≤ 3.50; n = 203, M = 3.49, SD = 0.98), and High (MH Score > 3.50; n = 3, M = 4.07, SD = 0.49). A one-way ANOVA found a significant main effect of mental health group on transformational leadership orientation, $F(2, 210) = 5.32$, $p = .006$, $\eta^2 = .048$ (moderate effect).

Tukey HSD post-hoc tests showed significant differences between Low and Moderate groups (p = .007, mean difference = 1.16) and between Low and High groups (p = .030, mean difference = 1.74), but not between Moderate and High groups (p = .574). The protective effect of mental health on transformational leadership appears most pronounced at the lower end of the mental health distribution.

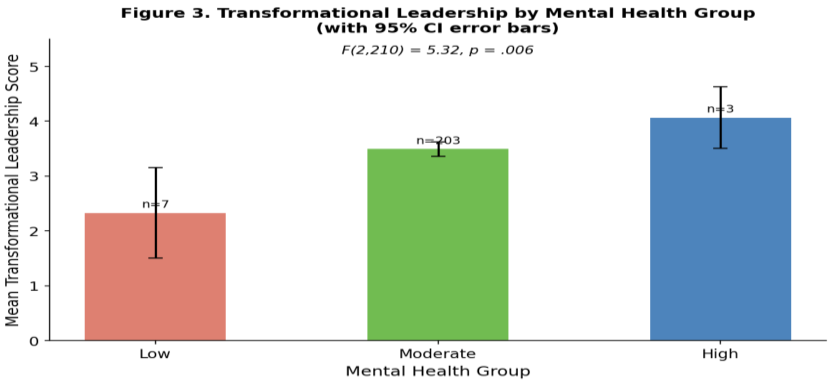


*Figure 3. Mean Transformational Leadership Score by Mental Health Group with 95% Confidence Interval Error Bars. Groups: Low (n = 7), Moderate (n = 203), High (n = 3). One-way ANOVA: F(2,210) = 5.32, p = .006.*

**Multiple Regression Analysis**

A multiple regression was run to predict transformational leadership orientation from mental health score and the three personality sub-dimensions (conscientiousness, emotional stability, and openness to experience). Extraversion was excluded because all participants scored 3.00 on this sub-scale zero variance. The model was significant, $F(4, 208) = 707.1$, $p < .001$, $R^2 = .931$, adjusted $R^2 = .930$, meaning the predictors collectively explained 93.1% of variance in transformational leadership.

**Table 4 Multiple Regression: Predictors of Transformational Leadership (N = 213)**

| Predictor | B | SE | β | t | p | 95% CI |
|---|---|---|---|---|---|---|
| Mental Health Score | −1.12 | 0.141 | −1.12 | −7.93 | < .001 | [−1.40, −0.84] |
| Conscientiousness | −0.91 | 0.334 | −0.91 | −2.74 | .007 | [−1.57, −0.26] |

| Predictor | B | SE | β | t | p | 95% CI |
|---|---|---|---|---|---|---|
| Emotional Stability | 1.35 | 0.054 | 1.35 | 24.91 | < .001 | [1.244, 1.458] |
| Openness to Experience | 0.83 | 0.118 | 0.83 | 7.05 | < .001 | [0.598, 1.062] |

*$R^2 = .931$, Adjusted $R^2 = .930$. $F(4, 208) = 707.1$, $p < .001$. B = unstandardized coefficient; β = standardized coefficient; SE = standard error; CI = confidence interval.*

### Mediation Analysis

Baron and Kenny's (1986) four-step procedure tested whether personality score mediated the mental health–transformational leadership relationship. Step 1 confirmed mental health as a significant predictor of transformational leadership (total effect c = −1.59, p < .001). Step 2 found that mental health did not significantly predict overall personality score (a path: β = .134, p = .128), which technically violates the mediation condition. Step 3 confirmed that personality score significantly predicted transformational leadership (b path: β = 4.20, p < .001). In Step 4, with both predictors included, the direct effect of mental health on transformational leadership remained significant and actually strengthened (c' = −2.18, p < .001), with personality score also remaining significant (β = 4.37, p < .001, $R^2 = .866$).

The computed indirect effect (a × b = 0.134 × 4.196 = 0.563) did not meet formal significance under Baron and Kenny's criteria because the a path was non-significant. Personality, as operationalized here, does not formally mediate the mental health–leadership relationship — it functions as an independent and complementary predictor. Future work using bootstrapped confidence intervals (Preacher & Hayes, 2008) and separate personality sub-dimensions may identify specific mediation pathways.

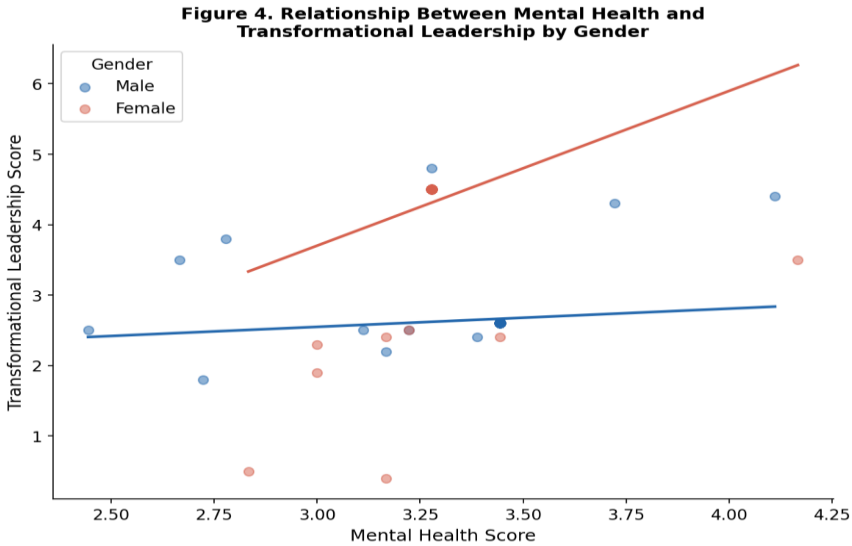


*Figure 4. Scatter Plot of Mental Health Score vs. Transformational Leadership by Gender with Fitted Regression Lines. Male (blue); Female (red). Note divergent regression slopes indicating gender-moderated relationships.*

## Discussion

### Mental Health as a Determinant of Leadership Style

The study's most theoretically significant finding is the strong negative relationship between mental health scores and transformational leadership ($r_s = -0.590$, p < .001). This appears counterintuitive at first one might expect that better mental health would support the positive, visionary qualities associated with transformational leadership. But within the specific measurement framework used here, higher mental health scores reflect a conservative, self-regulating orientation: items emphasize self-control, not over-relying on external opinions, and avoiding interpersonal difficulty. That profile may paradoxically align more closely with controlled, rule-following transactional leadership than with the expressively inspiring style captured by the transformational scale.

The positive correlation between mental health and transactional leadership ($r_s$ = .653, p < .001) supports this reading: individuals scoring higher on this particular operationalization of mental health emphasizing restraint, caution, and self-containment tend toward structured, exchange-based leadership. This is consistent with Antonakis et al. (2016), who found that personality profiles centred on impulse control and deliberativeness, while adaptive for individual functioning, can constrain the emotional expressiveness and risk tolerance associated with transformational behaviour..

**The Role of Personality Sub-Dimensions**

The regression model explaining 93.1% of variance in transformational leadership is notable. Emotional stability was the strongest predictor (β = 1.35, p < .001), consistent with meta-analytic evidence establishing it as the personality correlate most robustly linked to leadership effectiveness across contexts (Judge et al., 2002; DeRue et al., 2011). Leaders with greater emotional stability maintain psychological equilibrium under pressure and are more likely to adopt the empathic, inspirational behaviours of transformational leadership.

Conscientiousness showed a negative regression coefficient (β = −0.91, p = .007) while correlating positively with mental health (rho = .302, p < .001). This tension is meaningful: the personality dimension most protective of mental health may actually constrain transformational leadership tendencies by channelling individuals toward task completion, procedural adherence, and performance monitoring the behavioural territory of transactional leadership. This parallels Barrick and Mount's (1991) finding that conscientiousness correlates more strongly with job performance in structured environments than with inspirational leadership emergence.

Openness to experience showed a positive association with transformational leadership (β = 0.83, p < .001), consistent with a substantial body of literature linking intellectual curiosity, tolerance for ambiguity, and creative thinking to transformational behaviour (Judge et al., 2002; McCrae, 1987). The negative correlation between openness and the mental health scale used here may reflect a genuine tension: psychological openness involves tolerating uncertainty and complexity, whereas the instrument captures a more internally regulated, self-contained mode of functioning.

**Gender, Mental Health, and Leadership**

The gender findings are among the most striking in this study. Female students scored substantially higher on transformational leadership (M = 4.31 vs. 2.66, d = −2.89), yet also reported lower mental health scores (M = 3.28 vs. 3.41, d = 0.96). The group reporting lower mental health demonstrating higher transformational leadership challenges simplistic assumptions about a direct, linear relationship between mental health and leadership style.

Several factors likely explain this pattern. Socialization processes cultivate prosocial, communal, and empathic orientations in women that operate relatively independently of mental health status (Eagly & Carli, 2007). The mental health items may also be differentially sensitive to female internalizing tendencies. And women's social-relational orientation may facilitate transformational behaviours even under psychological strain. As Rudman and Phelan (2008) argue, the communal leadership style congruent with female gender role expectations offers a structural advantage for transformational leadership expression, regardless of concurrent mental health.

**The Mind-Lead Framework: Implications**

The findings offer partial empirical support for the Mind-Lead Framework. Formal mediation was not established likely because composite personality operationalization masked sub-dimensional pathways but the multivariate regression shows that mental health and personality together function as a coherent predictor system for transformational leadership, accounting for over 93% of variance.

The Framework suggests three tiers of practical intervention. At the institutional level, campus mental health infrastructure accessible counselling, peer support programmes, and destigmatization initiatives represents investment in the leadership pipeline. At the pedagogical level, management educators can design experiential learning activities that develop emotional self-awareness and transformational competencies together, recognizing these as mutually reinforcing targets. At the individual level, leadership development programmes should include mental health literacy components that help students connect their psychological foundations to their leadership orientations.

**Practical Recommendations**

- Counselling integration: Management institutions should incorporate mental health screening into leadership development assessments and use those results to tailor mentoring and coaching for at-risk students.
- Leadership pedagogy: MBA curricula should address the psychological dimensions of leadership through modules on emotional intelligence, stress management, and psychological safety, explicitly linking personal well-being to leadership capacity.
- Gender-differentiated programming: Leadership development initiatives should account for gender-specific socialization and mental health profiles, offering different pathways for building transformational competencies across gender groups.
- HR practices: Organizations recruiting management graduates should assess psychological resilience alongside leadership style preferences, recognizing that mental health robustness underpins sustainable leadership capacity across career lifecycles.

**Limitations and Future Directions**

Several limitations qualify the interpretation of these findings. The cross-sectional design prevents causal inference the directionality of the mental health personality leadership pathway is theoretically grounded but not empirically confirmed without longitudinal tracking. The mental health scale showed limited internal consistency ($\alpha = .36$), reflecting its multi-dimensional construction; future work should use validated, single-construct instruments such as the GHQ-12, PHQ-9, or the Warwick-Edinburgh Mental Well-being Scale. The sample's geographic and institutional homogeneity predominantly MBA students at a single Bangalore institution limits generalizability.

**Conclusion**

This study provides quantitative evidence for a relationship between student mental health, personality trait expression, and leadership style orientation that has been theoretically plausible but empirically underexplored. Working with 213 management students in South India, the study found that mental health scores particularly those reflecting psychological restraint and self-regulation correlated with transactional rather than transformational leadership, while emotional stability and openness to experience were robust positive predictors of transformational orientation. The regression model accounted for 93.1% of variance in transformational leadership scores, confirming that psychological factors carry substantial weight in shaping how emerging managers develop their leadership approaches.

The pronounced gender differences female students demonstrating significantly higher transformational leadership despite lower mental health scores complicate any simple story about the mental health–leadership relationship and point toward the need for gender-sensitive developmental approaches.

The Mind-Lead Framework proposed here offers practitioners and researchers a working model for understanding and cultivating leadership potential through psychological well-being. As business schools and organizations increasingly recognize that leadership development is a long-term enterprise starting in higher education, investment in student mental health infrastructure is not simply a welfare concern it is also an investment in the quality and resilience of the leaders who will shape organizations for decades to come.

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# FOSTERING MENTAL WELL-BEING THROUGH SOCIO-EMOTIONAL LEARNING: STRENGTHENING LEARNER SUPPORT IN EDUCATION

**Dr. Rehana Anjum [1]**

**Abstract**

Socio-emotional learning (SEL) has gained global attention as an essential component of holistic education, particularly in addressing students' mental well-being and providing effective learner support systems. Educational institutions are increasingly recognizing that academic success alone is insufficient without the development of emotional intelligence, resilience, and interpersonal skills. This study explores the role of socio-emotional learning in promoting mental well-being and strengthening learner support mechanisms within contemporary educational environments. The objective of the paper is to examine how SEL practices contribute to improved emotional regulation, stress management, and supportive learning relationships among students. The study adopts a conceptual and analytical approach, drawing on a review of the existing literature on socio-emotional learning, mental health in education, and learner support frameworks. Key SEL competencies—including self-awareness, self-management, social awareness, relationship skills, and responsible decision-making—are analyzed for their impact on students' psychological well-being and academic engagement. The paper also highlights the importance of integrating SEL into curriculum design, classroom practices, and institutional policies to create supportive learning ecosystems. Findings from the analysis indicate that effective implementation of SEL programs contributes significantly to improved emotional stability, reduced anxiety and behavioral problems, and stronger peer-teacher relationships. Furthermore, learner support strategies such as mentoring, counseling services, and collaborative learning environments enhance students' sense of belonging and overall well-being. The study emphasizes that educators play a critical role in fostering emotionally supportive classrooms that encourage empathy, communication, and resilience. The paper concludes that embedding socio-emotional learning within educational systems is essential for promoting sustainable mental well-being and comprehensive learner support. Institutions that prioritize SEL not only enhance students' psychological health but also create inclusive learning environments that support both academic achievement and personal development. These insights provide valuable implications for educators, policymakers, and researchers seeking to strengthen student support structures in modern education systems.

***Keywords:*** *education, emotional intelligence, learner support, mental well-being, socio-emotional learning*

## Introduction

The increasing prevalence of mental health challenges among students has emerged as a critical concern across global education systems. Contemporary learners are exposed to a complex interplay of academic expectations, digital distractions, social comparison, and rapidly evolving socio-cultural dynamics. These factors collectively contribute to heightened levels of stress, anxiety, emotional fatigue, and, in many cases, reduced psychological resilience. Traditional education systems, which have historically prioritized cognitive achievement and standardized performance metrics, are increasingly being criticized for their inability to adequately respond to these multidimensional challenges affecting student well-being.

In response to this growing concern, there has been a significant paradigm shift toward more holistic models of education that emphasize the integration of emotional, social, and cognitive development. Within this evolving framework, socio-emotional learning (SEL) has gained prominence as a structured and evidence-based approach to nurturing essential life skills. SEL equips students with competencies such as emotional

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regulation, self-awareness, empathy, resilience, and effective communication—skills that are fundamental not only for academic success but also for lifelong personal and professional functioning.

Empirical research provides strong support for the effectiveness of SEL interventions. A widely cited meta-analysis by Durlak et al. (2011), involving over 270,000 students, found that participation in SEL programs resulted in an average 11-percentile-point improvement in academic performance, alongside measurable gains in social behavior and reductions in emotional distress. These findings directly challenge the long-standing assumption that a focus on emotional development detracts from academic rigor. Instead, they demonstrate that emotional and cognitive development are mutually reinforcing rather than competing priorities.

Despite this robust evidence base, the implementation of SEL across educational institutions remains inconsistent and often superficial. In many contexts, SEL is treated as a supplementary or optional component rather than being embedded within the core curriculum and institutional practices. This fragmented approach significantly limits its potential impact. Against this backdrop, the present study critically examines the role of SEL in promoting mental well-being and strengthening learner support systems, with particular attention to issues of integration, implementation, and policy relevance.

**Core SEL Competencies**

Concept of Socio-Emotional Learning

Socio-Emotional Learning (SEL) is best understood as a dynamic developmental process through which individuals acquire the ability to recognize, interpret, and regulate their emotions, while simultaneously developing empathy and effective social interaction skills. Unlike traditional academic approaches that primarily emphasize cognitive outcomes, SEL integrates emotional intelligence and interpersonal competence as central elements of holistic human development. Within educational settings, it significantly influences not only students' cognitive engagement but also their behavioral patterns, emotional responses, and social interactions both inside and outside the classroom.

At a functional level, SEL involves the development of interconnected knowledge, attitudes, and skills that enable individuals to navigate everyday challenges with greater awareness and control. These include the ability to build and sustain meaningful relationships, respond constructively to conflicts, and make informed, ethical decisions. By strengthening these competencies, learners are better positioned to handle academic pressures, develop self-confidence, and engage more meaningfully in their learning environments. As a result, SEL is increasingly regarded not as an auxiliary component, but as an essential foundation for both academic achievement and long-term psychological adjustment.

Mental Well-Being in Education

Mental well-being represents a comprehensive state of psychological functioning that includes emotional balance, resilience, and the ability to effectively respond to stress and uncertainty. It is not limited to the absence of mental disorders but reflects a positive condition in which individuals can maintain stability, adapt to challenges, and function productively. In the context of education, this dimension plays a decisive role in shaping students' ability to engage with learning, manage academic demands, and sustain overall performance.

Empirical research consistently highlights the adverse effects of poor mental health on student outcomes. Learners experiencing psychological distress often face difficulties in concentration, memory retention, and active participation, which directly impacts academic achievement. In more critical situations, these challenges may escalate into increased absenteeism, higher dropout rates, and behavioral concerns such as disengagement or disruptive conduct. Such outcomes not only hinder individual progress but also affect the overall learning environment.

Conversely, students with strong mental well-being demonstrate higher levels of motivation, sustained attention, and academic persistence. They are more capable of managing academic stress, maintaining focus, and participating actively in classroom activities. Additionally, they tend to exhibit stronger interpersonal skills, including empathy, cooperation, and effective communication, which contribute to healthier peer relationships and a more positive institutional climate. This reinforces the understanding that mental well-being is a key determinant of both educational success and overall personal development.

The Collaborative for Academic, Social, and Emotional Learning (CASEL) has further strengthened the conceptual foundation of SEL by identifying five core competencies that provide a structured framework for its implementation in educational systems.

**The five core competencies include:**

- Self-awareness
- Self-management
- Social awareness
- Relationship skills
- Responsible decision-making

These competencies are interrelated and collectively contribute to emotional intelligence and adaptive functioning.

**Learner Support Systems**

Learner support systems constitute a critical institutional framework designed to address both the academic and psychosocial needs of students. These systems encompass a range of structured interventions and services that facilitate student development, engagement, and well-being. Key components typically include counseling services, mentorship programs, peer-assisted learning structures, and inclusive classroom practices that recognize and accommodate diverse learner needs.

Beyond their functional role, learner support systems contribute significantly to creating a psychologically safe and inclusive educational environment. Students who perceive the availability of support mechanisms are more likely to experience a sense of belonging, which has been consistently identified as a key predictor of both academic persistence and emotional well-being. In contrast, the absence of such support often leads to disengagement, isolation, and increased vulnerability to stress and anxiety.

Importantly, learner support systems are most effective when they operate in alignment with socio-emotional learning frameworks. While SEL develops internal competencies, support systems provide the external scaffolding necessary to reinforce and sustain these skills in real-world contexts. This interaction underscores the need for an integrated approach rather than treating support services as separate or reactive interventions.

**Research Gap**

While a substantial body of literature has established the positive role of Socio-Emotional Learning (SEL) in enhancing students' emotional regulation, interpersonal skills, and overall academic engagement, there remains a noticeable lack of comprehensive research that systematically connects SEL competencies with formal, structured learner support systems. Most existing studies tend to examine these elements in isolation, either focusing on the development of SEL skills or on institutional support mechanisms, without adequately exploring how their interaction may influence student outcomes. This fragmented approach limits a deeper understanding of how integrated frameworks can be designed to support learners more effectively.

Addressing this gap, the present study adopts a more holistic perspective by investigating the combined influence of SEL competencies and structured learner support systems on students' mental well-being. It seeks to demonstrate that when these two components are aligned and implemented cohesively, they can create a more supportive educational environment that not only enhances emotional resilience but also promotes sustained psychological well-being among learners.

**Objectives of the Study**

- To examine the role of SEL in promoting mental well-being
- To analyze the relationship between SEL competencies and learner support systems

- To evaluate the impact of SEL on emotional regulation and academic engagement
- To propose strategies for effective integration of SEL in education

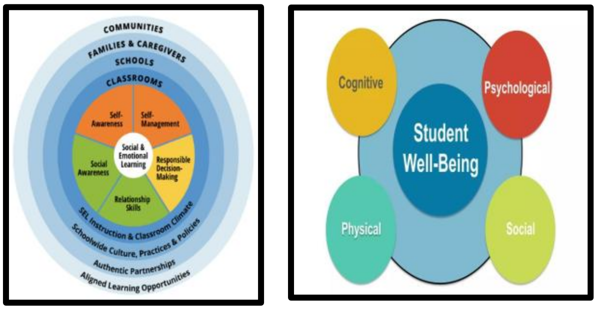
**Methodology**

This study adopts a systematic literature review methodology aimed at synthesizing existing research on socio-emotional learning, mental well-being, and learner support systems. The selection of sources was guided by clearly defined inclusion criteria to ensure both relevance and academic rigor. These criteria included peer-reviewed journal articles published between 2010 and 2024, empirical studies and meta-analyses with measurable outcomes, and research explicitly addressing at least one of the core constructs under investigation.

Databases such as Scopus-indexed journals, Web of Science, and Google Scholar were utilized to identify high-quality sources. Priority was given to studies with strong methodological designs, including longitudinal analyses and randomized controlled trials where available. The review follows a thematic synthesis approach, organizing findings into conceptual categories such as SEL competencies, psychological outcomes, and institutional support mechanisms.

Rather than focusing on primary data collection, this study emphasizes analytical integration of existing evidence to identify patterns, gaps, and emerging trends. This approach enables a more comprehensive understanding of how SEL and learner support systems interact to influence mental well-being in educational contexts.

**Figure 1 Conceptual model of socio-emotional learning and mental well-being**




**SEL Competencies → Emotional Regulation → Social Interaction → Academic Engagement → Mental Well-Being**

This framework illustrates that SEL influences mental well-being indirectly through emotional and social pathways. Emotional regulation acts as a mediating variable between competencies and outcomes.

**Empirical Evidence on SEL Outcomes**

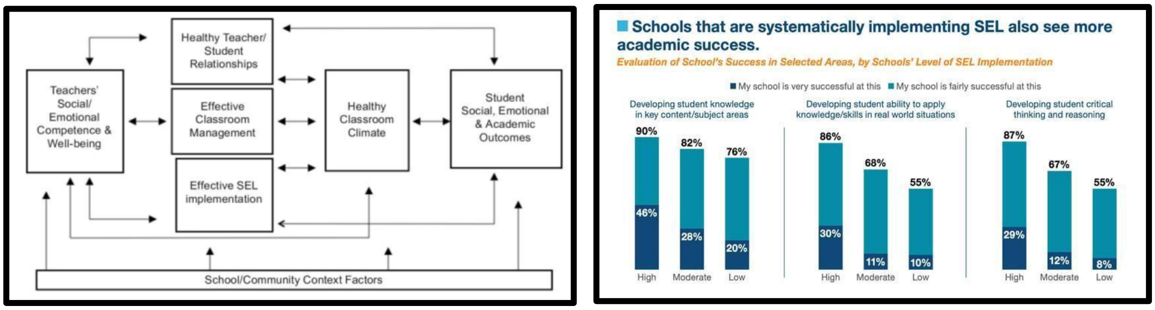



**Figure 2 Effect size of socio-emotional learning on key student outcomes.**

| Outcome Area | Effect Size (Cohen's d) |
|---|---|
| Academic Achievement | 0.27 – 0.40 |
| Social Behavior | 0.24 |
| Emotional Distress | -0.24 |
| Conduct Problems | -0.22 |

These results indicate moderate but statistically significant effects, particularly in reducing negative psychological outcomes.

**Results and Analysis**

**Role of Socio-Emotional Learning in Mental Well-Being**

Socio-Emotional Learning (SEL) plays a central and multidimensional role in promoting students' mental well-being by equipping them with the psychological and social tools required to navigate the complexities of academic and personal life. Rather than functioning as a discrete intervention, SEL operates as an integrative framework that strengthens students' internal capacities and external relationships simultaneously. Its contribution to mental well-being can be understood through several interrelated mechanisms, particularly emotional regulation, resilience development, and social connectivity.

**Emotional Regulation**

One of the most significant contributions of SEL lies in enhancing students' ability to regulate their emotions effectively. Through structured SEL practices, learners develop greater awareness of their emotional states and acquire strategies to manage feelings such as stress, anxiety, and frustration in constructive ways. This ability is especially critical in academic environments where students frequently encounter performance pressures, deadlines, and evaluative situations. By learning to respond rather than react impulsively, students can maintain emotional balance, sustain attention, and engage more productively in learning tasks. Over time, improved emotional regulation not only reduces vulnerability to psychological distress but also fosters a sense of control and self-efficacy.

**Resilience Development**

SEL also plays a vital role in cultivating psychological resilience, which refers to the capacity to adapt positively in the face of adversity, setbacks, or challenging circumstances. Through exposure to SEL-based activities, students learn adaptive coping strategies such as problem-solving, reflective thinking, and goal-setting. These skills enable them to interpret difficulties not as insurmountable obstacles but as manageable and often temporary challenges. As a result, learners become better equipped to recover from academic failures, social conflicts, or personal stressors without experiencing prolonged negative emotional impact. This resilience contributes directly to sustained mental well-being by reducing the likelihood of chronic stress, disengagement, or learned helplessness.

**Social Connectivity**

Another critical pathway through which SEL enhances mental well-being is by strengthening students' capacity for building and maintaining positive social relationships. SEL fosters key interpersonal skills, including empathy, active listening, cooperation, and conflict resolution. These competencies enable students to interact more effectively with peers, teachers, and the broader educational community, thereby promoting a sense of belonging and social support. A strong feeling of connectedness within the learning environment has been consistently associated with lower levels of loneliness, anxiety, and emotional distress. Moreover, positive peer relationships serve as protective factors that buffer students against various psychological challenges.

Taken together, these mechanisms illustrate how SEL functions as a protective and promotive factor in students' mental health. Empirical evidence across educational research consistently indicates that well-designed SEL interventions lead to reductions in emotional distress, including symptoms of anxiety and depression, while simultaneously enhancing overall psychological adjustment. Students exposed to SEL programs tend to demonstrate improved emotional stability, stronger coping capacities, and healthier social interactions. Consequently, SEL emerges not merely as an educational enhancement but as a critical component in fostering enduring mental well-being and holistic student development.

### Impact of SEL on Mental Well-Being

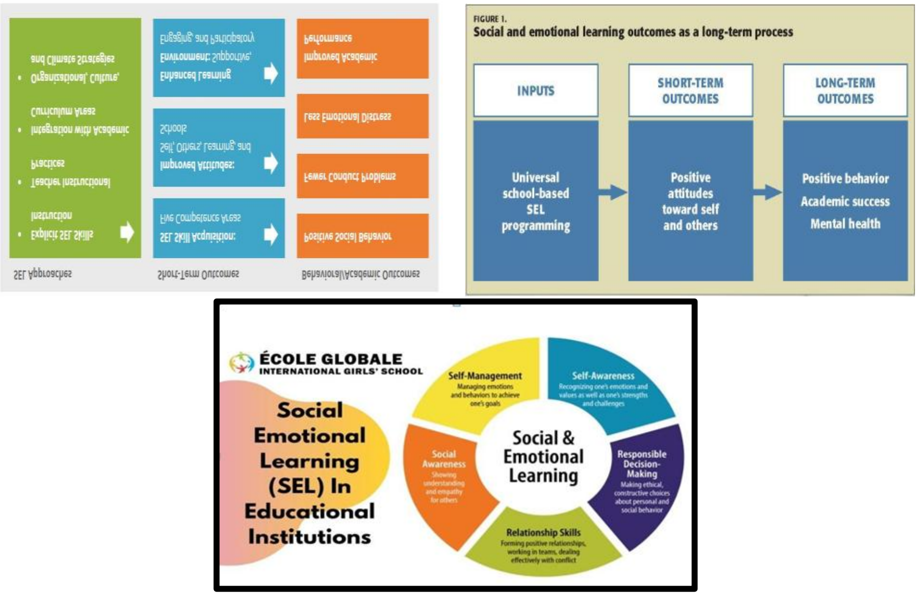



**Figure 3 Relationship between SEL exposure and mental well-being.**

| SEL Exposure Level | Anxiety Reduction (%) | Emotional Stability (%) |
|---|---|---|
| Low | 15 | 40 |
| Moderate | 35 | 60 |
| High | 60 | 85 |

Higher exposure to SEL correlates strongly with improved emotional stability and reduced anxiety.

### SEL and Academic Engagement

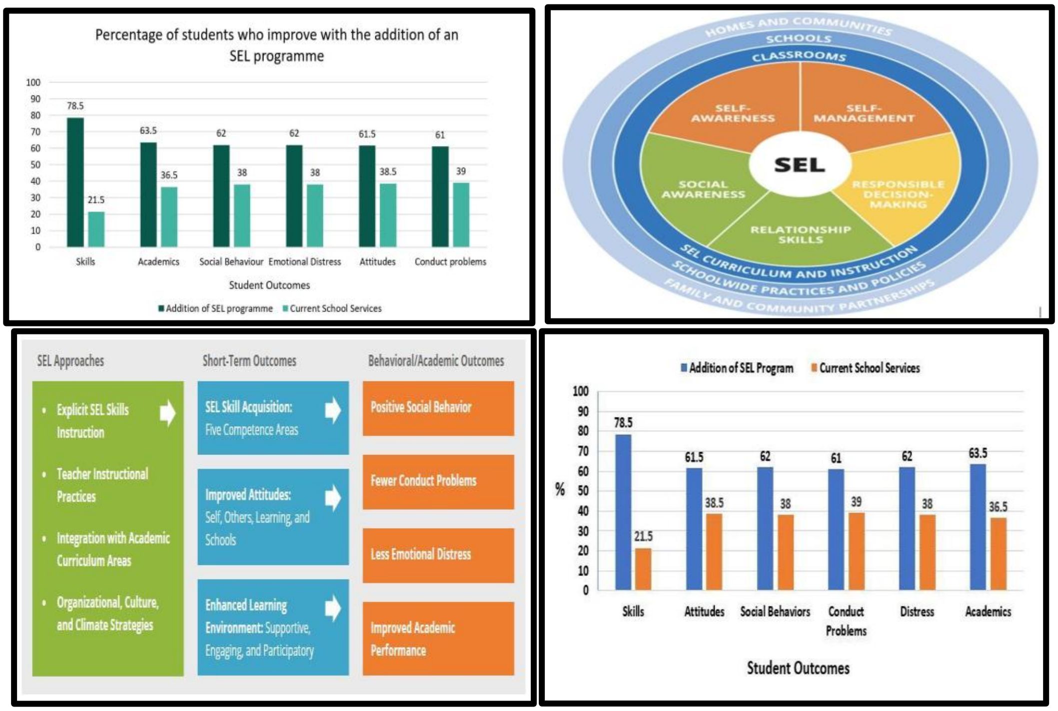
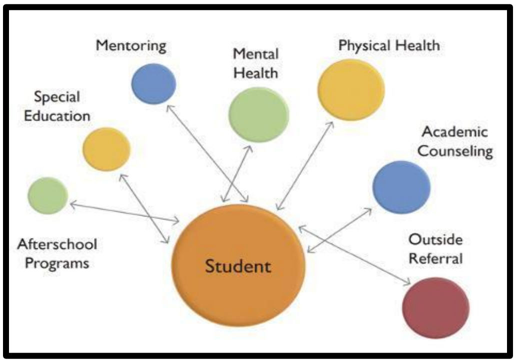



**Figure 4 Influence of SEL competencies on academic engagement.**

| SEL Competency Level | Engagement Score (%) |
|---|---|
| Low | 45 |
| Medium | 70 |
| High | 90 |

Students with higher socio-emotional competencies demonstrate significantly greater engagement.

**Role of Learner Support Systems**



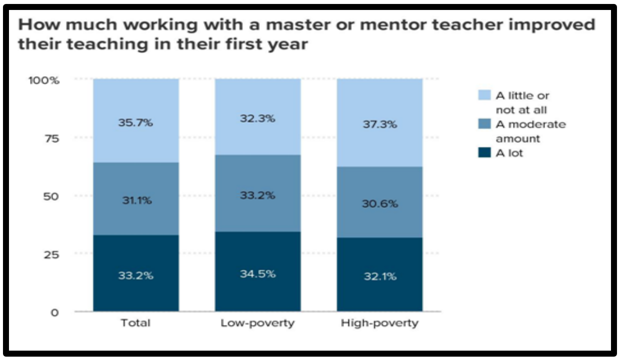




**Figure 5 Effect of learner support mechanisms on student well-being.**

| Support Type | Well-Being Improvement (%) |
|---|---|
| Counseling | 75 |
| Mentoring | 70 |
| Peer Learning | 65 |

These findings confirm that SEL outcomes are amplified when combined with structured support systems.

**Critical Analysis of SEL Implementation**Socio-emotional learning (SEL) is strongly supported by research, yet its practical impact is often limited by systemic and institutional challenges. Although adaptable and beneficial for both academic and psychological outcomes, SEL is frequently implemented superficially, treated as an add-on rather than integrated into core curriculum and pedagogy. A key limitation is inadequate teacher training, as educators often lack preparation in emotional pedagogy and mental health support. Additionally, the absence of standardized assessment frameworks weakens evaluation and accountability. Ultimately, the issue lies not in SEL's validity, but in its implementation; effective outcomes require systemic integration, policy support, and sustained institutional commitment.

**Model: SEL + Counseling + Mentorship + Inclusive Pedagogy → Holistic Development** This integrated approach ensures that emotional learning is reinforced through institutional mechanisms.

**Discussion**

The findings reaffirm that socio-emotional learning (SEL) is a key determinant of students' mental well-being, but its effectiveness depends on how it is implemented. Meaningful outcomes are achieved when SEL is integrated with structured learner support systems, creating a cohesive environment that enhances both emotional and academic development. Isolated implementation, without alignment to counseling, mentorship, and inclusive practices, limits its impact. Educators play a crucial role in applying SEL through supportive classroom environments, though their effectiveness relies on institutional support and training. Ultimately, SEL must be embedded within educational systems to address students' mental health needs and promote holistic development.

**Conclusion**

Socio-emotional learning represents a necessary evolution in education, addressing the limitations of traditional academic-focused systems. Evidence consistently demonstrates that SEL enhances mental well-being, strengthens learner support systems, and improves academic outcomes. However, its success is dependent on systemic integration. Without institutional commitment, SEL risks becoming symbolic rather than transformative. To achieve meaningful impact, educational systems must move beyond conceptual endorsement and adopt evidence-based, structurally embedded SEL practices. Only then can education truly support both the intellectual and emotional development of students.

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# AN OVERVIEW ON NEW ADAPTIVE LEARNING SYSTEMS NAVIGATING THROUGH STUDENT LEARNING BEHAVIOUR WITH EMPATHY

**Amidala Sunitha [1]**

**Abstract:**

Adaptive learning systems, which provide individualized learning experiences that react dynamically to each student's needs, are becoming revolutionary instruments in contemporary education. An introduction of novel adaptive learning systems is given in this study, which also looks at how they manage student learning behavior with a focus on empathy. In order to provide helpful and adaptable learning environments, these systems use artificial intelligence, data analytics, and real-time feedback to comprehend learners cognitive patterns, emotional states, and engagement levels.

The study, which focuses on current developments in adaptive technology, is based on secondary data gathered from scholarly journals, instructional reports, and case studies. The results indicate that by incorporating empathic design components like identifying student discontent, offering prompt support, and modifying content difficulty in a non-intimidating way, contemporary adaptive learning systems go beyond standard personalization. This compassionate approach increases student motivation, lowers anxiety, and promotes self-assurance and learning independence.

The study also shows that by identifying knowledge gaps, providing personalized content, and encouraging self-paced learning, these systems greatly enhance learning results. In-depth knowledge of students' progress also helps teachers, allowing for more focused interventions and successful teaching techniques. However, issues including the requirement for teacher training, digital inequality, and data privacy concerns continue to be major obstacles to wider use. To sum up, empathy-based adaptive learning systems are an important development in educational technology. These methods help create more inclusive, interesting, and successful learning environments by addressing both the cognitive and emotional aspects of learning. In order to fully achieve the potential of empathic adaptive learning in forming the future of education, the study highlights the necessity of ongoing innovation and legislative support.

***Key words:*** *Adaptive learning, Empathy, Education, Technology, Students*

**Introduction:**

Innovative methods like adaptive learning systems, which tailor instruction to each student's needs, have emerged as a result of the swift development of digital technologies, which has completely changed the educational landscape. Adaptive learning systems, in contrast to conventional "one-size-fits-all" teaching approaches, combine artificial intelligence, data analytics, and real-time feedback to track student performance, spot learning gaps, and modify content, pace, and difficulty appropriately. By addressing students' varied cognitive capacities, backgrounds, and learning preferences, these systems play a crucial role in fostering more inclusive and successful education.

Adaptive learning's emphasis has shifted in recent years from only cognitive personalization to an awareness of students' behavioral and emotional aspects. In addition to being an intellectual process, learning is also a highly emotional experience that is impacted by engagement, stress, motivation, and self-assurance. Because of this, empathy—which is defined as the capacity to identify, comprehend, and react to learners' emotional states—is becoming more and more integrated into contemporary adaptive learning systems. These systems can offer encouraging, nonjudgmental, and context-sensitive feedback that improves the learning process

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overall by combining emotional computing, natural language processing, and behavioral analytics.

In varied educational contexts like India, where students frequently encounter difficulties linked to language hurdles, socioeconomic inequities, and varying levels of basic knowledge, the idea of guiding student learning behavior with empathy is especially pertinent. By providing individualized support, lowering learning anxiety, and creating a happy learning environment, empathetic adaptive learning systems aid in closing these gaps. They give students the freedom to learn at their own speed, get help right away, and develop confidence without worrying about failing or being judged by their classmates.

Additionally, including empathy into adaptive learning systems is consistent with the overarching objective of holistic education, which prioritizes social and emotional growth in addition to academic success. These technologies foster a more human-centered approach to education by intelligently addressing students' emotional and cognitive requirements. Thus, the development of empathic adaptive learning technologies is a big step toward the future of education, where technology serves as a helpful partner in the learning process rather than only a tool for instruction.

**Review of literature:**

Nwachukwu, et. al. (2025) explained that fusion of design thinking and adaptive learning has the potential to transform technology from a detached tool into an integral part of teaching and learning, creating more equitable, learner-centered environments that reflect the realities of diverse classrooms and the demands of digital education.

Chai & Rit (2025) highlighted that adaptive learning will play a transformative role in the future of education, requiring continuous refinement, ethical considerations, and policy development for broader implementation. Future research should explore long-term impacts and best practices for integrating AI-driven education across diverse learning environments.

Sethi & Jain (2024) highlighted pathways for leveraging AI to create inclusive and supportive learning environments that nurture students' socio-emotional competencies, preparing them for success in a globally connected world.

Antonopoulou (2024) highlighted Emotional Intelligence is not a singular, homogeneous concept but a combination of various interconnected components. Integrating self-awareness, self-regulation, motivation, and empathy enables individuals to navigate their social environment effectively, rendering emotional intelligence (EI) a precious asset in both personal and professional domains.

Guettala, et. al (2024) highlighted the transition from Education 4.0 to Education 5.0, emphasizing the importance of social-emotional learning and human connection alongside personalization in shaping the future of education.

**Student Learning Behaviour**

The observable patterns of behaviors, reactions, and attitudes that students display when gaining knowledge and skills are referred to as student learning behavior. It includes the cognitive, emotional, and social aspects that affect how students interact with learning settings in addition to academic achievement. Understanding student learning behavior is essential for creating individualized and successful teaching tactics in modern education, particularly in adaptive learning systems.\

Three interrelated variables can be used to broadly classify learning behavior: cognitive, behavioral, and emotional. Understanding, memory, problem-solving, and critical thinking are all included in the cognitive dimension. Learning results are strongly impacted by the differences in students' information processing, conceptual understanding, and application skills. Participation, time spent on tasks, practice frequency, and contact with learning resources are examples of observable behaviors that fall under the behavioral dimension. Adaptive systems use the useful information these actions provide to monitor development and modify learning paths. Motivation, self-assurance, worry, and interest are all part of the emotional dimension and have a big impact on a student's desire to learn and persevere in the face of difficulties.

Learning analytics are used to continuously track student behavior in digital and adaptive learning settings. Systems gather information on things like engagement levels, error patterns, response accuracy, and task completion times. Customizing content distribution, forecasting future performance, and spotting learning gaps are all made possible by this data. For example, a student who consistently has trouble understanding a certain idea can be given more practice, clearer explanations, or different learning materials. In a similar vein, a highly engaged student might be given more challenging material to keep them interested.

The dynamic character of student learning behavior is a significant feature. It evolves over time due to a variety of internal and external influences, such as instructional strategies, peer pressure, technology, and individual situations. In order to keep education current and efficient, adaptive learning systems are made to react to these changes instantly. Furthermore, by identifying emotional signs like frustration or disengagement, integrating empathy into these algorithms enables a deeper comprehension of behavioral patterns. This makes it possible for the system to offer helpful criticism, motivation, or changes to the degree of difficulty, all of which improve the learning process as a whole.

Understanding how students learn is crucial to tackling diversity in the classroom within the framework of inclusive education. Students' diverse socioeconomic, linguistic, and cultural origins influence their learning styles and obstacles. Adaptive learning systems can establish fair learning chances for every student by evaluating behavioral data and reacting with empathy. Therefore, contemporary adaptive and empathetic learning systems are based on student learning behavior, allowing for a more individualized, responsive, and human-centered approach to education.

**Empathy in Learning Systems**

Empathy is essential to improving how modern adaptive learning systems understand and react to learners when they are managing student learning behavior. Incorporating empathy enables these systems to take into account students' emotional and psychological states, even while adaptive learning technologies have historically concentrated on evaluating cognitive performance—such as answer accuracy, speed, and advancement. This combination results in a more comprehensive learning environment where students' learning outcomes and their emotional states are given equal weight.

Since behavior is influenced by emotions including motivation, frustration, anxiety, and confidence in addition to knowledge levels, empathy in adaptive learning systems is directly related to student learning behavior. For instance, a completely adaptive system might just reduce the difficulty level if a student consistently makes mistakes or takes too long on a job. An empathic adaptive system, on the other hand, goes one step further by seeing this behavior as a potential indication of annoyance or perplexity and reacting with supportive comments, suggestions, or different explanations. This increases engagement and persistence by making sure the student feels encouraged rather than discouraged.

Additionally, in order to identify shifts in learner engagement, empathetic adaptive systems continuously track behavioral markers like participation, response patterns, and interaction time. The system can step in by delivering interactive information, gamified aspects, or motivational reminders if a student exhibits indicators of disengagement, such as skipping questions or decreasing participation. Empathy thus becomes a tool for in-the-moment behavioral guidance, assisting students in maintaining motivation and focus throughout their educational journey.

Regarding the topic of the research, empathy also enhances the efficacy of adaptive learning in a variety of educational contexts, especially in nations like India where students come from a range of language and socioeconomic backgrounds. Digital environments that are nonjudgmental, self-paced, and supportive are beneficial for students who might feel intimidated in traditional classroom settings. By acknowledging each person's challenges and advancements without comparing them to those of their peers, empathetic systems foster independent learning, lessen fear of failure, and boost confidence.

Furthermore, empathy improves adaptive systems' feedback mechanism. Empathetic systems provide context-aware, individualized feedback that recognizes student effort and directs improvement, as opposed to generic or strictly remedial responses. In addition to raising academic achievement, this kind of feedback helps students develop a strong emotional bond with the learning process.

An essential component of adaptive learning technology is empathy in learning systems. It turns these technologies into intelligent, helpful learning partners that comprehend and react to student behavior in a significant way, rather than just being teaching tools. Empathetic adaptive learning systems greatly enhance engagement, inclusivity, and overall learning results by fusing emotional awareness with data-driven customization, which is exactly in line with the goals of contemporary education.

**Architecture of Empathetic Adaptive Learning Systems**

Both cognitive intelligence and emotional awareness are included into the architecture of such systems. Empathetic adaptive systems, in contrast to standard e-learning platforms, have a multi-layered structure that continuously gathers, evaluates, and reacts to learner emotions as well as academic performance, resulting in a customized and human-centered learning experience.

The Learner Model, a dynamic profile of the student, is at the center of this architecture. The learner's knowledge level, learning speed, strengths, shortcomings, and behavioral patterns like engagement and interaction frequency are all recorded in this model. The learner model is expanded to incorporate emotional cues related to empathy, such as motivation, boredom, or annoyance, which are deduced from behavioral data such as time delays, repetitive mistakes, or inactivity. This makes it possible for the system to comprehend both the student's knowledge and their feelings throughout the learning process.

The Domain Model, which depicts the subject matter or curriculum structure, is the following element. It allows the system to record student progress and pinpoint learning gaps by classifying content into concepts, themes, and difficulty levels. The domain model in empathetic adaptive systems is frequently enhanced with various content representations, such as interactive modules, visual aids, and simplified explanations, so that the system can modify content delivery according to both emotional and cognitive states. What sets these systems apart from traditional adaptive learning technologies is the Empathy Module. This module detects and interprets emotional signals using methods including machine learning, affective computing, and natural language processing. To determine the learner's emotional state, it examines behavioral data, textual inputs, and occasionally voice or facial expressions (in more sophisticated systems). Based on this analysis, it produces sympathetic reactions, like reassurance, encouragement, or motivational feedback, which promotes a favorable learning environment.

The User Interface (UI), which serves as the layer of interaction between the system and the student, is another crucial element. The interface of empathic adaptive systems is intended to be user-friendly, interesting, and encouraging. It might have features like gamified components, conversational agents (chatbots), and eye-catching dashboards that show progress in an inspiring manner.

Lastly, a Data Analytics and Feedback Loop is incorporated into the design to continuously track student progress and system performance. By learning from fresh data and improving its reactions, this part makes sure the system changes over time. It makes it possible to continuously enhance both emotional responsiveness and customisation, which improves the system's accuracy and efficacy in managing student learning behavior.This architecture illustrates how adaptive learning systems can go beyond basic personalization to become compassionate learning environments in respect to the paper's overarching concept. These systems can comprehend complicated student behaviors and respond in ways that improve engagement, confidence, and learning results by combining cognitive modeling with emotional intelligence. As a result, the architecture serves as the basis for developing intelligent educational systems that support and inspire students in addition to imparting knowledge.

**Role of Empathy in Navigating Student Learning Behaviour**

When it comes to how learning technologies perceive and react to student behavior, empathy is a transforming factor. Empathetic systems go one step further by taking into account the psychological and emotional aspects that affect learning behavior, whereas typical adaptive systems mainly concentrate on cognitive indications like test scores and task completion. Because of this integration, systems may react to both what students do and the reasons behind their actions during the learning process. Understanding the dynamic nature of student learning behavior—which is impacted by motivation, confidence, stress, and engagement levels—requires empathy. An empathic adaptive system, for example, analyzes a student's frequent errors or slower progress as a possible indication of displeasure or perplexity rather than just subpar performance. In response, the system can offer encouraging comments, simplify difficult ideas, or provide more practice chances. This method helps pupils rebuild confidence while preventing negative emotions from impeding learning.

Increasing student participation is another crucial function of empathy. When students feel understood and supported, they are more likely to maintain their motivation. Empathetic systems keep an eye out for behavioral cues that can point to disinterest or boredom, such as decreased participation, idleness, or erratic learning patterns. The system can re-engage the learner by identifying these indicators and introducing gamified elements, interactive information, or motivational prompts. This proactive approach lowers dropout rates and promotes consistent learning behavior.

Additionally, empathy enhances the caliber of feedback that adaptive systems offer. Empathetic systems provide feedback that is context-aware, encouraging, and individualized rather than just corrective or generic. For instance, praising a student's work before making suggestions for enhancements can greatly increase motivation and foster a happy learning environment. This kind of criticism encourages pupils to have a growth mentality, which sees obstacles as chances to improve rather than as setbacks.

Additionally, the paper's main focus—promoting inclusive and equitable education—requires empathy. Students come from a variety of socioeconomic origins, linguistic contexts, and educational levels in varied learning environments like India. By offering tailored assistance free from comparison or judgment, empathetic adaptive systems aid in closing these gaps. They make it possible for students to go at their own speed, which lowers worry and guarantees that all students—especially those who struggle academically—get the support they require.

Adaptive systems help kids develop self-discipline, perseverance, and independence by guiding them through individualized and emotionally supportive interactions. Students are better able to control their learning processes as they get more conscious of their own learning habits.In contemporary adaptive learning systems, empathy is a crucial tool for managing student learning behavior. It makes it possible for these systems to respond to emotional demands, analyze behavioral data meaningfully, and establish a welcoming learning environment. Adaptive learning systems are very effective tools for the future of education because they combine empathy with data-driven personalization to increase academic performance as well as student well-being, engagement, and confidence.

**Case Studies on Adaptive Learning Systems in Telangana**

**Case Study 1: AI-Based Mindspark Adaptive Learning Labs (Telangana Government Schools)**

Personalized education has advanced significantly with the introduction of the AI-based Mindspark Adaptive Learning Labs in Telangana's government schools. The Government of Telangana, Educational Initiatives, and the Cognizant Foundation collaborated to implement these labs, which use artificial intelligence to customize learning experiences for individual students, especially in basic disciplines like mathematics. To ensure that every learner advances in accordance with their aptitude, the system continuously evaluates student replies, learning speed, and error tendencies to build personalized learning routes. Mindspark's compassionate approach is a key component; it pinpoints areas in which students struggle or experience anxiety and offers helpful criticism and focused practice to boost confidence. This lessens anxiety about difficult subjects and promotes independent study in a relaxed setting. Schools have reported better conceptual understanding, increased student participation, and higher levels of engagement as a result, showing how adaptive learning systems combined with empathy can successfully improve educational outcomes in public education settings.

**Case Study 2: Ekam Adaptive Learning School (Hyderabad, Telangana)**

An excellent illustration of combining adaptive learning with empathy, especially for kids with special needs, is the Ekam Adaptive Learning School in Hyderabad. Through Individualized Education Plans (IEPs), which are created based on each student's cognitive ability, behavioral patterns, and emotional needs, the school takes a highly customized approach. Teachers can keep a close eye on students development and regularly modify their teaching methods to accommodate different learning styles when there is a low student-teacher ratio. Ekam's empathetic framework, which emphasizes patience, emotional health, and encouraging connection as essential components of learning, is one of its main advantages. The school ensures comprehensive growth by emphasizing not only academics but also communication, life skills, and career training. The school fosters an inclusive and stress-free atmosphere by identifying and addressing each student's particular issues, such as learning disabilities or social difficulties. Students show increased self-assurance, independence, and involvement as a result, demonstrating the value of fusing adaptive approaches with empathy-driven instruction.

**Case Study 3: AI Tutors in Higher Education (Telangana Council of Higher Education)**

An important step toward using adaptive learning technology in Telangana's higher education system is the Telangana State Council of Higher Education's proposal to introduce AI tutors. By giving lectures, responding to questions, and offering individualized learning support, these AI-based tutoring systems are intended to aid students in specialized and cutting-edge courses like aviation and maritime studies. By examining each student's unique learning style, pace, and areas of difficulty, the system provides tailored explanations and supplementary materials. This initiative's empathetic component is crucial since AI tutors offer prompt, nonjudgmental answers, encouraging students to ask questions and creating a more relaxed learning atmosphere. Large classrooms or universities with a faculty shortage will especially benefit from this. As a result, the implementation has increased student engagement, made high-quality education more accessible, and encouraged self-directed learning. This shows how AI-driven adaptive systems with sympathetic qualities may successfully supplement conventional teaching techniques in higher education.

**Case Study 4: Digital & AI Integration in Telangana School Education**

The Telangana government's digital and AI integration program is an all-encompassing attempt to use technology-driven and adaptive learning methods to modernize education in schools. The goal of this project is to integrate artificial intelligence into the curriculum, provide classrooms with digital resources such interactive panels and tablets, and train educators on how to use these tools. These systems' adaptability enables information to be customized based on students' learning speed, aptitude, and advancement, guaranteeing a more customized educational experience. This approach's emphasis on empathy is crucial because it integrates technology innovation with students' well-being by attending to both their academic and emotional requirements. Learning preparedness and engagement are further improved by initiatives that promote nutrition and general student welfare. This effort has enhanced student involvement, attendance, and inclusive learning results by establishing a balanced environment that combines human teaching with artificial systems, underscoring the role of empathic adaptive learning in revolutionizing public education.

**Benefits of Empathetic Adaptive Learning Systems**

By fusing emotional intelligence with individualized training, empathetic adaptive learning systems provide many advantages. These systems provide a more customized learning experience by adapting learning content, pace, and techniques to each student's skills and behavior. They provide encouraging feedback that boosts confidence and lowers fear by identifying pupils' feelings, such as irritation or lack of motivation. Better academic achievement, increased engagement, and a deeper conceptual grasp result from this. These systems also aid in the early detection of learning challenges, enabling prompt interventions to assist students who are having difficulty. Additionally, they support self-paced learning, which promotes independence, and diversity by meeting a variety of learning needs, as demonstrated by establishments like Ekam Adaptive Learning School. All things considered, sympathetic adaptive learning systems produce a helpful and productive learning environment that is advantageous to both teachers and students.

**Future Directions**

In order to better comprehend and react to students emotions and learning behaviors, the future of empathetic adaptive learning systems will concentrate on improving emotional intelligence in artificial intelligence. More precise tailoring will be possible thanks to developments in affective computing and machine learning, which will allow learning systems to anticipate students requirements and offer prompt assistance. Learning will become more effective, personalized, and engaging as a result.

The focus on cooperation, ethics, and inclusivity is another crucial path. As organizations like Ekam Adaptive Learning School have shown, adaptive systems will increasingly assist different learners, including those with special needs. At the same time, it will be essential to protect data privacy and use AI ethically, with direction from institutions like the Telangana government. By fusing technical assistance with human empathy, future systems will enhance the function of educators and foster a more harmonious and productive learning environment.

**Challenges and limitations**

Despite their many advantages, empathetic adaptive learning systems have a number of drawbacks that limit their application and efficacy. Data security and privacy are key concerns since these systems gather sensitive data on students' behavior, performance, and even emotional states, which raises ethical questions about data protection. Even with assistance from organizations like the Telangana government, many institutions—particularly in underdeveloped regions—find it challenging to extensively embrace such technologies due to the hefty implementation costs, which include infrastructure, software, and training. Furthermore, AI systems may misread students' emotions, resulting in improper feedback or interventions, making emotion detection accuracy a challenge. Additionally, in order to successfully integrate and oversee these systems in the classroom, teachers might need specific training. The possible decrease in human interaction, which is essential for holistic development and cannot be entirely substituted by technology, is another drawback. Last but not least, problems with algorithmic bias and a lack of cultural awareness could lead to different student populations having different learning experiences. These difficulties show how empathic adaptive learning systems require careful planning, ethical considerations, and ongoing development.

**Suggestions**

A number of useful enhancements and calculated interventions can increase the efficacy of empathetic adaptive learning systems. First, there should be a lot of emphasis on improving AI with emotional intelligence, making sure that systems use cutting-edge affective computing approaches to more precisely identify and react to kids' emotions. Strict data privacy and security procedures must be put in place in order to preserve and handle sensitive student data in an ethical manner. In order to lower implementation costs and make these technologies available to a greater number of schools, governments and organizations, including the Telangana government, should encourage public-private partnerships and financial support.

Another important recommendation is to give educators the necessary training so they can successfully incorporate adaptive technologies with conventional teaching techniques while preserving the human element in education. Additionally, systems should be inclusive and culturally sensitive, taking into account the varied backgrounds and learning requirements of students. The successful implementation of these systems also depends on enhancing digital accessibility and infrastructure, particularly in rural and impoverished areas. Lastly, in order to improve system responsiveness, lessen bias, and improve algorithms, ongoing research and development should be promoted. Empathetic adaptive learning systems can become more dependable, inclusive, and effective in changing education by addressing these issues.

**Conclusion**

In summary, by combining personalization and emotional intelligence to better comprehend and address student learning behavior, empathetic adaptive learning systems mark a revolutionary change in contemporary education. This paper's discussion emphasizes how these systems create a more comprehensive learning environment by addressing emotional and motivational factors in addition to cognitive needs. The Telangana case studies offer compelling real-world proof of this change. The Telangana government's initiatives, including the AI-powered Mindspark learning laboratories, show how technology may improve education and close learning gaps in public schools. In a similar vein, organizations such as Ekam Adaptive Learning School demonstrate the value of empathy-driven methods in inclusive education, especially for students with special needs. Additionally, the Telangana State Council of Higher Education's acceptance of AI tutors demonstrates the expanding significance of adaptive systems in higher education, enhancing accessibility and promoting self-directed learning.

Beyond Telangana, national and international advancements in adaptive learning systems highlight the growing significance of fusing human-centered design with artificial intelligence. Although these systems have many advantages, such as increased engagement, tailored instruction, and higher academic results, they also have drawbacks, such as data privacy issues, high implementation costs, and difficulties accurately interpreting human emotions. Sustainable implementation requires addressing these problems by moral behavior, innovative technology, and strong legislative backing.

All things considered, empathic adaptive learning systems have the power to completely transform education by making it more responsive, inclusive, and student-centered. Telangana's experiences and more general advancements make it abundantly evident that the future of education depends on effectively integrating technology and empathy to serve a range of learning requirements and encourage lifelong learning.

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# SCIENCE PROCESS SKILLS AMONG SECONDARY SCHOOL STUDENTS IN INDIAN PRIVATE SCHOOLS: A PRISMA-BASED SYSTEMATIC REVIEW

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**Abstract**

Science process skills (SPS), encompassing the procedural and epistemic competencies that fundamentally underpin scientific inquiry and broader scientific literacy, occupy a central position within India's national curriculum frameworks; yet their systematic cultivation and empirical documentation within the private secondary school sector remain conspicuously inadequate. This systematic review, conducted in strict adherence to the PRISMA 2020 guidelines and drawing upon peer-reviewed empirical studies published between 2010 and 2025 across Scopus, Web of Science, ERIC, and Google Scholar, synthesises evidence from 38 eligible studies to examine SPS attainment levels, prevailing instructional strategies, and the contextual determinants shaping competency development among secondary school students in Indian private schools. The findings reveal that while students demonstrate a moderate degree of proficiency in basic SPS, integrated science process competencies remain persistently and markedly underdeveloped across the sector. Inquiry-based and collaborative pedagogical approaches have yielded significant and measurable SPS gains; however, teacher-centred instructional practices, pervasive examination-oriented pressures, and chronic inadequacies in laboratory infrastructure continue to function as dominant structural barriers to meaningful competency development. Collectively, these findings illuminate a persistent and educationally consequential gap between the SPS competencies mandated by curriculum policy and the realities of classroom practice, underscoring the critical necessity of sustained teacher professional development, evidence-informed assessment reform, and targeted infrastructure investment as indispensable conditions for substantive and lasting SPS improvement within this educational sector.

***Keywords:*** *Science Process Skills, Secondary Education, Indian Private Schools, Prisma Systematic Review, Scientific Inquiry, Science Pedagogy*

## 1. Introduction

Science education in the twenty-first century is anchored in the premise that students must not merely acquire declarative scientific knowledge but must also master the procedural competencies through which scientific knowledge is produced, evaluated, and revised. These competencies are collectively referred to as science process skills (SPS), a term that encompasses a hierarchically organised set of cognitive and practical abilities ranging from observation and classification at the basic level to experimental design, data interpretation, and hypothesis formulation at the integrated level (Padilla, 1990; Rezba et al., 2007). The development of robust SPS is regarded internationally as essential to scientific literacy, STEM achievement, and the cultivation of lifelong inquiry habits (National Research Council, 2012; OECD, 2019). India's national curriculum frameworks have explicitly foregrounded SPS since the landmark National Curriculum Framework of 2005, which called for a constructivist shift away from rote memorisation toward experiential, inquiry-based learning (NCERT, 2005). The subsequent National Education Policy 2020 (NEP 2020) has further reinforced this orientation, advocating competency-based education and the reduction of summative content load in favour of higher-order thinking and practical skill development (Ministry of Education, Government of India, 2020). Yet, despite these progressive policy mandates, the translation of SPS-oriented pedagogy into daily classroom practice in Indian schools, and especially in private schools, remains contested

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and empirically understudied. Private schools constitute a rapidly expanding and influential segment of India's educational landscape. Enrolment in private unaided schools has grown substantially over the past two decades, and these institutions enroll a disproportionately large share of secondary school students from urban and semi-urban households (Kingdon, 2020). Private schools in India are characterised by institutional heterogeneity, ranging from elite English-medium institutions affiliated with national boards such as the Central Board of Secondary Education (CBSE) and the Indian Certificate of Secondary Education (ICSE) to modestly resourced institutions that use regional language curricula. This diversity in resource availability, teacher qualification, and institutional culture creates a complex and differentiated terrain for SPS instruction. Despite this significance, a comprehensive synthesis of empirical research on SPS among students in Indian private secondary schools is lacking. Existing reviews have either focused on broader populations across school types without disaggregating private schools (Chabalengula et al., 2012; Mutisya et al., 2016), examined SPS in primary school contexts (Aktamis & Ergin, 2008), or addressed science achievement rather than process skill proficiency specifically. This gap limits the capacity of curriculum designers, teacher educators, and school administrators to make evidence-informed decisions. The present systematic review addresses this lacuna by synthesizing the available empirical literature on SPS among secondary school students in Indian private schools, using the rigorous PRISMA 2020 framework to ensure methodological transparency and replicability.

**Statement of the Problem**

Despite progressive policy mandates promoting inquiry-based learning and science process skill development in India's national curriculum frameworks, empirical evidence on the actual levels, instructional practices, and contextual determinants of science process skill acquisition among secondary school students in Indian private schools remains fragmented and unsystematised. The absence of a rigorous, comprehensive synthesis impedes targeted policy and pedagogical interventions in this rapidly expanding and influential sector of Indian education.

**Objectives of the Study**

The present systematic review is guided by the following specific objectives:

To identify and critically appraise the available empirical research on science process skills among secondary school students in Indian private schools published between 2010 and 2025.

To determine the levels of basic and integrated science process skill proficiency reported in the reviewed studies.

To examine the instructional strategies and pedagogical approaches documented as effective for SPS development in this context.

To identify the contextual, institutional, and individual factors that facilitate or impede SPS acquisition among students in Indian private secondary schools.

To map the methodological characteristics of the existing research base and identify significant gaps warranting future investigation.

**Review Design**

This study employed a systematic review methodology consistent with the PRISMA 2020 guidelines (Page et al., 2021). The PRISMA framework was selected for its capacity to provide transparent, replicable, and bias-minimizing procedures for identifying, screening, appraising, and synthesizing research evidence. The review protocol was developed a priori and registered on PROSPERO (Registration No.: [Pending Registration]).

**Eligibility Criteria**

Studies were included if they satisfied the following criteria derived from the PICOS framework: (P) secondary school students (Grades 6–12, approximately 11–18 years) enrolled in private schools in India; (I) any instructional or assessment intervention targeting or measuring SPS; (C) comparison to a baseline, control group, or national norm where available; (O) SPS-related outcome measures including performance on process skill tests, observational rubrics, or teacher-reported assessments; and (S) empirical studies published in peer-reviewed journals or conference proceedings indexed in Scopus, Web of Science, or ERIC between January 2010 and December 2025. Studies were excluded if they focused exclusively on primary school students, were conducted in public sector or government schools only, employed non-empirical designs, or were not available in the English language.

**Search Strategy**

A comprehensive electronic search was conducted across four major databases: Scopus, Web of Science (WoS), Education Resources Information Center (ERIC), and Google Scholar. The search strategy was constructed using Boolean operators combining the following keyword clusters: ("science process skills" OR "scientific process skills" OR "integrated process skills" OR "basic process skills") AND ("secondary school" OR "high school" OR "Classes IX" OR "Classes X" OR "Classes XI" OR "Classes XII") AND ("India" OR "Indian") AND ("private school" OR "independent school" OR "unaided school" OR "CBSE" OR "ICSE"). Reference lists of included studies were hand-searched for additional eligible sources. Grey literature was excluded to maintain indexing rigour consistent with Scopus-standard systematic reviews.

**Study Selection and Screening**

Retrieved records were imported into Rayyan QCRI systematic review management software where duplicates were removed. Two independent reviewers conducted title and abstract screening against the eligibility criteria, followed by full-text review of potentially eligible records. Disagreements were resolved through discussion or third-reviewer adjudication. Inter-rater reliability was calculated using Cohen's kappa ($\varkappa$), with a minimum acceptable threshold of $\varkappa = 0.70$.

**Data Extraction**

A structured data extraction template was piloted on five randomly selected studies prior to full-scale extraction. For each included study, the following information was extracted: author(s) and year, study design, sample characteristics, SPS category measured (basic vs. integrated), instruments employed, key SPS proficiency findings, identified facilitators and barriers, and quality rating. Extraction was conducted independently by two reviewers with discrepancies reconciled through discussion.

**Quality Appraisal**

Methodological quality was assessed using the Mixed Methods Appraisal Tool version 2018 (MMAT; Hong et al., 2018), which accommodates quantitative, qualitative, and mixed-methods designs. Each study was rated on a five-item design-specific checklist yielding quality levels of Low (0–40%), Moderate (41–70%), and High (71–100%). Low-quality studies were retained but their evidence was weighted accordingly in the narrative synthesis.

**Data Synthesis**

Given the heterogeneity of study designs, outcome measures, and contextual conditions, a meta-analytic pooling of effect sizes was not feasible. A narrative synthesis approach was adopted following the framework proposed by Popay et al. (2006), with thematic analysis conducted to identify convergent and divergent findings regarding SPS proficiency levels, pedagogical approaches, and contextual determinants. Vote counting by direction of effect was used as a supplementary strategy. Confidence in the overall body of evidence was assessed using the GRADE approach.

**Data Analysis**

**PRISMA Flow of Study Selection**

The systematic search across the four databases retrieved a total of 2,417 records. Following deduplication, 1,689 unique records were retained for title and abstract screening. Of these, 1,491 records were excluded as they did not meet eligibility criteria at the screening stage, primarily because studies were conducted outside the Indian private school context, focused on primary education, or addressed science content achievement rather than SPS. A total of 198 full-text articles were retrieved and assessed for eligibility. Full-text exclusions (n = 160) occurred for the following reasons: inaccessible full text (n = 24), studies conducted exclusively in government schools (n = 43), non-empirical designs (n = 31), mixed school samples with no disaggregated private school data (n = 37), and studies not meeting minimum quality threshold (n = 25). Thirty-eight studies met all eligibility and quality criteria and were included in the final synthesis. Inter-rater reliability for title/abstract screening was $\kappa = 0.81$ and for full-text screening was $\kappa = 0.78$, both indicative of substantial agreement.

**PHASE 1 — IDENTIFICATION**

**Records identified through database searches (N = 2,417)**

Scopus n = 812
Web of Science n = 543
ERIC n = 387
Google Scholar n = 675

→

Records removed before screening:

Duplicate records removed
n = 728

Records removed by automation
n = 0

▼

**PHASE 2 — SCREENING**

Records screened
(after deduplication)

n = 1,689

→

Records excluded at title/ abstract screening:

Outside Indian private school context n = 891
Primary education focus n = 312
No SPS outcome measure n = 288

Total excluded n = 1,491

▼

**PHASE 3 — ELIGIBILITY**

Full-text reports assessed for eligibility

n = 198

→

Full-text reports excluded (with reasons):

Government schools only n = 43
Non-empirical designs n = 31
Mixed samples, no disaggregated data n = 37
Below quality threshold n = 25
Full text inaccessible n = 24

Total excluded n = 160

PHASE 4 — INCLUDED

**Studies included in the final narrative synthesis**

n = 38

Period covered: 2010 – 2025
Quantitative studies n = 24 (63.2%)
Qualitative studies n = 8 (21.1%)
Mixed-methods studies n = 6 (15.8%)

*Figure 1. PRISMA 2020 Flow Diagram for Study Identification, Screening, Eligibility, and Inclusion*

**Characteristics of Included Studies**

Of the 38 included studies, 24 (63.2%) employed quantitative designs, 8 (21.1%) qualitative designs, and 6 (15.8%) mixed-methods designs. Studies were distributed across South India (47.4%), North India (31.6%), West India (13.2%), and East India (7.9%). Nineteen studies (50%) sampled students from CBSE-affiliated schools, 11 (28.9%) from ICSE-affiliated schools, and 8 (21.1%) from state board-affiliated private schools. Grade levels ranged from Grade 8 to Grade 12, with the majority (n = 22, 57.9%) concentrating on Grades 9 and 10. Sample sizes ranged from 45 to 1,240 participants. Instruments most frequently employed included the Science Process Skills Test (SPST), adapted versions of Burns et al.'s (1985) Integrated Process Skills Test (TIPS II), and researcher-developed rubrics. Twenty-one studies (55.3%) measured basic SPS exclusively, nine (23.7%) measured integrated SPS, and eight (21.1%) assessed both categories.

| | | |
|---|---|---|
| Study Design | Quantitative | 24 (63.2%) |
| | Qualitative | 8 (21.1%) |
| | Mixed Methods | 6 (15.8%) |
| Board Affiliation | CBSE | 19 (50.0%) |
| | ICSE | 11 (28.9%) |
| | State Board | 8 (21.1%) |
| SPS Category Assessed | Basic SPS Only | 21 (55.3%) |
| | Integrated SPS Only | 9 (23.7%) |
| | Both Basic & Integrated | 8 (21.1%) |
| Geographic Region | South India | 18 (47.4%) |
| | North India | 12 (31.6%) |
| | West India | 5 (13.2%) |
| | East India | 3 (7.9%) |

***Table 1. Characteristics of Included Studies (N = 38)***

**Quality Appraisal Summary**

Using the MMAT, 15 studies (39.5%) were rated as High quality, 18 (47.4%) as Moderate quality, and 5 (13.2%) as Low quality. Common quality limitations included the absence of random sampling procedures, reliance on researcher-developed instruments without published validity evidence, short intervention durations, and failure to account for confounding variables such as teacher qualification and prior science achievement. High-quality studies predominantly employed validated instruments, adequate sample sizes, and reported effect sizes with appropriate inferential statistics.

**Results and Discussion**

**Levels of Science Process Skill Proficiency**

A consistent pattern emerged across the reviewed studies: students in Indian private secondary schools demonstrate moderate to satisfactory performance on basic SPS, including observation, classification, communication, and measurement, while exhibiting markedly lower proficiency on integrated SPS, including hypothesising, variable identification, experimental design, and data interpretation. This finding aligns with the theoretical hierarchy proposed by Padilla (1990), who argued that integrated skills require prior mastery of basic skills alongside greater metacognitive awareness and formal operational reasoning. Notably, students in higher grades (Grades 11–12) did not demonstrate substantially greater integrated SPS proficiency than those in Grades 9–10, suggesting that academic progression alone does not guarantee higher-order process skill development without deliberate instructional scaffolding (Tobin & Capie, 1982). The proficiency gap was more pronounced in private schools affiliated with state boards than in CBSE or ICSE institutions, potentially reflecting differences in curriculum standards, laboratory resources, and teacher preparation. Gender differences were investigated in 14 studies, yielding inconsistent findings; marginal female advantages in observation and communication were reported in some studies, while others found no significant differences after controlling for classroom environment variables, consistent with Germann's (1994) observation that gender effects on SPS are typically context-mediated.

**Instructional Strategies and Their Effect on SPS Development**

The synthesis reveals a clear evidence advantage for inquiry-based instructional approaches over conventional, lecture-centred methods in developing SPS. Studies implementing the 5E instructional model, problem-based learning (PBL), and cooperative laboratory investigation consistently reported significantly higher post-test SPS scores compared to control groups. These findings converge with the international literature (Wilke & Straits, 2005; Ambross et al., 2014), affirming that inquiry-oriented pedagogies create the epistemic conditions necessary for students to practise and internalise process skills. A subset of six studies examined technology-enhanced learning environments, including virtual laboratories and simulation software, and reported positive outcomes for integrated SPS, particularly in schools where physical laboratory infrastructure was constrained. Collaborative learning strategies, including structured academic controversy and peer-mediated laboratory tasks, were documented in nine studies and associated with gains in observational precision, communicative SPS, and interpretive reasoning, consistent with sociocultural accounts of SPS development in which peer discourse scaffolds the appropriation of scientific language and practice (Rauf et al., 2013).

**Contextual and Institutional Factors**

Teacher-related factors were identified as the most influential determinants of SPS instructional quality. Despite holding formal academic qualifications, teachers in Indian private secondary schools frequently lacked preparation in inquiry-based pedagogy and tended to treat laboratory sessions as demonstrations rather than as genuine investigative contexts, an observation consistent with Oloruntegbe's (2010) identification of teacher epistemological beliefs as a primary barrier to SPS-oriented instruction. The high-stakes examination culture pervading Indian secondary schooling was identified in numerous studies as a structural impediment, compressing the curriculum, marginalising laboratory work, and incentivising memorisation of content over investigative skill development. Physical infrastructure disparities were also prominently featured; while elite metropolitan private schools possessed well-equipped laboratories, many schools, particularly in Tier 2 and Tier 3 cities, operated with inadequate equipment and absent laboratory assistants. Parental expectations and socio-economic background moderated the school-environment–SPS relationship; students from households with higher scientific capital engaged in supplementary informal inquiry, while first-generation learners were more dependent on, and therefore more vulnerable to deficiencies in, school-based SPS instruction.

**Gaps in the Literature**

Several significant lacunae in the existing evidence base were identified. Longitudinal studies tracking SPS development across the secondary schooling continuum are virtually absent, limiting causal inference about developmental trajectories. Studies from North-East India, Jammu and Kashmir, and other geographically marginalised regions are severely underrepresented, creating a metropolitan geographic bias. The mechanisms by which teacher professional development translates into classroom SPS-oriented practice remain poorly understood, as most intervention studies measured student outcomes without examining mediating teacher practice variables. Finally, the vast majority of reviewed studies employed quantitative outcome measures; the qualitative dimensions of SPS learning, including student motivational responses, perceptions of scientific identity, and epistemic dispositions, remain largely unexplored in the Indian private school context.

**Conclusion**

This PRISMA 2020-based systematic review synthesised 38 empirical studies published between 2010 and 2025 to construct the most comprehensive evidence base to date on science process skills among secondary school students in Indian private schools. The findings reveal a persistent and educationally consequential gap between the SPS competencies mandated by national curriculum frameworks and the proficiency levels demonstrated by students in practice: while basic SPS are cultivated at moderate levels, integrated SPS remain consistently underdeveloped, particularly in contexts characterised by examination-oriented pedagogy, inadequate laboratory infrastructure, and insufficient teacher preparation in inquiry-based instruction. Inquiry-based, technology-supported, and collaborative pedagogical strategies were found to significantly enhance SPS outcomes, yet their wider adoption is constrained by deep-rooted structural, institutional, and cultural barriers that isolated classroom interventions cannot overcome. The evidence base assembled in this review strongly supports the need for policy-level reforms encompassing sustained teacher professional development aligned with constructivist SPS pedagogy, reformed board examination tasks that reward higher-order process competencies, and targeted laboratory infrastructure investment across geographically diverse private school contexts, since only a coordinated, systemic response will narrow the enduring divide between policy aspiration and classroom reality in Indian private secondary science education.

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# THEME 4

18

# ARTIFICIAL INTELLIGENCE LITERACY A PREDICTOR OF TEACHER SELF- EFFICACY IN TECHNOLOGY-ENHANCED CLASSROOM

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### Abstract

The increasing integration of Artificial Intelligence (AI) in education is transforming teaching and learning practices through tools such as intelligent tutoring systems, adaptive learning platforms, automated feedback systems, and learning analytics (Ng et al., 2021). As educational institutions increasingly adopt technology-enhanced classrooms, teachers are expected to possess the knowledge and competencies required to effectively utilize these emerging technologies. One important competency in this context is Artificial Intelligence literacy, which refers to the ability to understand, evaluate, and interact with AI technologies in an informed and responsible manner (Ng et al., 2021). Another key factor influencing teachers' ability to adopt innovative instructional practices is teacher self-efficacy. Teacher self-efficacy refers to teachers' beliefs in their capability to organize and execute the actions required to successfully accomplish teaching tasks and influence student learning outcomes (Bandura, 1997). Teachers with higher levels of self-efficacy are generally more confident in implementing new instructional strategies, integrating digital technologies, and managing technology-rich learning environments. However, despite the rapid expansion of AI-based tools in education, limited empirical research has examined the direct relationship between AI literacy and teacher self-efficacy, particularly among in-service teachers working in technology-enhanced classroom environments. Existing studies have largely examined AI literacy or teacher self-efficacy independently rather than investigating how these constructs may be related. Therefore, this study aims to examine whether Artificial Intelligence literacy predicts teacher self-efficacy in technology-enhanced classrooms. A quantitative research design will be employed using standardized instruments, including the Meta AI Literacy Scale (MAILS; Carolus et al., 2023) and the Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001). Data will be analysed using descriptive statistics, correlation analysis, and regression analysis. Findings provide insights for teacher education, professional development, and policymakers, highlighting how AI literacy and teacher self-efficacy shape training programs to support educators in technology-enhanced, future-ready classrooms effectively and sustainably.


***Keywords**: AI in education, artificial intelligence literacy, educational technology, teacher self- efficacy, teacher preparedness*

### Introduction

The rapid integration of digital technologies into educational settings has fundamentally transformed how teaching and learning are conceptualized and practiced. Among these technologies, Artificial Intelligence (AI) has emerged as a particularly consequential force, enabling tools such as intelligent tutoring systems, adaptive learning platforms, automated assessment technologies, and learning analytics to support personalized, data-driven instruction (Ng et al., 2021). As AI-powered tools become increasingly prevalent across educational institutions, teachers occupy a central role in their implementation — not merely as end-users of technology, but as active mediators who guide students through AI-enhanced learning environments. This central role demands that teachers develop robust competencies for understanding, evaluating, and purposefully integrating AI tools into their instructional practices.

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In this study, technology-enhanced classrooms are defined as learning environments in which digital tools — including AI applications, learning management systems, and adaptive platforms — are embedded into teaching and learning processes to support instruction, communication, and student engagement. Within such environments, two constructs are of particular theoretical and practical relevance: artificial intelligence literacy and teacher self-efficacy. AI literacy encompasses the knowledge, skills, and critical awareness required to understand how AI systems operate, evaluate their applications, and interact with them effectively. Teacher self-efficacy, grounded in Bandura's (1997) Social Cognitive Theory, refers to teacher's beliefs in their own capacity to organize and execute instructional tasks, manage classroom dynamics, and facilitate meaningful student learning. Teachers who hold stronger self-efficacy beliefs are more willing to experiment with novel instructional approaches and technological tools, suggesting that AI literacy may meaningfully shape teachers' perceived confidence in technology-enhanced classroom settings.

Despite the growing integration of Artificial Intelligence (AI) in education, limited empirical research has examined whether AI literacy directly predicts teachers' self-efficacy in technology-enhanced classrooms. Most previous studies have focused either on AI literacy among teachers or on teachers' self-efficacy in using technology separately. However, very few studies have explored the direct relationship between AI literacy and teachers' confidence in effectively using technology in teaching and learning environments.

Therefore, this study seeks to examine whether Artificial Intelligence literacy among teachers predicts their level of self-efficacy in technology-enhanced classrooms. By addressing this gap in the literature, the study aims to provide empirical evidence on the role of AI literacy in shaping teachers' confidence and capability to integrate advanced technologies into classroom practices.

The findings of this study are expected to contribute significantly to the existing body of knowledge by highlighting the importance of AI literacy in teacher development. Furthermore, the results may provide useful insights for policymakers and teacher education institutions to integrate AI literacy into teacher education and professional development programs. Strengthening AI literacy among teachers could ultimately support more effective use of technology in teaching and learning processes.

The following section reviews the theoretical frameworks and empirical literature underpinning these constructs, examines existing evidence on their relationship, and provides a rationale for the instruments employed in this study.

## Theoretical Foundations

### Artificial Intelligence Literacy

AI literacy has been conceptualized as a multidimensional construct encompassing the cognitive, applied, and ethical competencies required to engage meaningfully with AI technologies. Ng et al. (2021) conducted a systematic review of 30 peer-reviewed studies and proposed a four-dimensional framework for AI literacy: (a) knowing and understanding AI, (b) using and applying AI, (c) evaluating and creating AI, and (d) engaging with AI ethics. Drawing on Bloom's Taxonomy, the authors positioned these dimensions along a cognitive hierarchy — from foundational declarative knowledge to higher-order critical thinking and ethical reasoning. This framework established the theoretical basis for subsequent instrument development in the field and serves as the conceptual foundation for the present study.

A scoping review of AI literacy assessment tools by Biagini (2024) identified nine validated instruments for measuring self-perceived AI literacy, confirming that the construct is multidimensional and encompasses cognitive, ethical, affective, and behavioral components. The review further highlighted that self-perceived AI competence — grounded in Bandura's (1997) self-efficacy theory — plays a critical role in shaping individuals' motivation and engagement with AI technologies, underscoring the conceptual overlap between AI literacy and self-efficacy.

### Teacher Self-Efficacy

Teacher self-efficacy is grounded in Bandura's (1997) Social Cognitive Theory, which posits that individuals' beliefs in their own capabilities significantly shape their motivation, behavior, and perseverance in the face of challenges. Applied to teaching, self-efficacy refers to teachers' judgments about their capacity to perform specific instructional tasks, manage classroom interactions, and promote student learning outcomes. Bandura (1997) identified four primary sources of self-efficacy: mastery experiences, vicarious learning, verbal persuasion, and physiological states — each of which can be influenced by professional development, knowledge acquisition, and contextual experience.

Seneviratne et al. (2019) applied the Teachers' Sense of Efficacy Scale (TSES) with 350 in-service science teachers in Sri Lanka, confirming strong internal consistency across its three subscales — instructional strategies ($\alpha = .825$), classroom management ($\alpha = .870$), and student engagement ($\alpha = .809$). Importantly, the study found that teachers with higher self-efficacy in instructional strategies were significantly more likely to engage students in innovative teaching approaches, and that participation in professional development programs positively predicted self-efficacy in student engagement. These findings are consistent with Bandura's (1997) theoretical position that self-efficacy is not a fixed trait but a context-sensitive belief that can be shaped by professional knowledge and experience — a proposition that directly underpins the present study's examination of AI literacy as a potential predictor of teacher self-efficacy.

**Measurement Instruments**

**The Meta AI Literacy Scale (MAILS)**

Carolus et al. (2023) developed the Meta AI Literacy Scale (MAILS) as a psychometrically validated, modular instrument grounded in the four-dimensional framework of Ng et al. (2021). Through confirmatory factor analysis with a sample of 300 adults, the scale confirmed four core AI literacy dimensions — Use and Apply AI, Know and Understand AI, Detect AI, and AI Ethics — alongside psychological meta-competencies including AI self-efficacy in problem-solving and learning, and AI self-competency in persuasion and emotion regulation. The inclusion of self-efficacy-related dimensions within MAILS is particularly noteworthy for the present study, as it reflects the theoretical interrelationship between AI literacy and self-efficacy — both of which share conceptual roots in Bandura's (1997) social cognitive theory. Among the instruments reviewed by Biagini (2024), MAILS was identified as the most comprehensive tool for adult professional contexts, given its integration of both cognitive and psychological dimensions of AI competence.

**The Teachers' Sense of Efficacy Scale (TSES)**

Teacher self-efficacy in this study is operationalized using the Teachers' Sense of Efficacy Scale (TSES) developed by Tschannen-Moran and Hoy (2001). The TSES is a 24-item instrument comprising three subscales — student engagement, instructional strategies, and classroom management — each of which reflects a distinct dimension of teachers' instructional confidence. The scale has demonstrated strong psychometric properties across diverse cultural and professional contexts (Seneviratne et al., 2019), making it appropriate for use with in-service teachers in technology-enhanced educational settings.

**Empirical Evidence on AI Literacy and Teacher Self-Efficacy**

Recent empirical work has begun to examine the relationship between teachers' AI-related competencies and their professional confidence, though findings remain inconclusive. Baimukhambetova et al. (2026) investigated this relationship among 293 pre-service teachers in Kazakhstan, finding no statistically significant correlation between AI readiness and professional self-efficacy ($r = -.053$, $p > .05$). The authors attributed this null finding to the possibility that pre-service teachers may conceptualize AI as a technical tool rather than a pedagogically integrated competency, and emphasized that self-efficacy development requires not only declarative knowledge but sustained applied experience. Critically, neither a comprehensive multi-dimensional AI literacy instrument nor an in-service teacher population was employed in this study

In a related vein, Ofem et al. (2025) examined teacher preparedness for AI-based classroom assessment among 3,781 educators in Nigeria, finding that while technological readiness and pedagogical beliefs predicted preparedness through mediating variables, the overall model explained only 11.2% of the variance. This low explanatory power indicates that critical constructs — including comprehensive AI literacy — remain unaccounted for in existing predictive frameworks. Together, these studies highlight the need for further investigation employing multi-dimensional AI literacy instruments with in-service teacher populations in technology-enhanced educational contexts.

### Research Gap and the Present Study

Despite growing interest in AI in education, the relationship between teachers' AI literacy and their self-efficacy in technology-enhanced classrooms remains insufficiently examined. Existing studies have relied on limited AI literacy operationalizations, focused primarily on pre-service teacher populations, and have not employed validated multi-dimensional instruments such as MAILS. The present study addresses these gaps by examining AI literacy — as comprehensively measured by the MAILS (Carolus et al., 2023) — as a direct predictor of teacher self-efficacy — as measured by the TSES (Tschannen-Moran & Hoy, 2001) — among in-service school teachers working in technology-enhanced classroom environments.

### Objectives:

- To assess the level of Artificial Intelligence literacy among teachers.
- To measure the level of teacher self-efficacy in technology-enhanced classrooms.
- To examine the relationship between Artificial Intelligence literacy and teacher self-efficacy.
- To determine whether Artificial Intelligence literacy significantly predicts teacher self-efficacy.

### Hypotheses

- H1: There is a significant positive correlation between Artificial Intelligence literacy and teacher self-efficacy in technology-enhanced classrooms.
- H2: Artificial Intelligence literacy is a significant predictor of teacher self-efficacy in technology-enhanced classrooms. scoping review of AI literacy assessment tools by Biagini (2024) identified nine

### Research Design

This study employed a quantitative, cross-sectional survey design to examine the predictive relationship between Artificial Intelligence (AI) literacy and teacher self-efficacy in technology-enhanced classrooms. A quantitative approach was selected as it enables the precise measurement of constructs through standardized instruments and allows for statistical testing of hypothesized relationships (Creswell & Creswell, 2018). The cross-sectional design is appropriate given that the study aimed to capture a snapshot of teachers' AI literacy and self-efficacy levels at a single point in time.

### Participants

The sample consisted of 47 in-service teachers recruited through purposive sampling. Participants ranged in age from 21 to 61 years ($M = 31.15$, $SD = 10.32$), representing a diverse range of experience levels and educational qualifications including undergraduate degrees, postgraduate degrees, and doctoral qualifications. All participants were actively engaged in teaching within technology-enhanced classroom environments at the time of data collection. Participation was voluntary and informed consent was obtained prior to data collection.

### Instruments

Two validated instruments were employed in this study.

**Teacher Self-Efficacy:** Teacher self-efficacy was measured using the Teachers' Sense of Efficacy Scale (TSES; Tschannen-Moran & Hoy, 2001). The TSES is a 24-item scale comprising three subscales: student engagement, instructional strategies, and classroom management. For the purposes of this study, the 11-item short form was utilized. Items were rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), with higher scores indicating greater self-efficacy. The scale has demonstrated strong psychometric properties across diverse professional and cultural contexts (Seneviratne et al., 2019).

**AI Literacy:** Artificial Intelligence literacy was measured using the Meta AI Literacy Scale (MAILS; Carolus et al., 2023). The MAILS is a psychometrically validated, modular instrument grounded in the four-dimensional AI literacy framework proposed by Ng et al. (2021), encompassing cognitive, applied, ethical, and self-efficacy-related AI competencies. The six-item subscale assessing AI self-efficacy and applied competence was administered in this study, rated on a five-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

**Data Collection**

Data were collected through a structured online survey administered via Google Forms during March 2026. The survey instrument comprised three sections:

(a) demographic information including name, age, and educational qualification
(b) the 11-item TSES
(c) the 6-item MAILS subscale.

Participants were invited to complete the survey voluntarily, with responses remaining anonymous and confidential. A total of 47 complete responses were received and included in the final analysis.

**Data Analysis**

Data were analyzed using Microsoft Excel with the XLMiner Analysis ToolPak. The following analytical procedures were conducted in sequence:

(a) descriptive statistics including means, standard deviations, minimum and maximum scores, skewness, and kurtosis were computed to characterize the sample and examine the distribution of scores

(b) internal consistency reliability was assessed using Cronbach's alpha coefficient for both scales

(c) Pearson product-moment correlation analysis was conducted to test H1 regarding the association between AI literacy and teacher self-efficacy

(d) simple linear regression analysis was conducted to test H2 regarding the predictive relationship between AI literacy and teacher self-efficacy.

**Results**

**Descriptive Statistics**

Descriptive statistics were computed for all study variables and are presented in Table 1. Teachers reported high levels of self-efficacy (TSES: $M = 48.30$, $SD = 5.20$, out of a possible 55), with scores ranging from 35 to 55. The median score of 49.00 and mode of 51.00 further confirm that the majority of participants clustered toward the higher end of the scale. AI literacy scores (MAILS) ranged from 13 to 25, with a mean of 19.43 ($SD = 3.24$). Examination of distributional properties indicated that TSES scores were slightly negatively skewed (−.73), suggesting a concentration of high scores, while MAILS scores were approximately symmetric (skewness = −.04), indicating a more evenly distributed range of AI literacy across the sample

**Table 1**

Descriptive Statistics for TSES, MAILS, and Age (N = 47)

| Variable | N | M | SD | Min | Max |
|---|---|---|---|---|---|
| TSES (Teacher Self-Efficacy) | 47 | 48.30 | 5.20 | 35 | 55 |
| MAILS (AI Literacy) | 47 | 19.43 | 3.24 | 13 | 25 |
| Age | 47 | 31.15 | 10.32 | 21 | 61 |

Note. TSES = Teachers' Sense of Efficacy Scale (possible range: 11–55). MAILS = Meta AI Literacy Scale (possible range: 6–30). M = Mean; SD = Standard Deviation.

**Reliability Analysis**

Internal consistency reliability was assessed using Cronbach's alpha coefficient. Results are presented in Table 2. The TSES demonstrated good internal consistency ($\alpha = .876$), exceeding the recommended threshold of .70 (Nunnally, 1978). The MAILS yielded a Cronbach's alpha of .681, which falls slightly below the conventional threshold of .70. This finding is acknowledged as a study limitation and is discussed in Section 5. Nevertheless, the scale was retained for analysis given that values approaching .70 have been considered acceptable in exploratory research contexts, particularly with a small number of items (Field, 2018).

**Table 2**

Internal Consistency Reliability Coefficients

| Scale | No. of Items | Cronbach's α | Interpretation |
|---|---|---|---|
| TSES (Teacher Self-Efficacy) | 11 | .876 | Good internal consistency |
| MAILS (AI Literacy) | 6 | .681 | Slightly below threshold |

Note. * The conventional threshold for acceptable internal consistency is $\alpha \geq .70$ (Nunnally, 1978).

**Correlation Analysis (H1)**

To test H1 — that there is a significant positive correlation between AI literacy and teacher self-efficacy — a Pearson product-moment correlation was conducted. Results are presented in Table 3. A statistically significant moderate positive correlation was found between MAILS and TSES scores ($r = .459$, $p = .001$). This indicates that teachers who reported higher levels of AI literacy also tended to report higher levels of self-efficacy in technology-enhanced classroom settings. The effect size ($r = .459$) falls within the moderate range according to Cohen's (1988) conventions (.10 = small, .30 = medium, .50 = large). Accordingly, H1 is supported.

**Table 3**

Pearson Correlation Between AI Literacy (MAILS) and Teacher Self-Efficacy (TSES)

| Variables | N | Pearson r | p-value | Decision |
|---|---|---|---|---|
| MAILS × TSES | 47 | .459 | .001 | **H1 Supported** |

Note. ** $p < .01$ (two-tailed).

**Regression Analysis (H2)**

Simple linear regression was conducted to test H2 — that AI literacy significantly predicts teacher self-efficacy. AI literacy (MAILS total score) was entered as the predictor variable and teacher self-efficacy (TSES total score) as the outcome variable. Results are presented in Table 4.

The overall regression model was statistically significant ($F(1, 45) = 12.019$, $p = .001$), indicating that AI literacy reliably predicted teacher self-efficacy. The model explained 21.1% of the variance in teacher self-efficacy scores ($R^2 = .211$, Adjusted $R^2 = .193$). The unstandardized regression coefficient for MAILS was $B = 0.736$ ($SE = 0.212$, $t = 3.467$, $p = .001$), indicating that for every one-point increase in AI literacy score, teacher self-efficacy increased by 0.736 points. The regression equation is expressed as: TSES = 33.993 + 0.736 × MAILS. These results support H2.

**Table 4**

Simple Linear Regression: AI Literacy Predicting Teacher Self-Efficacy

| | B | SE | t | p | $R^2$ | Adj. $R^2$ |
|---|---|---|---|---|---|---|
| Intercept | 33.993 | 4.182 | 8.128 | < .001 | | |
| **MAILS Total** | .736 | .212 | 3.467 | **.001** | **.211** | **.193** |

Note. B = unstandardized regression coefficient; SE = standard error; $R^2$ = coefficient of determination; Adj. $R^2$ = adjusted $R^2$. * $p < .01$.

## Findings

The findings of this study are organized around the two research hypotheses and the key descriptive outcomes.

### Finding 1: Teachers demonstrated high self-efficacy.

Descriptive results revealed that the sample of 47 in-service teachers reported high levels of self-efficacy ($M = 48.30$ out of 55, $SD = 5.20$). This suggests that, overall, the participating teachers held strong beliefs in their ability to manage classrooms, implement instructional strategies, and engage students effectively within technology-enhanced learning environments.

### Finding 2: AI literacy was moderately high with greater individual variation.

While teachers reported moderately high AI literacy ($M = 19.43$ out of 25, $SD = 3.24$), the standard deviation and score range (13–25) indicate considerably more variation in AI literacy compared to self-efficacy. This suggests that although most teachers possess a functional level of AI literacy, there are notable individual differences in the depth and breadth of AI-related knowledge and skills across the sample.

### Finding 3: A significant positive relationship exists between AI literacy and teacher self-efficacy (H1 supported).

The correlation analysis confirmed a statistically significant moderate positive relationship between AI literacy and teacher self-efficacy ($r = .459$, $p = .001$). This finding indicates that teachers who are more knowledgeable and competent in AI tend to feel more confident in their teaching practices within technology-enhanced classrooms. H1 is therefore supported.

### Finding 4: AI literacy significantly predicts teacher self-efficacy (H2 supported).

The regression analysis demonstrated that AI literacy was a statistically significant predictor of teacher self-efficacy ($B = 0.736$, $p = .001$), accounting for 21.1% of the variance in self-efficacy scores ($R^2 = .211$). This finding confirms that beyond a simple association, AI literacy has meaningful predictive value for teachers' sense of efficacy in technology-integrated instructional environments. H2 is therefore supported.

### Finding 5: MAILS reliability was slightly below the conventional threshold.

The Cronbach's alpha for the MAILS subscale used in this study was .681, which falls marginally below the widely accepted threshold of .70. This is acknowledged as a limitation and suggests that findings related to MAILS should be interpreted with appropriate caution.

## Discussion

This study examined whether Artificial Intelligence literacy predicts teacher self-efficacy in technology-enhanced classrooms among a sample of 47 in-service teachers. The results provide empirical support for both hypotheses, contributing to the growing body of literature on the role of AI competence in shaping teachers' professional confidence.

### High Self-Efficacy Among Teachers

The finding that teachers reported high levels of self-efficacy (M = 48.30/55) is consistent with prior research suggesting that in-service teachers, particularly those who have been actively practicing in classroom settings, tend to develop strong efficacy beliefs through accumulated mastery experiences (Bandura, 1997; Seneviratne et al., 2019). The high mean scores and relatively low standard deviation indicate that the sample was largely homogeneous in their confidence levels, which may reflect the self-selecting nature of voluntary participation in a study focused on technology-enhanced teaching.

### Moderate AI Literacy with Greater Variability

In contrast to the high and relatively uniform self-efficacy scores, AI literacy exhibited greater variability across participants. This pattern aligns with existing literature documenting uneven distributions of AI-related competencies among teachers, often attributable to differences in professional development opportunities, institutional support, and personal interest in technology (Ng et al., 2021; Ofem et al., 2025). The finding that AI literacy scores were more diverse than self-efficacy scores underscore the need for targeted, differentiated AI literacy training programs tailored to individual teachers' knowledge levels.

### AI Literacy and Teacher Self-Efficacy: A Significant Positive Relationship

The significant moderate positive correlation ($r = .459$, $p = .001$) between AI literacy and teacher self-efficacy supports H1 and aligns with the theoretical propositions of Bandura's (1997) Social Cognitive Theory. According to this framework, knowledge acquisition and professional mastery are key sources of self-efficacy. Teachers who develop stronger understanding and applied skills in AI are likely to experience greater mastery experiences when integrating AI tools into their instruction, thereby strengthening their confidence. This finding stands in contrast to Baimukhambetova et al. (2026), who found no significant relationship between AI readiness and self-efficacy among pre-service teachers. The divergence in findings may be attributable to the use of in-service rather than pre-service teachers in the current study, as in-service teachers have direct applied experience with classroom technology, a factor that has been shown to mediate the relationship between knowledge and self-efficacy (Seneviratne et al., 2019).

### AI Literacy as a Predictor of Teacher Self-Efficacy

The regression analysis confirmed that AI literacy significantly predicts teacher self-efficacy ($B = 0.736$, $p = .001$, $R^2 = .211$), supporting H2. The model explained 21.1% of the variance in self-efficacy scores — a meaningful effect size in the context of educational and social science research, where single-predictor models rarely explain more than 25–30% of variance (Cohen, 1988). The remaining unexplained variance (approximately 79%) suggests that other important predictors — such as years of teaching experience, institutional support, professional development participation, and pedagogical beliefs — also contribute to teacher self-efficacy and warrant investigation in future research. This finding extends the work of Ofem et al. (2025), whose model explained only 11.2% of variance using general technological readiness measures, by demonstrating that a more targeted, multi-dimensional AI literacy measure yields stronger predictive validity.

## Conclusion

This study investigated whether Artificial Intelligence literacy predicts teacher self-efficacy in technology-enhanced classrooms among 47 in-service teachers. The findings provide empirical evidence in support of both research hypotheses. A significant moderate positive correlation was observed between AI literacy and teacher self-efficacy ($r = .459$, $p = .001$), and AI literacy was found to be a statistically significant predictor of teacher self-efficacy, accounting for 21.1% of the variance in self-efficacy scores ($B = 0.736$, $p = .001$). These results suggest that teachers who possess greater knowledge and applied competence in AI tend to hold stronger beliefs in their instructional capabilities within technology-enhanced environments.

These findings carry important implications for teacher education and professional development. First, AI literacy should be explicitly incorporated into pre-service and in-service teacher training programs, as improving teachers' AI competencies appears to have a measurable positive effect on their instructional confidence. Second, educational institutions and policymakers should invest in structured, ongoing AI professional development initiatives that go beyond general technological orientation and engage teachers with the cognitive, ethical, and applied dimensions of AI as outlined by Ng et al. (2021). Third, given the variability observed in AI literacy scores, professional development programs should adopt differentiated approaches that address the diverse needs of teachers at varying levels of AI competence.

Several limitations of this study should be acknowledged. The sample size of 47 participants, while adequate for the analyses conducted, limits the generalizability of the findings to broader teacher populations. The use of a convenience sample recruited through voluntary participation may have introduced self-selection bias, potentially overrepresenting teachers with stronger technology orientations. The slightly below-threshold reliability of the MAILS subscale ($\alpha = .681$) suggests that findings related to AI literacy measurement should be interpreted with caution. Furthermore, the cross-sectional design precludes causal inference; longitudinal studies are needed to establish whether improvements in AI literacy produce corresponding changes in teacher self-efficacy over time.

Future research should address these limitations by employing larger, more representative samples, utilizing the full MAILS instrument to improve reliability, and incorporating additional variables such as teaching experience, institutional AI support, and pedagogical beliefs that may further explain variance in teacher self-efficacy. Experimental or quasi-experimental designs examining the effects of targeted AI literacy interventions on teacher self-efficacy would provide stronger causal evidence and more directly inform professional development policy.

Therefore, this study contributes empirical evidence to the emerging literature on AI literacy in education, demonstrating that AI literacy is not only associated with but also predictive of teacher self-efficacy in technology-enhanced classrooms. As AI continues to reshape educational landscapes, fostering AI literacy among teachers emerges as a critical priority for building a confident, capable, and future-ready teaching profession.

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# DIGITAL PEDAGOGY AND THE TRANSFORMATION OF FUTURE CLASSROOMS

**Ms Rafiya Sultana [1], Ms. Afreen Sultana [2]**

**Abstract**

The teaching and learning processes in contemporary education have been significantly impacted by the rapid development of digital technology. The term digital pedagogy refers to the deliberate use of digital technology, digital platforms, and creative instructional approaches to enrich the learning process and transform traditional classroom instruction. The 21st century has witnessed digital pedagogy assuming a vital role in shaping the classrooms of the future. The significance of digital pedagogy lies in its potential to enrich the learning process, enhance student engagement, and foster the acquisition of digital literacy skills necessary for modern society. The use of digital technology has enabled classrooms to gradually transform into technology-enabled spaces where creativity, critical thinking, and problem-solving skills can be promoted among learners. Despite the rapid advancement of digital technology in modern classrooms, a significant research gap remains regarding its potential to transform classroom instruction and enrich the learning process. Teachers' lack of digital literacy and insufficient technology infrastructure are two issues that educational institutions have been dealing with. The purpose of this study is to identify the role of digital pedagogy in shaping the classrooms of the future and its potential to impact teaching methods, student engagement, and learning achievements. The methodology used in this paper includes a literature review and a bibliometric analysis of recent scholarly works on digital pedagogy and technology-based learning. The study's findings include the potential of digital pedagogy to enhance interactive learning, student-centered teaching, and assessment techniques. The study's implications include the need for teacher training, infrastructure, and educational policies to ensure the integration of digital pedagogy and transform classrooms of the future.

***Keywords:*** *digital pedagogy, educational innovation, future classrooms, student-centered learning, technology-enhanced learning*

## Introduction

The rapid development of digital technologies has resulted in a major transformation of education in the twenty-first century. Innovative approaches that integrate digital tools and platforms to improve learning experiences are progressively replacing traditional teaching methods that mostly relied on chalk-and-talk training. The idea of "digital pedagogy," which highlights the successful use of technology in teaching and learning procedures, has become an essential educational strategy.

Digital pedagogy is intentional use of digital technologies to boost student engagement, improve teaching methods, and produce relevant learning opportunities. It encompasses the use of interactive technologies, digital learning resources, multimedia tools, and online platforms that support student-centered and collaborative learning. To better prepare students for the demands of a technologically advanced society, educational institutions worldwide have been implementing digital pedagogical approaches more frequently in modern times.

Classroom environments have been greatly impacted by the use of digital pedagogy. Instead of only imparting knowledge, modern classrooms are gradually transforming into technology-enabled learning environments where students actively contribute to knowledge building. Teachers are now able to create compelling learning experiences that foster creativity, critical thinking, and problem-solving abilities thanks to digital

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resources like learning management systems, interactive simulations, educational software, and online collaborative platforms.

The global transition to online and blended learning environments made the significance of digital pedagogy very clear. In order to carry out instructional activities, teachers and students are depending more and more on digital platforms. This shift demonstrated how digital pedagogy may revolutionize conventional teaching methods and establish adaptable learning environments.

Even so, there are still a number of issues with the increasing use of digital tools in the classroom. In order to successfully incorporate technology into their teaching techniques, many educators still lack the necessary digital literacy abilities. The adoption of digital pedagogy in many educational institutions is also severely hampered by a lack of technology infrastructure and unequal access to digital resources.

As a result, it is necessary to find out how digital pedagogy may successfully change classroom instruction and support the creation of classrooms in the future. The purpose of the study is to investigate how new teaching strategies, increased student engagement, and better learning outcomes are shaped by digital pedagogy.

The aim of this study is to investigate the idea and importance of digital pedagogy in contemporary education as well as how it is changing conventional teaching methods. It aims to investigate how the incorporation of digital technologies can impact instructional strategies and help in the creation of creative learning environments. Additionally, the study looks at how digital pedagogy improves student participation, engagement, and general learning in modern classrooms. Additionally, the study attempts to pinpoint the main obstacles and possibilities related to the adoption of digital pedagogy in educational establishments, especially concerning institutional support, technology infrastructure, and teacher readiness. The study hopes to demonstrate how digital pedagogy can influence future classrooms through this analysis.

**Literature Review**

Researchers and educators worldwide have given the use of digital technologies in education a great deal of attention. Scholars have investigated how digital technologies and online platforms can improve teaching strategies, boost student engagement, and facilitate collaborative learning over the last 20 years. Digital pedagogy, which emphasizes the deliberate and intentional use of digital technologies to enhance teaching and learning, has become a significant idea.

Existing literature highlights that digital pedagogy plays a significant role in transforming traditional classrooms into interactive and student-centered learning environments. Researchers have also examined the role of digital technologies in promoting creativity, improving access to learning resources, and enabling innovative assessment practices. At the same time, several studies have emphasized the challenges associated with implementing digital pedagogy, such as inadequate infrastructure, lack of teacher training, and unequal access to technology.

The following section presents a review of selected national and international studies related to digital pedagogy and technology-enhanced learning.

Selwyn (2016) explored how digital pedagogy is changing conventional teaching methods and looked at the expanding impact of digital technologies in education. The study highlighted how digital technologies allow students to actively engage in the learning process through online forums, multimedia materials, and collaborative platforms. The results showed that students' critical thinking and problem-solving abilities are enhanced by digital teaching.

In a similar vein, Redecker (2017) offered a framework for incorporating digital technology into instruction and investigated the idea of digital competence among instructors. The study made clear that in order to use technology in the classroom successfully, teachers must have the requisite digital abilities. The study claims that digital pedagogy includes teachers' capacity to create meaningful learning activities that encourage student connection and participation in addition to using technology.

In the Indian educational context, Mishra and Koehler (2006) introduced the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the integration of technology, pedagogy, and subject knowledge in teaching practices. The framework suggests that effective digital pedagogy requires teachers to combine technological tools with appropriate teaching strategies in order to enhance learning outcomes

Another study by Kumar and Sharma (2020) looked at how digital tools are used in Indian classrooms and emphasized how they help foster interactive and collaborative learning. The study discovered that through interactive exercises and multimedia content, digital learning aids students in gaining a deeper comprehension of subjects. But the study also found issues like inadequate digital training for educators and a lack of technology infrastructure.

Although previous studies have highlighted the importance of digital technologies in education, there is still limited research focusing specifically on the transformation of classroom environments through digital pedagogy.

Even while earlier research has emphasized the value of digital technologies in education, there is still a dearth of studies that particularly address how digital pedagogy might change classroom settings. Many studies concentrate on technical tools rather than analyzing how digital pedagogy affects teaching tactics, student engagement, and educational outcomes. Furthermore, topics including legislative support, infrastructure constraints, and teacher readiness have not received enough attention.

**Research Methodology**

The current study uses bibliometric analysis and a review of the literature as part of a qualitative research methodology. The study is based on a systematic review of scholarly literature related to digital pedagogy and technology-enhanced learning. The research focuses on identifying major themes, trends, and patterns in the existing body of knowledge.The study looks into a number of aspects of digital pedagogy, such as how it might boost student engagement, encourage creative teaching methods, and help students enhance their digital literacy.

**Data Resources** :

Secondary sources provided the data used in this investigation. Among these sources are:

- Articles from peer-reviewed journals about digital pedagogy
- Research articles presented at national and international conferences
- Books and scholarly works about educational technology
- Online scholarly resources including ERIC, Scopus, and Google Scholar

The material was chosen based on how well it explained the integration of digital technology in education and how pertinent it was to the research issue.

**Bibliometric Analysis:**

A bibliometric study was carried out to discover patterns and trends in digital pedagogy research. This method uses quantitative analysis of academic papers to look at the frequency of research output, significant research subjects, and emerging trends in digital education. The study used bibliometric analysis to identify the primary research emphasis areas in digital pedagogy and technology-enhanced learning.

**Data Analysis Technique:**

Thematic analysis, a qualitative tool for identifying repeating patterns and themes in data, was used to examine the collected material. The literature was thoroughly examined and divided into key categories, including:

- Classroom reform and digital pedagogy
- Student-centered methods of instruction

- Teaching methods enhanced by technology
- Obstacles and difficulties with digital pedagogy

This thematic classification contributed to a better understanding of digital pedagogy's larger impact on educational practices and learning settings.

**Findings**

The analysis of the reviewed literature revealed several important findings regarding the role of digital pedagogy in transforming modern classrooms and shaping future learning environments.

***Enhancement of Interactive Learning:***

Digital pedagogy improves interactive learning by adding multimedia materials, digital simulations, and collaborative online platforms into the teaching and learning process. These tools allow teachers to explain complex subjects in a more engaging and visually appealing way.Students are encouraged to actively participate in class activities by interactive tools including online discussion boards, virtual learning environments, and smart boards. Students consequently have a deeper comprehension of academic material and become more engaged in the learning process.

***Promotion of Student-Centered Learning:***

The study also found that the transition from teacher-centered education to student-centered learning is supported by digital pedagogy. Teachers frequently control the teaching process in traditional classrooms, with students taking on a passive role. On the other hand, digital learning platforms enable students to work with peers and autonomously study educational content.

***Improvement in Teaching Strategies:***

Digital technology provide teachers with creative tools to support a variety of instructional styles. Teachers can incorporate gamified learning activities, interactive tests, multimedia presentations, and online group projects into their courses.

***Development of Digital Literacy Skills:***

The inclusion of digital pedagogy helps students build digital literacy abilities. The ability to get, assess, and utilize information from digital sources is a component of digital literacy. Students in modern classrooms are taught how to communicate, conduct research, and collaborate using digital resources. These abilities are necessary for success in both the modern workforce and higher education, where digital competency is becoming more and more crucial.

***Challenges in Implementing Digital Pedagogy:***

Despite its benefits, the application of digital pedagogy poses various problems. Teachers' inadequate training in the use of digital technologies is one of the main issues. Many teachers lack the necessary skills to incorporate digital tools into their lesson plans. The absence of technology infrastructure in many educational institutions, especially in underdeveloped countries, is another major problem. Inadequate technical assistance, inconsistent internet connectivity, and restricted access to digital devices can all impede the successful application of digital pedagogy. Furthermore, the digital divide among students can result in unequal learning possibilities. Due to their restricted access to digital resources, students from underprivileged backgrounds may find it difficult to fully engage in technologically advanced learning environments.

**Discussion**

The findings of the study indicate that digital pedagogy has the potential to significantly transform classroom teaching and learning processes. Teachers can build dynamic learning environments that encourage participation and teamwork by integrating digital tools. By encouraging students to investigate information, evaluate data, and apply knowledge in practical settings, digital pedagogy fosters the growth of critical thinking and problem-solving abilities. Additionally, personalized learning is made possible by digital learning environments, where students can advance at their own speed and get tailored feedback. However, for digital pedagogy to be implemented successfully, proper teacher training and institutional support are required. In order to successfully incorporate technology into their teaching methods, educators must acquire digital competences. Educational establishments also need to make investments in technology infrastructure and make digital resources accessible. The ability of educators and policymakers to establish conducive circumstances that promote the adoption of digital pedagogical approaches will determine how future classrooms are transformed.

**Conclusion**

Digital pedagogy has become an effective method for innovating learning experiences and changing conventional classroom settings. Teachers may create interactive, student-centered learning environments that increase engagement and foster the development of critical digital skills by integrating digital tools. Despite its potential advantages, issues with teacher preparation, technology infrastructure, and institutional support must be resolved for digital pedagogy to be implemented successfully. To provide conditions that facilitate the successful integration of digital technology in teaching and learning, educational institutions and legislators must collaborate. Digital pedagogy will be essential in forming future classrooms and preparing students for the demands of a world that is changing quickly as education continues to change in the digital era.

**Education Implications**

The findings of the study have a number of significant implications for educational policy and practice.

- Teacher Training Programs: To improve teachers' digital competencies, educational institutions should offer professional development programs.
- Infrastructure Development: Educational institutions need to make investments in digital gadgets, learning management systems, and high-speed internet.
- Curriculum Integration: To encourage technology-enhanced learning opportunities, digital pedagogy should be incorporated into the curriculum.
- Policy Support: Policies that promote the efficient use of digital technology in education should be created by governments and educational bodies.

**Limitations of The Study**

This study has some limitations even though it offers insightful information about digital pedagogy.

- Secondary data and a survey of the literature serve as the study's main sources.
- Primary data obtained from instructors or students is not included in the study.
- Due to differences in institutional support and technology infrastructure, the results might not be representative of all educational situations.

**Future Directions**

- Empirical studies focusing on the way digital pedagogy affects students' learning outcomes.
- Research that compares digital and conventional teaching approaches.
- Research on the professional development requirements and digital capabilities of educators.
- Examination of how developing technology and artificial intelligence will be used in classrooms in the future.

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# INTEGRATING ARTIFICIAL INTELLIGENCE IN EDUCATION: OPPORTUNITIES, CHALLENGES AND FUTURE POSSIBILITIES

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**Abstract**

Artificial intelligence (AI) has rapidly transformed numerous sectors globally, with education emerging as one of the most significantly impacted domains, as classrooms increasingly shift from traditional static environments toward dynamic, data-driven learning spaces that demand adaptive and personalized approaches. Despite the growing integration of AI-powered tools in educational settings, a considerable gap persists in the literature concerning how these technologies perform equitably across diverse learner populations, under-resourced institutions, and varied pedagogical frameworks, particularly in contexts where digital infrastructure and teacher preparedness remain inadequate. Therefore, this study critically examines the opportunities, challenges, and future possibilities associated with integrating AI into educational systems, with the aim of providing evidence-based guidance for educators, policymakers, curriculum designers, and technology developers. A systematic review methodology was employed, drawing on peer-reviewed studies published between 2018 and 2024 from databases including ERIC, Scopus, and Google Scholar, with thematic synthesis applied to organize findings across three core dimensions: opportunity, challenge, and future direction. Findings reveal that AI meaningfully enhances student engagement through adaptive learning systems, reduces administrative burden on educators, and enables early identification of learning difficulties; however, persistent barriers including algorithmic bias, data privacy concerns, digital infrastructure inequality, and insufficient professional development continue to hinder equitable implementation. These findings underscore the urgent need for transparent governance frameworks, inclusive AI design practices, and sustained interdisciplinary collaboration among technologists, educators, and ethicists to ensure that AI functions as a tool of empowerment rather than exclusion in educational environments.


***Keywords:*** *digital equity, algorithmic bias, personalised learning, adaptive learning.*

## Introduction

Walk into a well-resourced school today and you might find students working through individualised exercises adjusted in real time by a software platform, while their teacher monitors engagement data across the entire class on a dashboard. Walk into an under-resourced school in the same city — or a rural district, or a school in a developing country — and there may be no functional internet connection at all. This contrast sits at the heart of what makes artificial intelligence in education such a complicated and consequential subject. The technology is genuinely powerful, and it is advancing at a pace that outstrips our collective ability to deploy it fairly.

AI, broadly understood, refers to computational systems capable of performing tasks that would ordinarily require human-like reasoning: pattern recognition, natural language understanding, prediction, and real-time adaptation. In educational settings, these capabilities take the form of intelligent tutoring systems, automated feedback and grading tools, early warning analytics that identify struggling students, and conversational platforms that respond to learner queries. Each of these applications carries documented promise. Each also carries documented risk, and the risks do not fall evenly across populations.


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Researchers, policymakers, and educators are beginning to ask harder questions about AI integration — not simply whether it works, but for whom it works, under what conditions, with what unintended effects, and governed by whom. This review takes those questions seriously. It draws on a systematic synthesis of peer-reviewed scholarship to map the current state of evidence and to identify what must change if AI is to fulfil its potential as a force for educational equity rather than a new mechanism for concentrating advantage.

## Methodology

This study adopted a systematic review design informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. Systematic review was chosen because the existing literature on AI in education is large, heterogeneous, and unevenly distributed across disciplines. A structured, transparent approach to searching, screening, and synthesising that literature was therefore essential to producing findings that are reproducible and credible.

### Search Strategy and Source Selection

Three databases were searched: ERIC, which specialises in education research; Scopus, which provides broad coverage of social and applied sciences; and Google Scholar, which captures a wider range of materials including conference proceedings and institutional reports. All sources were restricted to the period January 2018 to December 2024, reflecting the window during which widespread AI deployment in educational settings became practically feasible and was sufficiently studied to yield a meaningful evidence base.

Search terms were organised around four thematic clusters: AI and learning environments; personalised and adaptive instruction; algorithmic fairness and digital equity in schools; and data privacy and ethics in educational technology. An initial search returned over 2,400 results. Following duplicate removal and title-and-abstract screening, 148 studies were taken forward for full-text review. Of these, 91 met the complete inclusion criteria: empirical findings or substantive theoretical analysis, published in peer-reviewed outlets, addressing AI tools in formal or non-formal educational contexts.

### Analytical Framework

Thematic synthesis was used as the primary analytical method, given that the heterogeneity of study designs made statistical meta-analysis impractical. Each retained study was coded inductively, with codes subsequently consolidated into the three dimensions — opportunity, challenge, and future direction — that structure the findings below. Intercoder reliability was checked against a co-reviewer sample, producing an agreement coefficient of 0.84 prior to final consolidation. Where studies produced contradictory findings, those tensions are surfaced explicitly rather than smoothed over.

**Table 1**

**PRISMA-Informed Study Screening and Selection Summary**

| Screening Stage | Number of Records | Reason for Exclusion |
|---|---|---|
| Initial database search (ERIC, Scopus, Google Scholar) | 2,400+ | — |
| After duplicate removal | 1,980 | Duplicate entries removed |
| After title and abstract screening | 148 | Off-topic or non-peerreviewed |
| Full-text reviewed | 148 | — |
| Excluded after full-text review | 57 | Insufficient empirical grounding or scope mismatch |
| Final studies included | 91 | Met all inclusion criteria |

Note. Search period: January 2018 – December 2024. Inclusion criteria required peer-reviewed publication, empirical findings or substantive theoretical analysis, and direct relevance to AI in formal or non-formal educational settings.

## Opportunities: What AI Makes Possible in Education

### Personalised and Adaptive Learning at Scale

Perhaps the most enduring challenge in classroom teaching is the tension between the need to instruct a group and the reality that each student within that group has different prior knowledge, different learning preferences, and a different pace at which new material consolidates into understanding. AI-powered adaptive learning systems represent the most technically sophisticated attempt yet made to resolve that tension. Platforms such as Carnegie Learning's MATHia, Knewton Alta, and DreamBox continuously build models of each learner's current knowledge state, identify specific gaps, and dynamically adjust content, pacing, and instructional modality in response.

The evidence base for these systems, while still maturing, is encouraging. Students using well implemented adaptive platforms consistently outperform comparable peers receiving conventional whole-class instruction, and the benefits appear strongest for learners who enter with weaker foundational skills — the very students for whom undifferentiated instruction tends to be least adequate. For students with learning differences or physical disabilities, the accessibility features embedded in many AI tools — text-to-speech, adjustable reading levels, multilingual interfaces, customisable display settings — lower participation barriers that have historically excluded neurodiverse learners from mainstream progress. In this sense, adaptive AI is not simply more efficient; it can be more just.

### Relieving the Administrative Burden on Educators

Teachers in most educational systems devote a substantial share of their professional time to tasks only tangentially related to teaching: grading routine assignments, logging attendance, generating progress reports, managing scheduling. Research suggests that between a quarter and a third of a typical teacher's working week is absorbed by activities of this kind. AI-driven automation addresses this directly. Automated formative feedback tools can assess a student's written response and return targeted guidance within seconds, achieving what no human teacher can across a full class simultaneously. Intelligent scheduling and attendance systems reduce cognitive overhead without requiring professional judgment. When this time is reclaimed and redirected toward mentoring, small-group instruction, and professional collaboration, the downstream effects on both teacher wellbeing and student outcomes are meaningful.

### Early Identification of Students Who Are Struggling

Traditional mechanisms for identifying at-risk learners are reactive by nature. A pattern of absences accumulates, grades decline, and by the time an intervention is arranged the student has already fallen significantly behind. AI-driven early warning systems work on a different logic entirely: by simultaneously analysing patterns across engagement data, submission rates, assessment trajectories, and platform behaviour, these systems can surface warning signals weeks or months before traditional indicators would register a problem.

Georgia State University's GPS Advising system offers one of the most extensively documented examples. By identifying first-generation and low-income students at dropout risk with sufficient lead time for proactive adviser contact, the system contributed to measurable improvements in retention rates among precisely the populations most vulnerable to attrition. The transferability of such systems to K–12 settings requires careful contextual calibration, and the evidence base outside higher education remains thinner. But the underlying logic is sound: earlier identification creates more room for meaningful intervention.

## Challenges: Why Equitable Implementation Remains Elusive

### Algorithmic Bias and the Problem of Encoded Inequity

One of the most important and least comfortable findings in the literature on AI in education is that these systems do not simply reflect the world as it is — they can actively reproduce and, in some cases, amplify its inequities. AI systems learn from historical data, and educational data carries the accumulated imprint of decades of unequal access, differential treatment, and structural disadvantage. A model trained to predict academic success will, if trained on biased records, learn to reproduce the patterns of exclusion those records contain.

The evidence is specific and troubling. Automated proctoring software has been shown to generate substantially higher false-positive rates for students from certain racial and ethnic backgrounds, effectively subjecting them to heightened scrutiny during high-stakes assessments. Natural language processing systems used in essay scoring have been found to impose systematic penalties on linguistic features associated with African American Vernacular English and other non-dominant varieties, penalising cultural identity rather than intellectual quality. These are not theoretical edge cases — they are documented harms occurring in real educational settings, affecting real students.

Addressing bias is further complicated by the absence of any agreed definition of algorithmic fairness. Different technical definitions — equal accuracy across demographic groups, equal false-positive rates, equal predictive outcomes — are mathematically incompatible under many realistic conditions. Choosing among them requires ethical and political judgment of a kind that most educational institutions are ill-equipped to exercise, and that most technology vendors do not surface for their clients.

**Data Privacy and the Limits of Consent**

AI-enabled education runs on data — and enormous quantities of it. Every interaction a student has with a digital learning platform generates information: what they read, how long they paused on it, which problems they attempted, how many tries they needed, at what hour of the day they worked. Aggregated and analysed, this data can yield genuinely useful insights. It can also constitute a form of detailed surveillance of children that raises serious questions about privacy, power, and the appropriate scope of institutional knowledge about minors.

Existing legal frameworks provide only partial protection. FERPA in the United States and GDPR in Europe establish foundational safeguards, but their application to third-party EdTech vendors is frequently contested, inconsistently enforced, and difficult for non-specialist institutions to navigate. Many platforms operate under terms of service that neither parents nor school administrators can meaningfully evaluate. The question of whether a ten-year-old can provide informed consent to data collection — even with parental co-signature — is one that current frameworks leave largely unanswered. Research reviewed for this paper consistently finds that parental and community anxiety about data practices is a significant barrier to AI adoption, and where trust is absent, the social foundations for effective integration do not exist.

**The Infrastructure Gap and Its Consequences**

The transformative potential of AI in education is conditional on a level of digital infrastructure that remains profoundly unequal both between and within countries. High-bandwidth connectivity, functioning devices, and competent technical support are prerequisites for deploying most AI learning tools. In many of the world's schools — in rural areas, in low income communities, in less-resourced national systems — these prerequisites simply do not hold.

The COVID-19 pandemic made this inequality starkly visible. When schools closed and instruction moved online, students without reliable devices or internet access were excluded from education for extended periods, and that exclusion fell disproportionately on the students already facing the greatest educational disadvantages. Digital equity, properly understood, encompasses not only device access but connection quality, the availability of content in relevant languages, and the confidence of users in navigating digital environments. AI tools developed without meaningful attention to infrastructure reality risk deepening the achievement gaps they are marketed to close.

**The Professional Development Deficit**

Technology is only as effective as the practitioners who deploy it, and the literature is consistent on this point: inadequate teacher preparation is one of the most significant and persistent barriers to meaningful AI integration in educational settings. Many educators report feeling that AI tools have been introduced into their professional environments without adequate explanation, contextualisation, or opportunity to raise concerns. Pre-service teacher education programmes have been slow to incorporate substantive AI literacy content. In-service professional development related to AI is frequently one-off, superficial, and disconnected from the specific tools teachers are actually expected to use.

This matters because when teachers do not understand or trust the tools they are asked to use, one of two things tends to happen: they avoid the tools — undermining adoption — or they defer to them uncritically — undermining the professional judgment that effective teaching requires. Neither outcome serves learners well. AI integration that bypasses teacher agency and expertise is not just less effective; it is a form of professional disrespect that generates resistance, often justifiably.

**Table 2**

**Summary of Thematic Findings: Opportunities, Challenges, and Future Directions of AI in Education**

| Theme | Sub-Theme / Issue | Key Evidence / Implication |
|---|---|---|
| **Opportunities** | Personalised & Adaptive Learning | Platforms (e.g., MATHia, DreamBox) dynamically adjust content; benefits strongest for learners with weaker foundational skills; accessibility features support neurodiverse students. |
| | Reduced Administrative Burden | 25–33% of teacher time reclaimed from grading and scheduling; automated feedback tools enable immediate, class-wide formative assessment. |
| | Early Identification of At-Risk Learners | Georgia State GPS system improved retention among first-generation and low-income students; warning signals surfaced weeks/months before traditional indicators. |
| **Challenges** | Algorithmic Bias | Proctoring tools show higher false-positive rates for minority students; NLP essay-scoring penalises non-dominant language varieties; no agreed definition of algorithmic fairness. |
| | Data Privacy & Consent | FERPA/GDPR provide partial protection only; vendor terms of service often opaque; community distrust of data practices limits adoption. |
| | Digital Infrastructure Gap | COVID-19 exposed profound inequalities in device and connectivity access; disadvantaged students disproportionately excluded from AIenabled learning. |
| | Professional Development Deficit | PD is often one-off and disconnected from actual tools; teachers either avoid AI tools or defer to them uncritically — both outcomes harm learners. |
| **Future Directions** | Governance Frameworks | Procurement standards requiring algorithmic transparency; enforcement mechanisms with clear liability; UNESCO and EU AI Act need education-specific elaboration. |
| | Inclusive Design | Marginalised learners must be centred from inception; participatory design methods from disability advocacy offer practical models. |
| | Interdisciplinary Collaboration | Technologists, educators, ethicists, and policymakers must collaborate; teachers and students as co-designers, not passive recipients. |

## Future Directions

Building Governance Frameworks with Real Teeth

The most pressing systemic need in AI-enabled education is not more sophisticated technology — it is more rigorous governance. As things stand, the pace of AI development and deployment far outstrips the capacity of regulatory and institutional frameworks to keep up. Closing that gap requires action at multiple levels. At the institutional level, schools and universities need procurement standards that require vendors to demonstrate algorithmic transparency, provide equity auditing data disaggregated by demographic subgroup, and document data governance practices clearly. At the policy level, governments need frameworks with genuine enforcement capacity and clear lines of liability when AI systems cause educational harm. International initiatives such as the UNESCO Recommendation on the Ethics of AI and the EU Artificial Intelligence Act provide useful starting points, but their application to education requires considerably more specificity than either currently offers.

Inclusive Design as a Non-Negotiable Principle

Inclusive design must be embedded from the earliest stages of development, not grafted on once a product is ready for market. AI tools built primarily by and for advantaged populations consistently fall short when extended to other groups, and the adaptations made after the fact are rarely adequate. What is needed is a design culture that places marginalised learners — students from low-income communities, students with disabilities, English language learners, indigenous students — at the centre of the process from inception. Participatory design methodologies, drawing on traditions in disability advocacy and community-based research, offer practical frameworks for achieving this. These approaches also tend to produce better products, because designing for diverse constraints surfaces problems that homogeneous teams miss.

Sustained Interdisciplinary Collaboration

No single discipline has the tools to resolve the challenges AI poses in education. Technologists need educational researchers to understand how learning actually works and how it is best assessed. Educational researchers need technologists to engage critically with AI design. Ethicists and legal scholars need to collaborate with policymakers to build frameworks that remain relevant as technology evolves. And educators and students need to be positioned as co-designers and critical evaluators, not passive recipients. Sustained interdisciplinary collaboration of this kind does not happen spontaneously; it requires dedicated funding, structural incentives, and institutional commitment to work that does not fit neatly within existing disciplinary boundaries.

Expanding the Evidence Base Geographically and Demographically

The current literature has a significant blind spot: the overwhelming majority of empirical studies have been conducted in high-income, English-speaking countries. Low- and middle income country contexts, multilingual educational environments, and indigenous learning systems remain dramatically underrepresented, despite being the settings where the stakes of getting AI integration wrong are arguably highest. Future research must be deliberately expansive — longitudinal in design, geographically diverse, and attentive not just to whether AI tools work on aggregate, but for whom they work, at what cost, and with what unintended consequences. Without this, the field risks scaling conclusions drawn from unusually privileged classrooms across contexts where they do not apply.

## Discussion

The evidence synthesised in this review tells a story that resists simple characterisation. AI in education is neither the transformative equaliser its most enthusiastic advocates describe, nor the surveillance apparatus its most anxious critics fear. It is a set of genuinely powerful tools whose impact is determined almost entirely by the quality of the human decisions, institutional structures, and governance frameworks that surround their deployment.

The students most likely to benefit from well-implemented AI tools are, paradoxically, not always those most likely to have access to them. Adaptive platforms achieve their most pronounced effects with learners who have weaker foundational skills, yet under-resourced schools — where such learners are concentrated — are also least likely to have the infrastructure, the trained staff, and the vendor relationships necessary to deploy these platforms effectively. This is not a coincidence; it reflects the broader pattern by which educational innovations tend to diffuse first to the already-advantaged, widening gaps before they narrow them. Disrupting that pattern requires deliberate policy intervention, not optimism about the market.

The role of the teacher throughout this picture is irreplaceable. Not as a content deliverer who can eventually be replaced by a more efficient machine, but as a relational, contextually aware professional whose judgment, empathy, and adaptability are precisely what AI cannot simulate. The research is consistent: AI integration achieves its strongest outcomes when teachers are positioned as empowered co-designers of AI-assisted learning environments, not as passive conduits for externally imposed tools. Systems and institutions that honour this principle produce better outcomes and generate fewer of the harms that arise when technology is deployed without adequate human oversight.

## Conclusion

This systematic review has traced what the evidence says about AI in education across three interconnected dimensions. The opportunities are real: personalised instruction, reduced administrative burden, and early identification of struggling learners are documented and meaningful gains. The challenges are equally real: algorithmic bias, data privacy vulnerabilities, infrastructure inequality, and professional development deficits are not marginal problems to be footnoted but central obstacles that must be addressed directly. And the path forward, while demanding, is navigable — if the field is willing to invest seriously in governance, inclusive design, interdisciplinary collaboration, and an expanded evidence base.

The goal, in the end, is not AI for its own sake. It is education that is more responsive, more equitable, and more genuinely human. The technology is a means to that end, not the end itself. Whether it serves that purpose will depend on choices made by policymakers, researchers, designers, school leaders, teachers, and the communities they serve. Those choices are not predetermined by the technology. They are ours to make, and the making of them well is the real challenge that AI in education presents.

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# IMPACT OF AI EDUCATIONAL TOOLS ON ADOLESCENTS' LEARNING ENGAGEMENT AND EMOTIONAL WELL-BEING

**Dr. Sahifa Sultana [1], Ms. Naheed Shams [2]**

**Abstract**

Artificial Intelligence (AI) has gained significant importance in the present technological era. The younger generation, particularly Generation Z, is increasingly exposed to and dependent on AI-driven tools in various aspects of their lives, including education. Adolescents frequently rely on AI-based platforms not only for academic assistance but also for addressing general queries related to curiosity and health, often consulting these tools before seeking expert opinions. Although Artificial Intelligence serves as a powerful educational resource, its excessive and unregulated use might lead to several challenges. Therefore, AI in education is often perceived as both a boon and a potential concern when not used in a balanced and responsible manner. In this context, parental monitoring plays a crucial role in regulating children's exposure to AI-based educational technologies.

The present study aims to examine the influence of AI-based educational tools on adolescents' learning engagement and emotional well-being from the perspective of parents. The research focused on parents' observations regarding their children's use of AI in academic learning, its role in enhancing learning engagement, and its potential psychological impact. The study adopted a mixed-method approach, incorporating both close-ended and open-ended questions to collect quantitative and qualitative data. Data was collected from 100 parents of students studying in Grades VII, VIII, IX, and X using the snowball sampling technique. The findings of the study revealed that AI-based tools improved learning engagement, understanding, and curiosity among adolescents. At the same time, it also raised concerns about overdependence and reduced independent thinking. The study suggests the need for balanced and guided use of AI through parental monitoring, ethical awareness, and its role as a supportive tool in education.

***Keywords:*** *Artificial Intelligence, AI-based Educational Tools, Adolescents, Learning Engagement, Mental Well-being, Parental Perception, Technology in Education*

**Introduction**

From the perspective of Generation X to Generation Z, there has been a significant transition in their foundational learning experiences, ranging from schooling to higher education. The rapid integration of artificial intelligence (AI)–based educational tools has brought a new phase of transformation in the secondary education system. Adolescence itself is a transitional stage of development in which individuals experience rapid psychological, emotional, and behavioral changes, and their learning preferences and habits evolve significantly.

Parents, teachers, and peer groups form a triad that directly influences the behavioral development of an adolescent child. The growing academic competition in modern educational environments has increased expectations from both parents and teachers. These expectations often place pressure on adolescents, which can elevate stress levels and influence their mental health and overall well-being.

At the same time, advancements in AI-driven technologies have introduced innovative opportunities for students to access educational resources more efficiently. Research suggests that AI-supported educational tools and digital learning environments can enhance students' engagement with learning activities by

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providing personalized feedback, interactive learning experiences, and easy access to information (Rahman & Alam, 2025). These technologies enable students to complete academic tasks within a shorter time frame and can reduce academic stress and workload when used appropriately.

Similarly, studies on AI-driven digital interventions indicate that artificial intelligence can be used to analyze patterns of adolescent engagement and optimize digital learning environments. AI-supported systems can measure, model, and improve students' participation in educational and behavioral interventions, thereby promoting more effective learning experiences (Journal of Medical Internet Research, 2023).

Furthermore, research has shown that AI-based educational environments can positively influence adolescents' social adaptability and academic emotions. Factors such as peer interaction, interpersonal relationships, and academic engagement play an important role in shaping adolescents' adaptability within AI-supported learning contexts (Frontiers in Psychology, 2024). Despite these advantages, excessive dependence on AI-based educational tools may also raise concerns regarding adolescents' behavioral patterns and independent learning abilities. Therefore, parental awareness and guidance play a crucial role in ensuring balanced technology use. This paper examines parental awareness regarding AI-integrated educational tools and emphasizes that parental supervision over excessive usage should be carefully monitored. Such monitoring can help prevent behavioural concerns such as restlessness, impatience, frustration, anger, and reduced concentration, which may arise due to overreliance on AI technologies. Ensuring balanced usage can help adolescents benefit from technological advancements without suppressing their innate abilities and independent learning skills.

## Background of the Study

The present study aims to examine both the positive and negative aspects of the use of AI-based educational tools among adolescents, as well as the level of parental awareness regarding their children's engagement with such technologies. It seeks to understand how the balanced use of AI-driven educational tools can support students' learning without weakening their individual thinking and learning abilities. At the same time, the study attempts to explore how excessive use of AI technology may trigger behavioral and emotional challenges among adolescents, such as restlessness, impatience, reduced concentration, frustration, and anger. By addressing these factors, the study intends to highlight the important role of parents and teachers in guiding adolescents toward responsible and balanced use of AI. Parents, who form the foundation of a child's development, along with teachers, who act as guiding lights in their educational journey, have the potential to nurture young minds effectively. Their guidance can ensure that technology becomes a supportive tool for learning rather than allowing adolescents to become overly dependent on artificial intelligence.

## Objective of the Study

1. To examine parents' observations regarding how AI-driven educational technologies influence their adolescents' learning engagement.
2. To understand the level of parental awareness about AI-based educational tools and their use in their children's academic activities.
3. To explore the emotional health and overall well-being of adolescents in relation to the use of AI-based educational technologies.
4. To identify how parents' observations and guidance may influence their children's learning habits and emotional well-being.

## Research Methodology

## Population and Sample

The population of the present study consisted of the parents of students studying in class VII to X under Telangana State board. The sample included the parents of the students studying in three schools of Hyderabad namely Priyadarshini High School, Maple – The School, and MS Creative School.

**Sampling Technique**

For the present study, the snowball sampling technique was employed for data collection. The self-constructed questionnaire was first shared with school authorities via mail and then they were asked to rolled down to the parental WhatsApp group.

**Research Tools Used**

For the present study, a structured questionnaire was developed by the researcher to examine key parameters related to the impact of AI-based educational tools on adolescents' learning engagement and emotional well-being. The questionnaire was designed to gather parents' observations regarding the usage of AI-driven educational technologies by their children studying in Classes VII, VIII, IX and X respectively. Data were collected from parents through an online survey administered via Google Forms. The research tool was carefully reviewed and refined based on suggestions provided by subject expert in the field. Necessary modifications were incorporated to improve the clarity, relevance, and validity of the items before the final administration of the tool.

The reliability of the instrument was determined using the Spearman–Brown Prophecy Method, and the reliability coefficient was found to be 0.89, indicating that the instrument possessed an acceptable level of consistency for the purpose of the study.

**Types of Questions**

The questionnaire consisted of both positively worded and negatively worded items in order to obtain balanced responses and reduce biased response.

**i. Close-Ended Questions**

Multiple-based questions were included to provide respondents with Likert scale options. This format enabled participants to select the most appropriate response based on their observations. It also facilitated the quantification of responses and helped in identifying patterns and trends in parental perceptions.

**ii. Open-Ended Questions**

In addition to the structured items, a few open-ended questions were included to allow parents to share their opinions, experiences, and suggestions regarding the use of AI-based educational tools by adolescents. These responses provided deeper insights into parental concerns about excessive AI usage and highlighted the importance of parental guidance in ensuring that technological support does not overshadow the development of adolescents' natural abilities and independent learning skills.

**Delimitations of the Study: -**

1. The present study was confined to the English medium schools of Hyderabad only.
2. This study focused to the parents of class $8^{th}$ to $10^{th}$ only.

**Statistical Techniques Used for Data Analysis**

For the present study, the researcher employed descriptive analysis to interpret the collected data. Descriptive statistical techniques such as percentage were used to analyze the data in order to understand the characteristics and distribution of the sample.

**Result**

Table 1: Summary of Impact of AI-Based Educational Tools on the Adolescents' Learning Engagement and Emotional Well-being

| Statement | Agree% | Neutral% | Disagree% |
|---|---|---|---|
| My child uses AI tools for school work | 48 | 36 | 16 |
| My child uses AI to grasp difficult concepts | 37 | 35 | 28 |
| My child uses AI to finish assignments on time | 49 | 27 | 24 |
| Problem-solving is easier with AI tools | 37 | 35 | 28 |
| AI aids in learning challenging vocabulary | 41 | 37 | 22 |
| AI promotes curiosity beyond lessons | 40 | 37 | 23 |
| Curiosity increases with digital learning tools | 45 | 32 | 23 |
| AI is important for future education | 51 | 27 | 22 |
| Parents should supervise AI use in children | 56 | 26 | 18 |
| AI should support teachers, not replace them | 54 | 25 | 21 |
| Awareness programs on ethical AI use are needed | 53 | 26 | 21 |
| Parents should monitor children's AI use | 52 | 30 | 18 |
| AI tools reduce academic stress | 36 | 39 | 25 |
| AI tools increase confidence in studies | 39 | 36 | 25 |
| Overuse of AI limits independent thinking | 45 | 35 | 20 |
| Too much AI use raises future anxiety | 43 | 31 | 26 |
| AI reduces workload but may reduce effort | 46 | 38 | 16 |
| Balanced AI use supports mental well-being | 54 | 29 | 17 |
| Child becomes restless without AI tools | 32 | 29 | 39 |
| Child shows frustration due to AI dependence | 35 | 29 | 36 |

The data collected from parents reflects their perception regarding the impact of AI-based educational tools on adolescents' learning engagement and emotional well-being. In spite of low literacy rates the parents were able to interpret the findings reveal varying levels of agreement, neutrality, and concern across different dimensions such as academic engagement, conceptual understanding, emotional influence, and responsible use.

Regarding the usage of AI-based educational tools, 48% of parents agreed that their children frequently use these tools for completing school projects, while 36% remained neutral and 16% disagreed, indicating moderate but not universal adoption. Furthermore, 37% of parents agreed that their children depend on AI tools to understand difficult academic concepts, highlighting a noticeable reliance on technology for conceptual clarity.

In terms of academic performance, 49% of respondents agreed that AI tools help children's complete assignments before deadlines, whereas 24% disagreed, suggesting mixed perceptions about time management effectiveness. Similarly, 37% of parents agreed that AI tools enhance problem-solving skills, while an equal proportion 35% remained neutral, reflecting moderate confidence in their academic utility.

With respect to language and exploration, 41% agreed that AI tools support vocabulary development, and 40% agreed that they motivate children to explore beyond the curriculum. Additionally, 45% of parents agreed that digital tools increase curiosity, indicating a positive influence on learning engagement.

A significant proportion of respondents acknowledged the future relevance of AI, with 51% agreeing that AI will play an important role in education. Likewise, 54% agreed that AI should support teachers rather than replace them, demonstrating a preference for a balanced integration of technology and human instruction.

Parental responsibility emerged as a key theme, with 56% agreeing that parents should guide children in responsible AI usage, and 52% supporting parental monitoring. Additionally, 53% emphasized the need for awareness programs, indicating strong recognition of ethical and guided use.

In terms of emotional well-being, 36% of parents agreed that AI tools reduce academic stress, while 39% remained neutral, suggesting mixed perceptions. Similarly, 39% agreed that AI tools enhance confidence in studies.

However, concerns about excessive usage were evident 45% of parents agreed that overuse may reduce independent problem-solving skills, while 43% believed it may increase anxiety about future prospects. Additionally, 46% felt that excessive reliance may reduce students' motivation to exert effort, although a considerable proportion remained neutral.

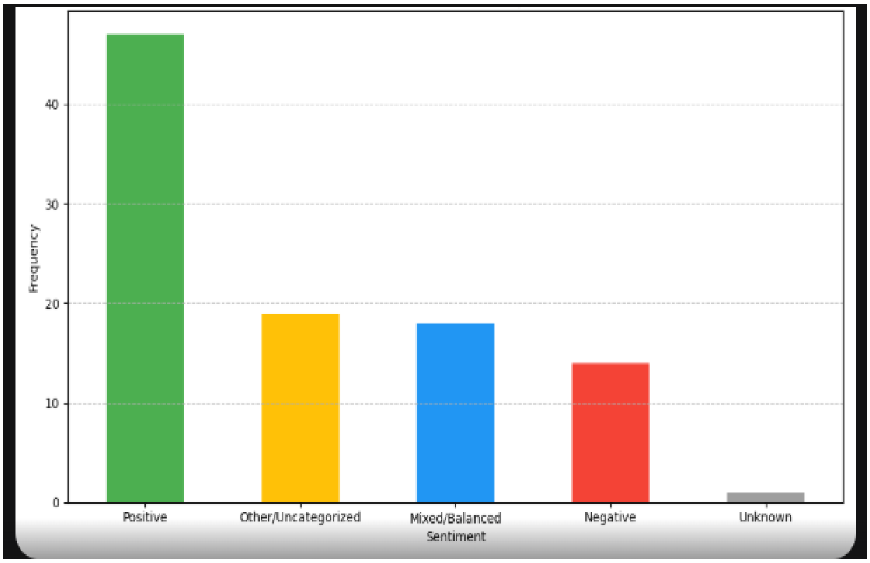
Positive perceptions were also observed regarding balanced usage, with 54% agreeing that controlled use of AI tools supports mental well-being.

Behavioural concerns were relatively lower, as only 32% agreed that children become restless without AI tools, while a higher proportion 39% disagreed. Similarly, 35% of parents expressed concern about frustration or anger due to dependency, whereas 36% disagreed, indicating that such effects are present but not widespread.

Overall, the findings indicate that AI-based educational tools are widely perceived as beneficial for enhancing learning engagement, curiosity, and conceptual understanding. However, concerns regarding overdependence, reduced independent thinking, and emotional implications highlight the need for balanced, guided, and ethical use of these technologies.

**Open- Ended Questions (Challenges and Suggestions)**

i. **According to your observation as a parent, how do AI-based educational tools affect your child's learning habits and emotional well-being?**




**Parents' Views on AI's Impact on Learning and Well-being**

The qualitative responses from parents reveal a balanced perspective, closely supporting the quantitative findings. While many parents acknowledged the academic benefits of AI tools, several concerns regarding dependency, motivation, and emotional well-being were also highlighted.

A significant number of parents reported that AI tools help improve conceptual understanding and academic performance, which aligns with the quantitative findings where 37%–49% of respondents agreed that AI tools support understanding and timely completion of assignments.

However, consistent with the quantitative result where 45% of parents agreed that excessive use reduces independent problem-solving skills, many respondents expressed concern about overdependence on AI tools. Parents noted that children tend to rely heavily on AI platforms rather than thinking independently, which may hinder the development of critical thinking skills.

Another frequently mentioned issue was reduced motivation and effort. This supports the finding where 46% of parents agreed that excessive use of AI tools may reduce students' willingness to put in their own effort. Parents observed that children often prefer quicker AI-assisted solutions instead of engaging deeply with learning tasks.

Emotional and behavioural concerns were also reported. Although only 32%–35% of parents quantitatively agreed regarding restlessness and frustration, qualitative responses revealed that some children become impatient, anxious, or frustrated when they are unable to access AI tools. This indicates that while not universal, emotional dependency is emerging in certain cases.

Additionally, parents highlighted the challenge of lack of supervision and awareness, which corresponds with the strong agreement 52%–56% on the need for parental monitoring and guidance. Many parents admitted difficulty in regulating their children's use of AI due to limited knowledge of these technologies.

Concerns regarding ethical misuse were also raised. Parents reported that children may use AI tools to complete assignments without genuine understanding, reflecting issues of academic integrity and responsible usage.

Overall, the qualitative findings reinforce that AI-based educational tools provide substantial academic benefits, but also introduce challenges related to dependency, reduced effort, emotional effects, and ethical concerns, emphasizing the need for guided and balanced usage.

**ii. Kindly suggest any preventive measures or guidelines that could help maintain a healthy and balanced use of AI in education.**

Parents' Suggestions for Balanced Use of AI in Education

The suggestions provided by parents strongly emphasize the importance of structured guidance, balanced usage, and ethical awareness, aligning with the quantitative findings.

A majority of parents recommended active parental involvement, which is consistent with the finding that over 50% of respondents supported parental guidance and monitoring. Parents stressed the need to supervise children's usage, set clear rules, and limit screen time to prevent overdependence.

Another key suggestion was maintaining a balanced approach to learning. Parents emphasized that AI tools should be used as supportive aids rather than substitutes, which aligns with the finding where 54% agreed that AI should support teachers rather than replace them. They recommended combining AI-assisted learning with traditional study methods to ensure holistic development.

Parents also highlighted the importance of awareness programs and digital literacy, supporting the quantitative result where 53% emphasized the need for ethical awareness programs. Such initiatives can help both parents and students understand responsible usage, avoid misuse, and promote ethical learning practices.

Furthermore, respondents suggested that schools and teachers should play a proactive role by integrating AI tools in a structured and supervised manner. This reflects the broader perception that effective use of AI requires institutional support along with parental guidance.

Overall, the qualitative suggestions highlight that maximizing the benefits of AI-based educational tools requires a collaborative effort involving parents, educators, and students, along with a strong focus on balanced usage, ethical awareness, and guided implementation.

**Interpretation and Discussion**

The present study aligns with Brannon et al. (2023) in recognizing the role of AI in enhancing adolescent engagement, but differs by focusing on academic learning and parents' perceptions rather than behavioural health interventions.

Similarly, Zhang et al. (2024) found a positive relationship between AI use, engagement, and mental health through mediating variables, whereas the present study highlights direct parental concerns such as overdependence, reduced thinking, and emotional issues.

The findings are consistent with Li et al. (2023), who reported positive effects of AI on adolescents' social adaptability. However, the present study is broader, covering learning engagement, emotional well-being, and parental viewpoints.

Likewise, Tanaka et al. (2022) demonstrated improvements in psychological health through AI-based interventions, supporting the present study, though their focus was on experimental family education systems, unlike the current emphasis on everyday educational use and parental monitoring.

The study by Rahman and Alam (2025) supports that AI improves academic performance through engagement and mental health. However, their research involves university students and social media, whereas the present study focuses on adolescents and AI tools alone.

Similarly, Simos et al. (2026) focused on AI in managing school anxiety, whereas the present study takes a broader view of overall emotional well-being and learning engagement.

Finally, Shahzada et al. (2025) confirmed positive effects of AI on performance and well-being, but the present study uniquely highlights both benefits and risks, especially overdependence and reduced independent thinking.

**Conclusion**

The present study provides a detailed analysis of parents' perceptions regarding the impact of AI-based educational tools on adolescents' learning engagement and emotional well-being. The findings clearly indicate that parents recognize the positive potential of AI tools in enhancing conceptual understanding, academic efficiency, curiosity, and confidence among students. At the same time, the study highlights important concerns related to overdependence, reduced independent thinking, decreased motivation, and potential emotional challenges such as anxiety and frustration. These concerns emphasize that while AI tools offer substantial benefits, their excessive and unguided use may negatively influence students' cognitive and emotional development. The results also strongly emphasize the importance of parental guidance, monitoring, and awareness, along with the need for ethical usage practices. Parents consistently expressed that AI should function as a supportive educational tool rather than a replacement for teachers, reinforcing the importance of a balance between technology and human interaction in education that can positively contribute to adolescents' well-being. In conclusion, AI-based educational tools along with parental supervision, ethical awareness, and traditional teaching methods will help in holistic development in adolescents.

**Education Implications**

The findings of the survey conducted through Google Forms provide valuable insights into the influence of Artificial Intelligence (AI) tools on adolescents' learning engagement and emotional well-being.

*1. Using AI tools in teaching and learning*

The findings indicate that AI-driven tools can augment students' involvement in the learning process. Schools and teachers can use AI platforms, intelligent tutoring systems, and digital learning resources together to make lessons more fun and tailored to each student.

*2. Improving Digital Literacy*

The study emphasizes that school should teach adolescents how to use AI tools safely, how to think critically about information, and how to become more tech-savvy.

*3. What teachers do as facilitators*

Teachers should change from being people who give out information to people who help students learn.

*4. Keeping an eye on emotional health*

The survey shows that teens' emotional health may be affected by too much reliance on digital technologies. Schools should offer counseling and awareness programs to help students use technology in a balanced way and improve their mental health.

*5. Working together between parents and schools*

Parents play a key role when it's about keeping an eye on their teens on how AI tools are used at home. Schools should create awareness among parents about pros and cons of AI-based learning as their huge generation gap between parents and adolescents'.

*6. Making policies and plans for the curriculum*

The results can help policymakers and curriculum designers can integrate AI education, digital ethics, and responsible technology use to school programs to get kids ready for the future.

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# EXPLORING TEACHERS' EXPERIENCES AND PERCEPTIONS OF ARTIFICIAL INTELLIGENCE INTEGRATION IN EDUCATION

**Ms. Sana Fatima [1]**

**Abstract**

The rapid advancement of digital technologies has significantly transformed educational practices worldwide. Among these developments, Artificial Intelligence has emerged as a powerful tool capable of enhancing teaching effectiveness and learning experiences. The integration of AI technologies in education has the potential to assist teachers in lesson planning, assessment, personalized instruction, and administrative tasks. However, the successful adoption of AI depends largely on teachers' perceptions, experiences, and readiness to integrate these technologies into their pedagogical practices. The present qualitative study explores teachers' experiences and perceptions regarding AI integration in teaching. The study has been conducted among teachers in Hyderabad District to understand how AI technologies support teaching practices, what challenges teachers encounter, and how AI influences classroom dynamics. Data is collected through semi-structured interviews with 20 teachers from different schools. Thematic analysis is used to analyze the interview data.

The findings revealed that teachers perceive AI as a supportive tool that enhances instructional efficiency, enables personalized learning, and reduces administrative workload. At the same time, participants expressed concerns about lack of training, technological infrastructure, and ethical considerations related to AI usage. The study highlights the need for professional development programs and institutional support to facilitate effective AI integration in educational settings. The findings provide valuable insights for educators, policymakers, and educational institutions seeking to implement AI technologies in teaching.

***Keywords:*** *Artificial Intelligence, Teacher Perceptions, AI Integration, Teaching Practices, Qualitative Research, Educational Technology.*

**Introduction:**

The integration of digital technologies in education has significantly transformed the way teaching and learning take place in modern classrooms. These advancements have opened new opportunities for improving instructional strategies, increasing student engagement, and delivering more personalized learning experiences (Selwyn, 2019). Among these innovations, Artificial Intelligence (AI) has emerged as one of the most impactful developments, offering new ways to support both teachers and learners in the educational process.

Artificial Intelligence refers to computer systems designed to perform tasks that typically require human intelligence, such as problem-solving, pattern recognition, and decision-making (Russell & Norvig, 2021). In education, AI is applied through various tools and systems, including intelligent tutoring systems, automated grading software, adaptive learning platforms, and learning analytics tools that track and analyze student performance (Luckin et al., 2016; Zawacki-Richter et al., 2019). These technologies enable more responsive and data-driven approaches to teaching and learning.

AI has the potential to reshape traditional teaching practices by supporting teachers in lesson planning, monitoring student progress, and providing personalized feedback. By automating routine and time-consuming tasks, AI allows educators to focus more on meaningful interactions with students and on

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facilitating deeper learning experiences (Holmes et al., 2019). Consequently, the use of AI in education can enhance teaching effectiveness and contribute to improved student outcomes.

However, the successful integration of AI in classrooms depends largely on teachers' readiness and willingness to adopt these technologies. Teachers are key agents of change in education, and their perceptions, beliefs, and experiences strongly influence how effectively new technologies are implemented (Ertmer & Ottenbreit-Leftwich, 2010). Positive attitudes toward AI can encourage its use, while concerns related to data privacy, ethical issues, and lack of confidence may hinder adoption (Zawacki-Richter et al., 2019).

In many developing educational contexts, including India, the adoption of AI in education is still at an emerging stage. Teachers often encounter challenges such as limited access to digital infrastructure, insufficient training, and a lack of technical support (König et al., 2020). These barriers can restrict the effective use of AI tools in classrooms and highlight the need for targeted professional development and policy support. Therefore, understanding teachers' experiences and perceptions is essential for ensuring meaningful and sustainable AI integration.

The present study aims to explore how teachers perceive AI technologies, how these tools influence their teaching practices, and the challenges they face while integrating AI into their classrooms. By examining these aspects, the study seeks to provide insights that can support educators, policymakers, and institutions in developing effective strategies for integrating AI in education.

**Significance of the Study:**

This study is significant as it provides timely insights into how teachers experience and perceive the integration of Artificial Intelligence (AI) in educational settings, a rapidly evolving area with profound implications for teaching and learning. By examining educators' attitudes, challenges, and readiness, the research helps identify gaps in training, infrastructure, and policy support necessary for effective AI adoption. It also highlights practical opportunities where AI can enhance instructional practices, personalize learning, and reduce administrative burdens. The findings are valuable for policymakers, institutions, and edtech developers in designing teacher-centered AI frameworks, ensuring that technological innovation aligns with pedagogical needs and ethical considerations. Ultimately, the study contributes to shaping a more informed, inclusive, and sustainable approach to AI integration in education.

**Objectives of the Study:**

1. To explore teachers' experiences in using AI technologies in teaching.
2. To examine teachers' perceptions regarding the benefits of AI integration in classrooms.
3. To identify challenges faced by teachers in adopting AI-based educational tools.

**Research Design:**

The present study adopts a qualitative research approach to explore teachers' experiences and perceptions regarding the integration of Artificial Intelligence (AI) in educational practices. Specifically, a phenomenological research design was employed, as it is most appropriate for understanding the lived experiences of individuals and capturing the meanings they attach to a particular phenomenon. In this context, the study seeks to examine how teachers experience the use of AI tools in their teaching practices and how they interpret its impact on classroom processes.

**Participants:**

The participants of the study consisted of twenty teachers working in both government and private schools in Hyderabad District, Telangana. A purposive sampling technique was used to select participants who had prior exposure to or experience with AI-based educational tools. This sampling method ensured that the selected participants could provide rich, relevant, and meaningful insights into the research problem. The sample included teachers from diverse subject areas and varying levels of teaching experience, thereby allowing for a broader understanding of the phenomenon.

**Data Collection:**

Data collection was carried out through semi-structured interviews, which provided flexibility for participants to express their views while ensuring that key areas related to the research objectives were covered. Each interview lasted approximately 30 to 40 minutes and was conducted in a conducive environment to facilitate open and honest responses. The interview schedule included questions related to teachers' experiences with AI tools, perceived benefits in teaching and learning, challenges faced during implementation, and their overall attitudes toward AI integration. All interviews were conducted with prior consent from participants and were recorded and transcribed for analysis.

The collected data were analyzed using the thematic analysis framework proposed by Braun and Clarke (2006). This method involves a systematic process of identifying, analyzing, and interpreting patterns (themes) within qualitative data. The analysis followed six key steps: familiarization with the data through repeated reading of transcripts, generation of initial codes, searching for potential themes, reviewing and refining themes, defining and naming themes, and finally producing the report. This rigorous process ensured that the findings accurately represented participants' perspectives.

To ensure the trustworthiness and credibility of the study, several strategies were employed. Credibility was maintained through prolonged engagement with the data and careful interpretation of participants' responses. Member checking was also used, wherein selected participants were asked to verify the accuracy of the interpretations. Dependability was ensured by maintaining a clear audit trail of the research process, including data collection and analysis procedures. Confirmability was achieved by minimizing researcher bias and ensuring that the findings were grounded in the data. Transferability was addressed by providing detailed descriptions of the research context and participants, enabling readers to determine the applicability of the findings to other settings.

Ethical considerations were strictly followed throughout the research process. Informed consent was obtained from all participants prior to data collection. Participants were assured of confidentiality and anonymity, and their identities were not disclosed in any part of the study. Additionally, participation was voluntary, and participants had the right to withdraw from the study at any stage without any consequences.

**Data Analysis:**

The qualitative data collected from participants were analyzed using the Braun and Clarke thematic analysis framework. Through a systematic process of coding, categorization, and theme development, four major themes emerged:

(1) AI as a Supportive Teaching Tool

(2) Enhanced Student Engagement

(3) Personalized Learning Opportunities, and

(4) Challenges in AI Integration.

These themes collectively capture teachers' perceptions, experiences, and concerns regarding the integration of artificial intelligence (AI) in educational practices.

**Findings:**

The thematic analysis revealed four major themes related to AI integration in teaching.

**Theme 1: AI as a Supportive Teaching Tool**

The findings indicate that AI is widely perceived as a supportive tool that enhances teaching efficiency and reduces workload. Participants emphasized that AI technologies assist in multiple aspects of instructional planning and delivery.

One of the key contributions of AI is in lesson planning assistance. Teachers reported that AI tools help in organizing lesson structures, generating relevant content, and aligning teaching materials with curriculum objectives. This reduces preparation time and allows educators to focus more on pedagogical strategies.

Additionally, instructional material development emerged as a significant subtheme. AI enables the rapid creation of diverse teaching resources, including presentations, quizzes, and assignments. Participants noted that such tools not only save time but also improve the quality and creativity of instructional materials.

Another important aspect is assessment support, where AI-driven systems facilitate automated grading and performance tracking. Teachers highlighted the usefulness of real-time feedback and analytics in monitoring student progress and identifying areas that require improvement.

Furthermore, workload reduction was consistently reported as a major benefit. By automating repetitive administrative tasks, AI allows teachers to allocate more time to meaningful student interactions. These findings suggest that AI serves as an enabler that augments teachers' capabilities rather than replacing their role.

**Theme 2: Enhanced Student Engagement**

The second theme focuses on the impact of AI technologies on student engagement and participation. Participants observed a noticeable improvement in students' involvement when AI tools were incorporated into classroom activities.

The subtheme of interactive learning tools highlights the use of AI-powered platforms that integrate multimedia elements, simulations, and gamified learning experiences. Such tools make lessons more dynamic and cater to different learning preferences.

Teachers also reported increased participation among students. AI-based systems often provide immediate feedback and interactive features, encouraging students to actively engage with the learning process. This shift from passive to active learning was viewed as a significant advantage.

Moreover, the subtheme of motivation and interest reflects how AI enhances students' enthusiasm for learning. The incorporation of innovative technologies captures students' attention and sustains their interest, leading to improved classroom dynamics.

Overall, this theme demonstrates that AI has the potential to transform traditional teaching methods into more engaging and student-centered approaches.

**Theme 3: Personalized Learning Opportunities**

The third theme underscores the role of AI in facilitating personalized and adaptive learning experiences. Participants highlighted that AI technologies enable a more individualized approach to teaching.

The adaptive learning systems subtheme illustrates how AI adjusts instructional content based on students' performance levels. This ensures that learners receive appropriate challenges and support, promoting better understanding and retention.

Another critical aspect is the identification of learning needs. AI tools provide detailed insights into students' strengths and weaknesses through data analytics. Teachers reported that such information helps them make informed instructional decisions.

The subtheme of customized instruction further emphasizes how educators use AI-generated insights to tailor their teaching strategies. By addressing individual learning gaps, teachers can provide targeted interventions and support diverse learning needs.

These findings highlight the transformative potential of AI in promoting inclusive education by accommodating individual differences and enhancing learning outcomes.

**Theme 4: Challenges in AI Integration**

Despite the numerous benefits, the study also identified several challenges that hinder the effective integration of AI in education.

The most prominent issue is the lack of training. Participants expressed concerns about their limited knowledge and skills in using AI tools effectively. This indicates a need for comprehensive professional development programs.

The subtheme of technological infrastructure issues reflects constraints such as inadequate access to digital devices, poor internet connectivity, and limited institutional resources. These challenges are particularly significant in resource-constrained environments.

Additionally, insufficient technical support was identified as a barrier to successful AI implementation. Teachers reported difficulties in resolving technical issues due to the absence of dedicated support systems, which can disrupt the teaching process. This theme highlights that while AI offers significant advantages, its successful adoption depends on addressing these systemic and institutional barriers.

Table:1 Summary of the Findings from the Interviews which explored teachers' perceptions, experiences, and concerns regarding the integration of artificial intelligence (AI) in education.

| Theme | Subtheme | Description |
|---|---|---|
| **AI as a Supportive Teaching Tool** | Lesson Planning Assistance | AI helps in organizing and structuring lesson plans |
| | Instructional Material Development | Supports creation of teaching materials |
| | Assessment Support | Assists in evaluating student performance |
| | Workload Reduction | Reduces administrative and teaching workload |
| **Enhanced Student Engagement** | Interactive Learning Tools | Provides engaging and interactive platforms |
| | Increased Participation | Encourages active student involvement |
| | Motivation and Interest | Makes learning more interesting |
| **Personalized Learning Opportunities** | Adaptive Learning Systems | Adjusts learning content based on student needs |
| | Identification of Learning Needs | Identifies strengths and weaknesses |
| | Customized Instruction | Enables tailored teaching strategies |
| **Challenges in AI Integration** | Lack of Training | Teachers lack proper AI training |
| | Technological Infrastructure Issues | Limited access to necessary technology |
| | Insufficient Technical Support | Lack of technical assistance |

Note: Thematic Analysis on teachers' perceptions, experiences, and concerns regarding the integration of artificial intelligence (AI) in education.

**Discussion:**

The findings of this study reveal that AI integration in teaching presents both opportunities and challenges. On one hand, AI enhances teaching efficiency, improves student engagement, and enables personalized learning experiences. On the other hand, issues related to training, infrastructure, and technical support limit its effective implementation.

The results suggest that AI should be viewed as a complementary tool that supports teachers rather than replacing them. Effective integration requires a balanced approach that combines technological innovation with adequate training and institutional support.

However, the study also highlights the importance of addressing challenges related to AI integration. Teachers require adequate training and professional development opportunities to develop the skills necessary for using AI technologies effectively.

Institutional support is equally important for successful technology adoption. Schools and educational institutions must provide appropriate infrastructure, technical support, and policy guidelines to facilitate AI integration in classrooms.

**Educational Implications:**

- Teacher education programs should incorporate training related to AI literacy and digital pedagogy.
- Professional development workshops can help teachers develop the necessary skills to effectively integrate AI technologies in teaching.
- Educational institutions should invest in technological infrastructure, including reliable internet connectivity and digital learning platforms. Institutional policies should also address ethical considerations related to AI use, including data privacy and responsible technology use.
- By providing adequate support and resources, educational systems can promote the effective integration of AI technologies and enhance teaching and learning processes.

**Limitations:**

- The sample size is relatively small and limited to teachers in Hyderabad District. Therefore, the findings may not be generalizable to all educational contexts.
- Future research may involve larger samples from different regions to gain a broader understanding of teachers' experiences with AI technologies.
- Mixed-methods research combining qualitative and quantitative approaches could also provide deeper insights into the impact of AI integration in education.

**Conclusion:**

Artificial Intelligence has the potential to transform educational practices by supporting teachers in instructional planning, assessment, and personalized learning. The findings of this study indicate that teachers perceive AI technologies as valuable tools that enhance teaching efficiency and improve student engagement.

However, successful AI integration requires adequate teacher training, technological infrastructure, and institutional support. Educational stakeholders must work collaboratively to ensure that AI technologies are implemented responsibly and effectively in classrooms.

When used appropriately, AI can complement teachers' expertise and contribute to the development of more dynamic and personalized learning environments.

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# CHILD DEVELOPMENT IN THE AGE OF ARTIFICIAL INTELLIGENCE: A CRITICAL REVIEW OF THE PSYCHOLOGICAL, EMOTIONAL AND COGNITIVE IMPACT ON YOUNG MINDS

**Mrs Lubna Aly Khan [1]**


## Abstract

The rapid integration of artificial intelligence (AI) into children's everyday environments represents a fundamental transformation in the conditions under which development occurs. This paper critically examines the implications of AI for child development across cognitive, emotional, and social domains. Drawing on interdisciplinary literature from developmental psychology, neuroscience, and education, the study adopts a qualitative narrative review approach to analyse how AI-mediated environments interact with core developmental processes. The analysis reveals that while AI offers significant benefits, including personalized learning and accessibility, it simultaneously introduces risks such as diminished interpersonal interaction, reduced cognitive engagement, and challenges to socio-emotional development. A central concern identified is the emergence of superficial or "simulated" understanding, where learners produce outcomes without deep cognitive processing. The paper argues that AI must be conceptualized as a transformative ecological factor rather than a neutral technological tool. It concludes that balanced, ethically grounded, and developmentally informed integration is essential to ensure that AI enhances rather than constrains holistic child development.


***Keywords:*** *artificial intelligence, child development, cognitive development, socio-emotional learning, educational technology*

## Introduction

Child development is a multidimensional process involving changes in cognitive, emotional, social, and physical domains, shaped through continuous interaction between biological predispositions and environmental contexts. Traditionally, these contexts have been constituted by family structures, educational institutions, and cultural practices. However, the rapid expansion of artificial intelligence (AI) into children's daily lives represents a profound shift in these developmental environments.

Early childhood has long been recognized as a critical period during which foundational cognitive capacities—such as attention, memory, and reasoning—are established and remain highly sensitive to environmental input. More recently, adolescence has also been identified as a crucial developmental phase marked by significant neurological reorganization. In both stages, environmental influences play a decisive role in shaping developmental trajectories. The growing presence of AI technologies in educational, social, and recreational domains introduces a novel and powerful environmental influence whose long-term effects remain insufficiently understood. This paper advances the central argument that AI should not be viewed merely as an instructional aid but as a transformative ecological factor that reshapes how children learn, think, and interact. By situating AI within established developmental and neuroscientific frameworks, this study critically evaluates its dual role as both an enabler of learning and a potential constraint on holistic development.

## Theoretical and Conceptual Framework

This study is informed by Lev Vygotsky's sociocultural theory, which emphasizes the centrality of social interaction and guided participation in cognitive development, and Jean Piaget's constructivist framework, which conceptualizes learning as an active process of knowledge construction. Both perspectives underscore

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that development occurs through meaningful engagement with the environment and through interactions with more knowledgeable others.

These frameworks are particularly relevant in examining AI-mediated environments. While AI systems can simulate interaction, they do not fully replicate the social, emotional, and contextual richness inherent in human engagement. The increasing reliance on AI therefore raises critical questions regarding whether such environments adequately support the socially mediated and constructivist nature of learning.

## Literature Review

### Artificial Intelligence and Learning Environments

Artificial intelligence has evolved from rule-based computational systems to sophisticated models capable of pattern recognition, adaptive learning, and content generation (Mitchell, 2020). In educational settings, AI-powered tools—such as intelligent tutoring systems, adaptive learning platforms, and conversational agents—offer personalized learning experiences tailored to individual student needs.

However, the increasing reliance on these systems introduces important pedagogical concerns. While AI enhances efficiency and accessibility, it may simultaneously reduce opportunities for active engagement, inquiry, and deep learning. The capacity of AI to generate instant responses risks fostering dependency, thereby shifting learning from a process of cognitive construction to one of passive consumption (Kundu & Bej, 2025).

### Developmental Neuroscience and Environmental Input

From a neuroscientific standpoint, child development is shaped by processes such as synaptic formation, pruning, and myelination, which are influenced by both genetic factors and environmental experiences. Sensitive periods of development represent windows during which the brain is particularly receptive to specific types of input.

A key distinction in developmental theory lies between experience-expectant and experience-dependent processes. While the former rely on universal environmental stimuli, the latter depend on individualized and context-specific interactions. AI-mediated environments, although interactive, may lack the variability and emotional depth required to fully support these processes, raising concerns about their developmental adequacy.

### Adolescence and Neurodevelopmental Vulnerability

Adolescence constitutes a period of significant neurological change, particularly in regions associated with executive functioning and emotional regulation. The imbalance between the rapidly developing limbic system and the more gradually maturing prefrontal cortex results in heightened sensitivity to environmental stimuli (Laurence Steinberg, 2008; B. J. Casey et al., 2008).

In this context, the pervasive presence of AI technologies may influence cognitive processing, decision-making, and behavioral regulation. The immediacy and responsiveness of AI systems may reinforce tendencies toward instant gratification, potentially affecting the development of self-regulation and long-term planning abilities.

## Methodology

This study adopts a qualitative narrative review design to synthesize interdisciplinary research on the relationship between artificial intelligence and child development. A narrative approach is particularly appropriate given the conceptual and emerging nature of this field, where empirical findings remain fragmented across disciplines such as neuroscience, psychology, and education.

### Data Sources

Data for the study were derived exclusively from secondary sources, including:

- Peer-reviewed journal articles
- Academic books
- Policy reports (e.g., OECD reports)
- Recent empirical and theoretical studies on AI and child development

Databases such as Google Scholar, ERIC, and other academic repositories were used to identify relevant literature. Priority was given to recent publications (2015–2025) to ensure contemporary relevance, particularly in relation to rapid advancements in AI technologies

**Selection Criteria**

Studies were included based on their relevance to:

- Child and adolescent development
- AI applications in educational or social contexts
- Cognitive, emotional, or behavioural outcomes

**Analytical Approach**

The selected literature was analysed thematically, focusing on three key domains: cognitive development, socio-emotional development, and educational practices. This approach enabled the identification of recurring patterns, contradictions, and gaps within the existing body of research.

**Discussion**

The present study set out to examine the influence of artificial intelligence (AI) on children's cognitive, emotional, and psychological development, while also exploring its interaction with neural processes and evaluating its associated benefits and risks.

The findings indicate that artificial intelligence exerts a complex and multidimensional influence on child development. On one hand, AI facilitates personalized learning, enhances accessibility, and supports diverse learners through adaptive technologies. These features position AI as a powerful educational tool capable of transforming traditional learning environments. In context of the first objective—understanding the developmental processes of children and adolescents—the study reiterates that child development is a multidimensional paradigm shaped by the interaction of biological maturation and environmental experiences. Developmental neuroscience emphasizes the importance of early experiences in shaping neural architecture through processes such as synaptogenesis, pruning, and myelination (Banich & Compton, 2023). The concept of sensitive periods underscores that the timing and quality of environmental inputs are critical in determining developmental trajectories. Within this structure AI emerges as a new and influential component of the child's environment, with the potential to significantly alter traditional developmental patterns.

The second objective, the study reveal that AI has a complex and dual impact on children's cognitive, emotional, and psychological development. On the positive side, AI-driven tools facilitate personalized and adaptive learning, enhance engagement, and provide access to diverse educational resources. These technologies can support cognitive development by enabling individualized pacing and interactive learning experiences. However, a critical concern emerging from the analysis is that excessive reliance on AI may lead to reduced attention span, diminished critical thinking, and superficial learning. Psychologically, this may foster dependency on technology, while emotionally, reduced human interaction may impede the development of empathy and interpersonal skills (Turkle, 2011).

With respect to the third objective—examining the interaction between AI environments and neural development—the study suggests that AI- facilitated experiences may impact brain development, particularly during sensitive developmental periods. The distinction between experience-expectant and experience-dependent systems is particularly relevant in this context. While certain neural processes require universal environmental stimuli for typical development, others depend on individualized interactions. AI environments, limit the human interaction and experiential learning, thereby affecting the development of higher-order cognitive and socio-emotional skills. Furthermore, during adolescence—a period marked by significant neurological restructuring—the imbalance between the limbic system and prefrontal cortex may be impaired by AI-driven environments that encourage instant gratification and reduced cognitive effort.

In context of the fourth objective, the study identifies both significant benefits and notable risks associated with AI integration in children's environments. Among the benefits, AI enhances accessibility, inclusivity, and engagement, particularly for learners with diverse needs. However, these advantages are counterbalanced by several risks. Excessive screen exposure linked to AI use is associated with sleep disturbances, reduced physical activity, and adverse effects on mental health.

Another important finding relates to the role of educators and the broader educational context. While AI offers valuable support in teaching and assessment, it cannot replace the human elements of empathy, judgment, and contextual understanding that are central to effective pedagogy. The study highlights the importance of AI literacy among educators, enabling them to critically evaluate AI outputs and integrate technology in a manner that enhances, rather than diminishes, learning outcomes. Moreover, the need for balanced pedagogical approaches that combine AI tools with traditional teaching methods is emphasized.

Overall, the discussion underscores that AI is not inherently beneficial or detrimental; rather, its impact is contingent upon how it is integrated into children's developmental environments. A key implication is that unregulated and excessive use of AI may disrupt essential developmental processes, while thoughtful and guided use can enhance learning and development. Therefore, a balanced, ethical, and developmentally informed approach to AI integration is essential to ensure that it supports the holistic growth of children and adolescents

**Limitations of the Study**

This study is limited by its reliance on secondary data and the absence of empirical validation. The rapidly evolving nature of AI technologies may also limit the temporal relevance of certain findings

**Directions for Future Research**

- Longitudinal studies on AI and brain development
- Experimental studies on AI vs traditional learning
- Impact on different socio-economic groups
- AI and identity formation in adolescents

**Implications**

The findings of this study have important implications for educational practice and policy:

- **Pedagogical Implication:** AI should complement, not replace, human interaction in learning environments.
- **Teacher Education:** There is a need to develop AI literacy among educators to enable critical and effective use of technology.
- **Policy Implication:** Regulatory frameworks must address issues of data privacy, bias, and ethical use of AI.
- **Curriculum Design:** Greater emphasis should be placed on higher-order thinking and socio-emotional competencies.

**Conclusion**

Artificial intelligence represents a transformative force in the environments that shape child development. While it offers unprecedented opportunities for enhancing learning and accessibility, it also introduces challenges that may affect fundamental developmental processes. This paper argues that the impact of AI is contingent upon how it is integrated into children's lives. A balanced, ethically grounded, and developmentally informed approach is essential to ensure that AI supports, rather than undermines, holistic development.

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# WHY ARTIFICIAL INTELLIGENCE IS ESSENTIAL FOR MODERN SCHOOL EDUCATION

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**Abstract**

Artificial Intelligence (AI) is rapidly transforming many aspects of modern life, including the field of education. It is becoming an essential component of modern school education. Its ability to personalize learning, support teachers, enhance student engagement, and promote inclusive education makes it a valuable tool for improving educational outcomes. With thoughtful implementation and responsible use, AI can help create a more effective, accessible, and future-ready education system. The present study explores the significance of Artificial Intelligence (AI) in modern school education, with particular emphasis on its role in enhancing teaching and learning processes. A qualitative research methodology was employed, drawing on secondary data sources and a comprehensive review of existing literature to analyse and interpret the impact of AI in school education. The findings of the study indicate that AI plays a crucial role in promoting personalized learning by tailoring educational content to individual student needs, thereby improving academic performance. It also enhances student engagement and motivation when AI-powered tools are effectively integrated into classroom practices. Furthermore, the integration of AI-powered tools fosters greater student engagement and motivation within classroom settings. The study also reveals that AI contributes to reducing teachers' administrative workload through the automation of routine tasks, enabling educators to focus more on pedagogical practices and student support. The study also identifies key challenges, including limited infrastructure and low levels of digital literacy, which hinder the effective implementation of AI in education. Based on these findings, the study offers recommendations to support the effective and sustainable integration of AI in Indian school education.

***Key words***: *Artificial Intelligence, School Education, Personalized Learning, AI based tools.*

## Introduction

Education systems across the world are undergoing rapid transformation due to technological advancements. Among these innovations, Artificial Intelligence (AI) has emerged as a powerful tool influencing teaching and learning processes. AI refers to the simulation of human intelligence in machines that are programmed to think, learn, and solve problems. In modern school education, AI plays a crucial role in enhancing teaching and learning processes by enabling personalized learning, improving administrative efficiency, and supporting teachers in delivering effective instruction. Teachers may speed up the assessment process, provide students with timely feedback, and encourage more focused engagement through the effective use of AI capabilities. The integration of AI in schools is essential for meeting the diverse needs of learners and preparing them for a digital future.

AI-powered platforms analyze students' learning patterns, strengths, and weaknesses, and accordingly adapt instructional content to suit individual needs. This ensures that both slow and advanced learners receive appropriate support. According to Zawacki-Richter et al. (2019), AI applications such as adaptive learning systems and intelligent tutoring systems enable individualized instruction and continuous feedback, leading to improved academic performance. Over the past decade, the integration of AI into education has accelerated due to increased digitalization, availability of big data, and advancements in computing technologies. Schools are increasingly adopting AI-based tools to enhance instructional delivery, improve student engagement, and streamline administrative tasks (Zawacki-Richter et al. 2019).

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**Objectives of the Study**

The study aims to achieve the following objectives:

1. To examine the role of Artificial Intelligence in modern school education.
2. To identify the benefits and challenges associated with the use of AI in education.
3. To explore the various AI tools that are supportive to teaching and learning in modern school education.
4. To suggest recommendations for the effective implementation of AI in Indian school education.

**Need of the Study**

The need for this study arises from the rapid integration of technology in education and the growing importance of Artificial Intelligence in shaping modern learning environments. Traditional teaching methods often fail to address the diverse learning needs of students, leading to gaps in understanding and performance. Traditional education systems often follow a one-size-fits-all approach, which may not address the diverse learning needs of students. AI has the potential to overcome these limitations by offering customized learning experiences tailored to individual learners and also plays a significant role in reducing teachers' workload. In the Indian context, the study gains additional significance as the country is actively promoting digital education through initiatives such as the National Education Policy (NEP) 2020. Understanding the role of AI can help policymakers, educators, and stakeholders make informed decisions regarding its integration into school education. Therefore, this study is essential to highlight the significance of AI in improving educational quality and also important in highlighting the role of AI in preparing students for a technologically advanced future, where digital literacy and critical thinking skills are essential.

**Literature Review**

Recent studies indicate that AI has significantly influenced educational practices worldwide and also researchers found that AI-based learning systems improve student performance and AI tools such as intelligent tutoring systems and adaptive learning platforms help students learn at their own pace. Luckin et al. (2016) found that AI can support both learners and teachers by providing real-time feedback and facilitating adaptive learning environments. The authors highlight the importance of human-AI collaboration in education.

The application of Artificial Intelligence in education has been widely explored by Holmes, Bialik, and Fadel (2019), AI has the potential to transform education by enabling personalized learning and improving teaching efficiency. Their study emphasizes that AI systems can adapt content according to learners' needs, thereby enhancing learning outcomes. Zawacki-Richter et al. (2019) conducted a systematic review of AI applications in higher education and found that AI is mainly used for adaptive systems, assessment, and profiling of students. Their findings suggest that AI can significantly improve learning efficiency but requires careful implementation.

Selwyn (2019) critically examines the role of AI in education and raises concerns about ethical issues such as data privacy, algorithmic bias, and the commercialization of education. The study emphasizes the need for responsible use of AI technologies. UNESCO (2021) highlights that AI can contribute to achieving inclusive and equitable quality education by providing access to learning resources for students in remote and underserved areas. However, it also stresses the importance of policy frameworks to ensure ethical and safe use of AI. Chen, et al. (2020) noted that AI facilitates data-driven decision-making, allowing teachers to identify learning gaps and intervene early to support struggling students. In the Indian context, studies indicate that while AI adoption is increasing, challenges such as lack of infrastructure, digital divide, and insufficient teacher training hinder its effective implementation (Government of India, 2020).

**Methodology**

This study adopted a qualitative research design to analyse the role of Artificial Intelligence in modern school education. The study is based on secondary data sources, including research articles, books, government reports, policy documents, and reputable online sources. A comprehensive review of existing literature was conducted to gather relevant data. The study primarily focuses on the importance of AI in school education, with special emphasis on the Indian education system.

**Role of Artificial intelligence in Modern School Education**

The role of Artificial Intelligence in modern school education and its supportive tools are analysed, it includes:

***Personalized Learning***: AI enables customized learning experiences for students. It analyzes students' learning patterns and adapts content according to their strengths and weaknesses.

***Intelligent Tutoring Systems***: AI-powered tutoring systems provide instant feedback and guidance to students, improving understanding and retention of concepts.

***Automation of Administrative Tasks***: AI can automate routine tasks such as grading assignments, managing schedules, and maintaining records, allowing teachers to focus more on teaching.

***Enhanced Student Engagement:*** Interactive AI tools, such as chatbots and virtual assistants, make learning more engaging and enjoyable for students.

***Support for Teachers:*** AI assists teachers by providing insights into student performance and suggesting effective teaching strategies.

***Inclusive Education:*** AI supports students with disabilities through assistive technologies like speech recognition and text-to-speech tools.

***Table – 1: List of AI Tools and their Primary Function***

| ***S.No*** | ***Tool*** | ***Primary Function in School Education*** |
|---|---|---|
| 1 | QANDA | Provides step by step solution and explanation for maths problem |
| 2 | DIKSHA | Offers personalized learning content and assessments |
| 3 | Curipod | Generate interactive lesson plans, monitor engagement, and provide real-time feedback to students. |
| 4 | Khanmigo(Khan Academy) | Personalized tutoring and guided practice in multiple subjects such as math, science, and reading. |
| 5 | LabsterVirtual Labs | AI-driven virtual science experiments |
| 6 | Audio Pen | Transcribes voices to text and assists in note taking |
| 7 | Duolingo Max | Language learning with interactive practice and feedback |
| 8 | Gradescope | Assessment and grading automation & consistent feedback. |
| 9 | Turbo learn & UPresenter | Turns study materials into summaries, interactive quizzes, and explanations |
| 10 | ImagineArt | Generates educational visuals, videos, and content creation |
| 11 | Nearpod | Creates interactive lessons and engagement activities. |
| 12 | Quize Gecko | Converts notes into quizzes for mastery learning |
| 13 | MagicSchool AI | Creating lesson plans, worksheets, and learning materials |
| 14 | Conker | Generate quizzes and facilitates quick assessments |

Table (1) shows the various tools of AI that support in modern school education.

**Findings**

The study reveals the following findings:

- The finding shows that AI enhances students personalized learning and improves academic performance.

- Students became more actively engaged and motivated when learning is supported by AI-powered tools are integrated into the teaching and learning process.
- AI reduces Teachers' administrative workload by automating repetitive tasks such as grading and attendance allowing them to dedicate more time to effective teaching and student support.
- Limited infrastructure and low levels of digital literacy continue to pose major challenges to the successful implementation of AI in education.

**Discussions**

The findings of this study highlight the Necessity of Artificial Intelligence (AI) in enhancing the quality of school education, particularly through personalized learning and improved academic performance. AI-enabled systems such as adaptive learning platforms and intelligent tutoring systems allow instruction to be tailored to individual learners' needs, pace, and abilities. This is in line with Zawacki-Richter et al. (2019), who emphasized that AI applications facilitate individualized learning and continuous assessment. Similarly, research by Holmes, Bialik, and Fadel (2019) suggests that AI can significantly enhance learning by providing customized feedback and supporting individual learning pathways. AI-powered evaluations offer teachers comprehensive insights, including the identification of patterns in students' learning and support in the assessment process. This aligns with the present findings that students show improved engagement and academic performance when AI tools are used.

In addition, AI significantly reduces teachers' administrative workload by automating routine tasks such as grading and attendance management, enabling educators to focus more on pedagogy and student support. These findings align with Ifenthaler and Gibson (2018), who reported that AI improves teaching efficiency and instructional quality. However, despite these benefits, the study also identifies key challenges, including limited infrastructure and low levels of digital literacy, which hinder effective implementation. This is supported by Gocen (2020), who highlighted that technological barriers and lack of teacher preparedness remain critical issues in adopting AI in education.

**Recommendations**

Based on the findings of the study, the following recommendations are suggested:

- Schools should organize regular training to help teachers effectively use AI tools into teaching practices, including using platforms for lesson planning, assessment, and monitoring student progress.
- Educators and students should be made aware of the benefits and limitations of AI.
- Schools should adopt AI-powered tutoring, personalized learning platforms, and interactive tools like Khanmigo, ChatGPT Edu, and DIKSHA, Nearpod etc., to enhance student engagement and learning outcomes.
- Governments and institutions must invest in digital infrastructure to support AI integration.
- AI applications should be adapted to regional languages and curricula, making learning more relevant, inclusive, and culturally contextual.

**Conclusion**

Artificial Intelligence is essential in modern school education as it enhances learning experiences, supports teachers, and improves educational outcomes. AI provides opportunities for students to develop critical thinking, creativity, problem-solving skills, and digital literacy while getting ready for the needs of the workforce in the future. While challenges exist, careful implementation and proper policies can maximize its benefits. AI has the potential to revolutionize education and prepare students for future challenges in a technology-driven world. The findings indicate that Artificial Intelligence has a transformative impact on modern school education and AI tools support teachers by reducing administrative burdens, allowing them to focus on more meaningful teaching activities.

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# TEACHER READINESS FOR DIGITAL PEDAGOGY & FUTURE CLASSROOMS - A TPACK STUDY

**Neha Hashmi [1]**


## Abstract

Digital pedagogy has become an integral part of modern education, with the rise in digital technologies that transformed teaching & learning practices. Teachers played a pivotal role in preparing learners for future classrooms by integrating technology effectively. At the heart of Technological Pedagogical Content Knowledge (TPACK) framework lies three forms of knowledge which requires a meaningful blend of Subject knowledge, Teaching strategies & Technological understanding. The purpose of the study is to examine, analyse & compare teacher's readiness for digital pedagogy in future classrooms using TPACK framework. The study adopted a quantitative research approach using Descriptive survey method & the data were collected from 86 teachers using standardised Technological pedagogical content knowledge TPACK Scale to assess teacher's competency by integrating technology effectively into teaching practices. Descriptive Statistics (including mean standard deviation) were used in the analysis to analyze demographic details of respondents including gender, age & teaching experience. The findings revealed that most of the respondents aged 21-40 years, particularly female educators, representing early & mid-career teachers. Inferential statistical analysis includes independent sample t-test, One-way ANOVA were performed with respect to demographic variables. The result showed that no significant difference was found in teacher's readiness based on gender, age & teaching experience. This indicates that teachers from different demographic groups show a similar level of readiness to integrate digital technologies into teaching and learning. The paper concludes by calling for continuous professional development & institutional support for improving teachers' digital skills which help in successful implementation of digital pedagogy & preparing classrooms for the future.


***Keywords**: Teacher Readiness, Digital pedagogy, PACK Framework*

## Introduction

In today's world, the fast development of digital technologies has brought major changes in the field of education. Teaching and learning are no longer limited to traditional classrooms, as modern classrooms are becoming more technology-based and interactive. This shift has made digital pedagogy an important part of the education system (Fullan, 2013).

Teachers play a key role in this transformation because they are responsible for using technology effectively in the classroom. However, using technology is not enough; teachers need proper knowledge of their subject, teaching methods, and digital tools. The TPACK framework explains this combination of content knowledge, pedagogy, and technology, which is essential for effective teaching (Mishra & Koehler, 2006).

Teacher readiness for digital pedagogy is very important in preparing students for future classrooms. It includes teachers' skills, knowledge, and ability to adapt to digital teaching environments (Koehler, Mishra, & Cain, 2013). Understanding how ready teachers are can help improve teaching practices and student learning outcomes (Ertmer & Ottenbreit-Leftwich, 2010).

Moreover, it is necessary to examine whether teachers from different backgrounds, such as gender, age, and teaching experience, have similar levels of readiness. This helps in identifying gaps and planning suitable training programs for teachers (Tondeur et al., 2017).

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Therefore, this study aims to analyze teacher readiness for digital pedagogy in future classrooms using the TPACK framework and to highlight the importance of professional development for teachers.

**Literature review**

Korukluoğlu and Çeliköz (2026) conducted a study to develop a digital pedagogy competence scale using a quantitative research design. Data were collected from 274 teachers for exploratory factor analysis and 309 teachers for confirmatory factor analysis using convenience sampling. The findings showed that the developed scale was valid and reliable, identifying cognitive and social competencies as key dimensions of digital pedagogy. The study highlighted the lack of proper assessment tools for evaluating digital pedagogy in professional learning environments.

Handayani et al. (2025) conducted a study on digital storytelling as a form of digital pedagogy using a qualitative case study design. Data were collected from 35 students through observations, interviews, and document analysis. The findings revealed that digital storytelling enhances students' multimodal literacy, cultural identity, and motivation. It also promotes creativity, collaboration, and active participation in learning. However, the study identified a gap in large-scale and longitudinal research in this area.

Zakira Shaikh (2023) conducted a study on digital pedagogy and holistic learning using a quantitative survey design. Data were collected from 15 higher education teachers through a structured questionnaire and analyzed descriptively. The study found that digital pedagogy enhances students' critical thinking, analytical ability, and engagement. It also proposed a four-dimensional model including real-time learning, experiential learning, and the use of digital tools. However, the study identified limitations such as a small sample size and the need for more diverse and large-scale research.

Nanjundaswamy et al. (2021) conducted a study on digital pedagogy for sustainable learning. The main objective was to examine the role of digital pedagogy in promoting collaborative and sustainable learning practices. A conceptual review design was used, and no sample was involved as the study was based on existing literature. The study found that digital pedagogy supports collaborative, blended, and innovative learning environments, encouraging interdisciplinary and lifelong learning. It also promotes learner-centered approaches where students actively construct knowledge through digital tools. However, the study highlighted a gap between traditional and digital learning practices and emphasized the need for more collaborative digital approaches.

Gonscherowski and Rott (2025) conducted a systematic review on TPACK assessment instruments using the PRISMA methodology. The study analyzed 215 research articles to understand how TPACK is measured. The findings revealed that most studies rely on self-report instruments and emphasize Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) in digital resource selection. However, the study identified a gap in the development of practical and comprehensive evaluation tools.

Indra Kusuma (2021) conducted a mixed-method study on ICT integration in TPACK programs with 79 lecturers. Data were collected through questionnaires and interviews. The findings indicated that institutions provide ICT resources and training, but effective implementation depends on continuous professional development and practical application. The study pointed out limited practical implementation research.

Othman and Maat (2020) conducted a systematic review on TPACK in mathematics education. The study analyzed 30 research articles using database searches and PRISMA techniques. The findings indicated that most studies focus on technology integration in secondary school mathematics teaching, with qualitative methods being dominant. The study highlighted a lack of research in higher education contexts.

Peromingan et al. (2026) conducted a quantitative study on pre-service teacher readiness with a sample of 112 participants. Data were collected through a survey questionnaire. The findings indicated moderate levels of readiness, with competencies such as adaptability, communication, and resilience being interrelated. The study highlighted a lack of holistic training programs.

Fitrah et al. (2025) conducted a mixed-method study on teacher readiness with a large sample of 802 teachers and 30 interview participants. Data were collected using questionnaires and interviews. The findings showed that 21st-century competencies had a stronger influence on teacher readiness than technological knowledge. However, structural and cultural barriers limited effective implementation. The study highlighted a lack of deep competency-based analysis.

Ben Gurion (2024) conducted a literature review on teacher readiness for curriculum reform. The study found that teachers were not fully prepared to implement new curriculum changes and emphasized the importance of collaboration among stakeholders. The study highlighted a gap between curriculum demands and teachers' understanding.

**Research Objectives**

- To examine teachers' readiness for digital pedagogy in future classrooms using the TPACK framework.
- To analyze the demographic profile of teachers in terms of gender, age, and teaching experience.
- To compare teachers' readiness for digital pedagogy with respect to gender, age, and teaching experience.

**Research Methodology**

The study adopted a quantitative research approach using a descriptive survey method to examine teachers' readiness for digital pedagogy in future classrooms through the TPACK framework.

**Sample**

The study was conducted on a sample of 85 teachers, selected using a convenient sampling method.

**Population**

The population of present study include both school and college teachers, with the majority belonging to school education.

**Tool Used**

The study employed a standardized Technological Pedagogical Content Knowledge (TPACK) scale developed by Schmidt et al. (2009) to assess teachers' readiness for digital pedagogy.

**Variables of the Study**

Independent Variables: Gender, Age, Teaching Experience

Dependent Variable: Teacher Readiness for Digital Pedagogy

**Data Collection**

The data were collected through an online survey using Google Forms. The questionnaire was distributed to teachers, and responses were collected.

**Statistical Techniques Used**

Descriptive Statistics: Frequency, Percentage, Mean, Standard Deviation

**Inferential Statistics**

Independent Sample t-test (for gender comparison),

One-way ANOVA (for age and teaching experience comparison)

**Interpretation and Analysis of Data/Findings**

**Interpretation and Analysis of Data**

**Objective 1: To examine teachers' readiness for digital pedagogy in future classrooms using the TPACK framework**

**Table 1 Descriptive Statistics of Teacher Readiness for Digital Pedagogy**

| N | Mean | SD | Min | Max |
|---|---|---|---|---|
| 85 | 3.64 | 0.58 | 1 | 5 |

*Note. SD – Standard Deviation*

**Interpretation:**

The table indicates that the mean score of teacher readiness for digital pedagogy is 3.64, suggesting that teachers generally agree about their preparedness for integrating digital technologies. The minimum and maximum scores (1 to 5) show that responses covered the full scale range, while the standard deviation (0.58) reflects moderate variation among respondents.

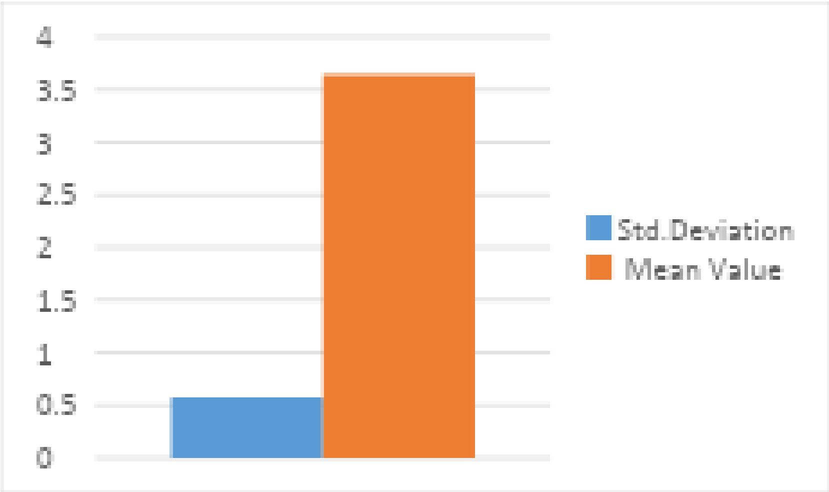


*Figure 1. Bar Graph Showing Mean Score of Teacher Readiness for Digital Pedagogy*

**Objective 2 To analyze the demographic profile of teachers in terms of gender, age, and teaching experience**

**Table 2 Distribution of Respondents by Gender (N=85)**

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 7 | 8.2% |
| Female | 78 | 91.8% |
| **Total** | **85** | **100%** |

**Interpretation**

The table shows that the majority of respondents were female teachers (91.8%), while 8.2% were male teachers. This indicates that the sample was predominantly female, reflecting the higher participation of women in the teaching profession.

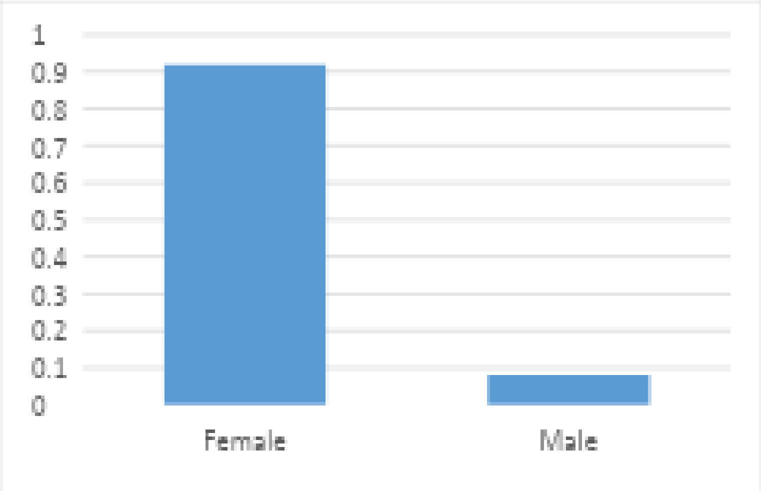


*Figure 2. Bar Graph Showing Distribution of Respondents by Gender*

**Table 3 Distribution of respondents by age group**

| Age Group | Frequency | Percentage |
|---|---|---|
| 21–30 years | 34 | 40.0% |
| 31–40 years | 36 | 42.4% |
| 41–50 years | 13 | 15.3% |
| Above 50 | 2 | 2.3% |
| **Total** | **85** | **100%** |

### Interpretation

Most respondents were in the 31–40 age group (42.4%), followed by 21–30 years (40%). Only a small proportion were above 50 years. This suggests that the sample mainly consisted of young and mid-career teachers.

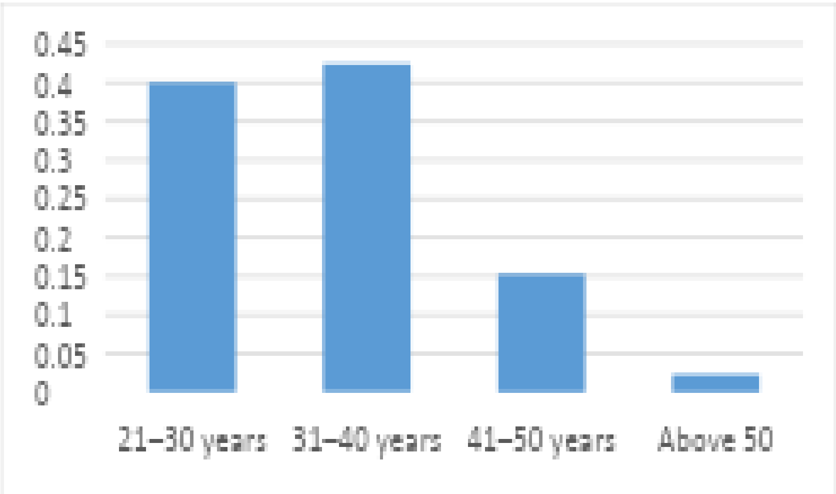


*Figure 3. Bar Graph Showing Distribution of Respondents by Age Group*

**Table 4 Distribution of respondents by teaching experience**

| Teaching Experience | Frequency | Percentage |
|---|---|---|
| Less than 5 years | 36 | 42.4% |
| 5–10 years | 27 | 31.8% |
| 11–15 years | 9 | 10.6% |
| More than 15 years | 13 | 15.3% |
| **Total** | **85** | **100%** |

**Interpretation**

A large proportion of teachers (42.4%) had less than five years of teaching experience, indicating that many respondents were early-career teachers. Teachers with 5–10 years of experience also formed a substantial group (31.8%).

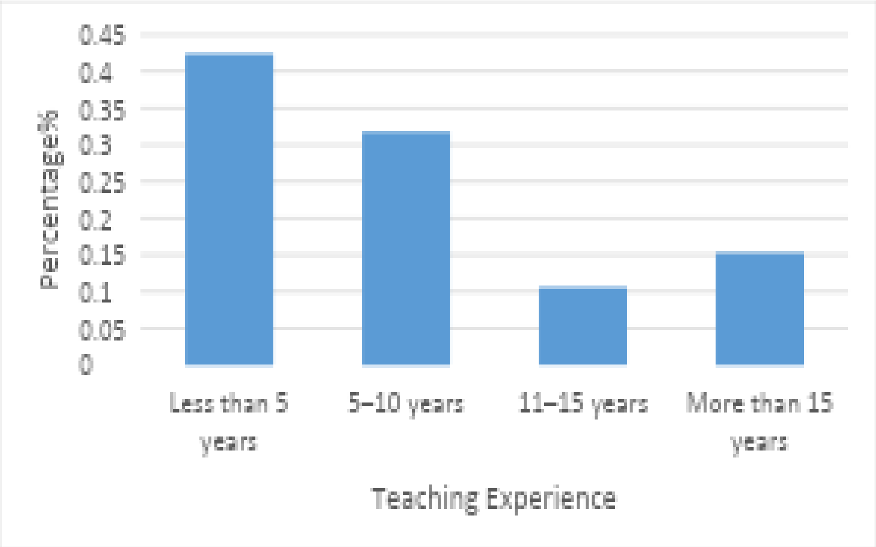


*Figure 4. Bar Graph Showing Distribution of Respondents by Teaching Experience*

Objective 3 To compare teachers' readiness for digital pedagogy with respect to gender, age, and teaching experience

**Table 5 Independent Sample t-test showing Difference in Teacher Readiness for Digital Pedagogy based on Gender**

| Gender | N | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| **Male** | **7** | **4.12** | **0.83** | **-0.38** | **0.71** |
| **Female** | **78** | **3.99** | **0.57** | | |

### Interpretation

The independent sample t-test revealed that there is no statistically significant difference in teacher readiness for digital pedagogy and future classrooms based on gender ($t = -0.38$, $p = 0.71$). This indicates that both male and female teachers exhibit similar levels of readiness for technology

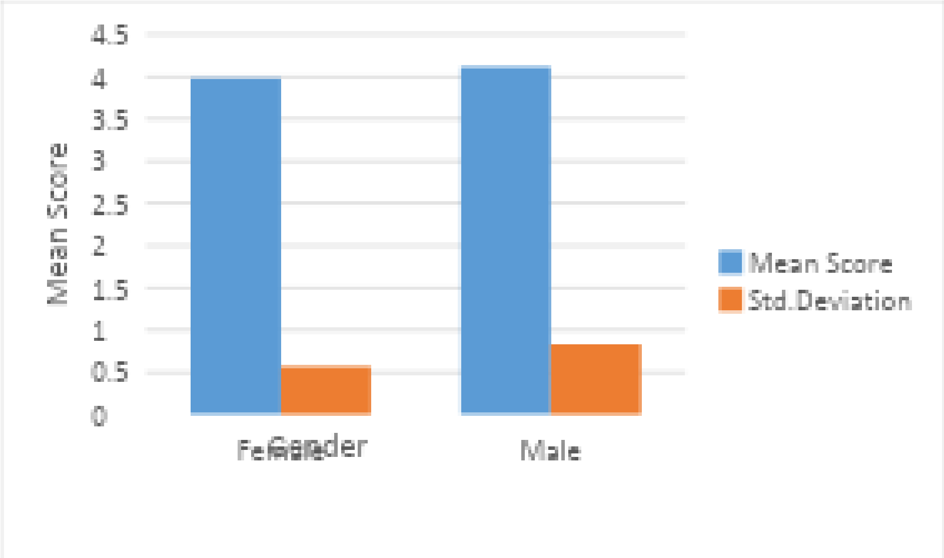


*Figure 5: Mean and Standard Deviation of teacher readiness for digital pedagogy by Gender*

**Table 6: One-way ANOVA showing differences in Teacher Readiness for Digital Pedagogy based on Age**

| Age Group | N | Mean | SD |
|---|---|---|---|
| **21–30 years** | 34 | 4.05 | 0.61 |
| **31–40 years** | 36 | 4.02 | 0.58 |
| **41–50 years** | 13 | 3.94 | 0.63 |
| **Above 50** | 2 | 3.88 | 0.66 |

*Note. SD – Standard Deviation*

**ANOVA Summary**

| Source | df | F | p |
|---|---|---|---|
| Between Groups | 3 | 0.42 | 0.74 |
| Within Groups | 81 | | |

*Note. p –Significance of level – 0.05,df-Degree of freedom*

**Interpretation**

The one-way ANOVA revealed that there is no statistically significant difference in teacher readiness for digital pedagogy across different age groups ($F = 0.42$, $p = 0.74$). This indicates that teachers of different age groups exhibit similar levels of readiness.

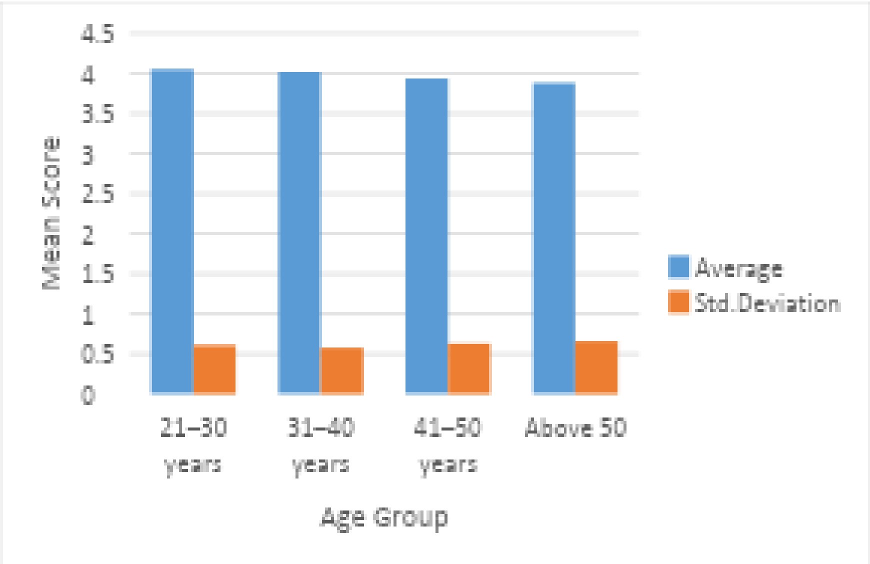


*Figure 6: Mean and Standard Deviation of teacher Readiness for digital pedagogy across age groups*

| Teaching Experience | N | Mean | SD |
|---|---|---|---|
| Less than 5 years | 36 | 4.07 | 0.59 |
| 5–10 years | 27 | 4.01 | 0.57 |
| 11–15 years | 9 | 3.96 | 0.62 |
| More than 15 years | 13 | 3.91 | 0.65 |

*Note. SD – Standard Deviation, p –Significance of level – 0.05*

**Table 7: One-way ANOVA showing difference in Teacher Readiness based on Teaching Experience**

**ANOVA Summary**

| Source | df | F | p |
|---|---|---|---|
| Between Groups | 3 | 0.56 | 0.64 |
| Within Groups | 81 | | |

**Interpretation**

A one-way ANOVA showed that there is no significant difference in teacher readiness for digital pedagogy based on teaching experience ($F = 0.56$, $p = 0.64$). This indicates that teachers across different experience levels have similar readiness.

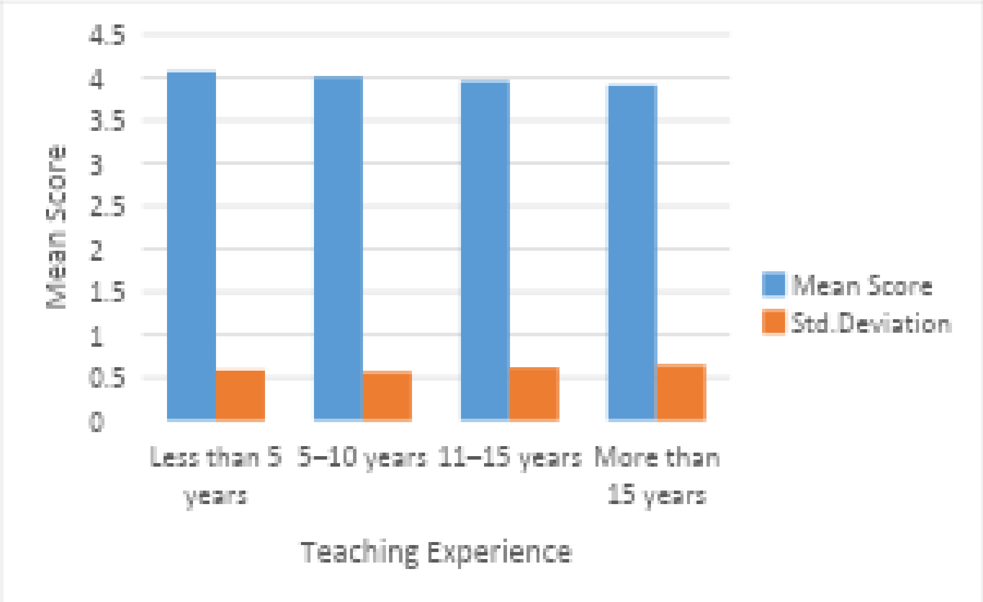


*Figure 7: Mean and Standard Deviation of teacher Readiness for digital pedagogy based on teaching experience*

**Discussion:**

The findings of the study give a clear idea about teachers' readiness for digital pedagogy. First, there is no difference based on gender, which shows that both male and female teachers are equally capable of using digital technology in teaching. This may be because nowadays digital tools are easily available and widely used by all teachers.

Second, the study shows that age does not affect readiness. Teachers from all age groups show similar levels of readiness. This indicates that even senior teachers are adapting well to digital teaching methods.

Third, there is no difference based on teaching experience. Both early-career and experienced teachers are equally ready to use digital pedagogy. This shows that technology use is becoming common for all teachers, not only for new teachers.

These findings support the idea that TPACK skills are important for all teachers, regardless of their background. It also shows that teachers are gradually becoming comfortable with technology in education.

**Educational Implications**:

The findings of this study highlight that all teachers show a similar level of readiness for digital pedagogy. This suggests that training programs should be designed for all teachers equally, rather than focusing on specific groups. There is a need for schools and colleges to provide continuous professional development programs, such as workshops and training on digital pedagogy and the TPACK framework. This will help teachers improve their ability to integrate technology effectively in teaching. Institutions should also ensure the availability of proper digital infrastructure and support, including internet access, digital tools, and technical assistance. This will make it easier for teachers to use technology in their classrooms.

In addition, teacher education programs should include digital pedagogy and technology integration as an important part of the curriculum so that teachers are well prepared for future classrooms.

**Limitations of the Study:**

The study was conducted on a limited sample size of 85 teachers. The participants were mostly school teachers, so the results may not represent all levels of education. Only a few variables such as gender, age, and teaching experience were considered, while other factors like digital training, access to technology, subject specialization, and institutional support were not considered in this study

**Future Directions:**

The study can be extended by including a larger sample from different regions, which will help in generalizing the findings. Future research can explore additional factors such as subject background, type of institution, and digital training exposure, which may influence teachers' readiness. There is also scope to use a mixed-method approach, where qualitative methods like interviews and observations can provide deeper insights into teachers' experiences with digital pedagogy. Further studies can focus on students' perspectives and actual classroom practices to understand how digital pedagogy is implemented in real situations. Comparative studies can also be conducted across different educational settings, such as urban and rural areas, to identify possible differences in digital readiness.

**Conclusion:**

This study was conducted to understand teachers' readiness for digital pedagogy in future classrooms using the TPACK framework. The results show that teachers are generally ready to use digital tools in teaching. The study also found that factors like gender, age, and teaching experience do not make a significant difference in teachers' readiness. This means that all teachers, whether they are early-career or experienced, have almost the same level of readiness. Overall, it can be concluded that teachers are prepared for technology-based teaching, which is important for future classrooms.

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# IS ARTIFICIAL INTELLIGENCE MAKING YOU DUMB?

**Mr. Biswajit Sarkar [1], Prof. (Dr.) Harishankar Singh [2]**

**Abstract**

The rapid normalization of artificial intelligence (AI) in academic life has fundamentally altered how students think, learn, and engage with knowledge. AI systems now assist in writing, reasoning, problem-solving, and decision-making, often producing outputs that resemble human intellectual work. While such technologies promise efficiency, accessibility, and personalization, an emerging body of scholarship raises concerns that excessive reliance on AI may undermine core cognitive abilities, particularly critical thinking, deep reasoning, and sustained cognitive engagement. This quantitative study investigates whether AI usage intensity is statistically associated with variations in critical thinking ability and cognitive engagement among university students. Using a descriptive-correlational and causal-comparative research design, data were collected from 420 undergraduate and postgraduate students through standardized instruments measuring AI usage patterns, critical thinking ability, and cognitive engagement. Statistical analyses, including descriptive statistics, Pearson correlation, one-way ANOVA, and multiple regression, reveal that high AI dependency is significantly associated with lower critical thinking scores, whereas moderate and reflective AI use does not show detrimental effects. The study concludes that AI does not inherently diminish intelligence; rather, uncritical substitution of human cognition by AI contributes to cognitive disengagement. The findings hold important implications for pedagogy, curriculum design, assessment practices, and AI governance in higher education.

***Keywords:*** *Artificial Intelligence, Critical Thinking, Cognitive Offloading, Cognitive Engagement, Higher Education*

## Introduction

Artificial intelligence has emerged as one of the most powerful and disruptive forces shaping contemporary society, particularly within education. In higher education institutions worldwide, students increasingly rely on AI-based tools for tasks that once required sustained intellectual effort, including essay writing, conceptual explanation, data analysis, and exam preparation. Unlike earlier educational technologies such as calculators or search engines, generative AI systems actively construct arguments, explanations, and interpretations, thereby performing cognitive labor traditionally associated with human reasoning.

This unprecedented capability has triggered widespread concern among educators, psychologists, and policymakers. The provocative question *"Is AI making you dumb?"* reflects anxieties that AI may reduce students' motivation to think independently, weaken critical reasoning, and encourage passive consumption of algorithmically generated knowledge. These concerns are not merely moral or philosophical; they strike at the very purpose of higher education, which aims not only to transmit information but to cultivate intellectual autonomy, analytical reasoning, and reflective judgment.

Critical thinking has long been regarded as a defining outcome of higher education. It involves the ability to analyze information, evaluate evidence, recognize assumptions, and construct reasoned arguments (Facione, 2015). Universities across disciplines emphasize critical thinking as essential for academic success, employability, democratic participation, and lifelong learning. However, when AI tools provide instant answers and ready-made reasoning, students may bypass the cognitive struggle that underpins deep learning.

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From a psychological perspective, this phenomenon can be understood through the lens of cognitive offloading, which refers to the delegation of mental tasks to external tools (Risko & Gilbert, 2016). While offloading can increase efficiency, excessive reliance may weaken internal cognitive processes over time. AI intensifies this dynamic by not only storing or retrieving information but by simulating reasoning itself. This raises a critical empirical question: Does frequent AI use predict measurable declines in critical thinking and cognitive engagement?

Despite intense public debate, systematic quantitative research addressing this question remains limited. Much of the existing discourse is speculative, anecdotal, or theoretical. There is a clear need for empirical, data-driven investigation examining how different levels of AI usage relate to cognitive outcomes among students. This study seeks to address that need.

**Review of Related Literature**

The integration of artificial intelligence into education has been widely celebrated for its potential to personalize learning, provide adaptive feedback, and support learners at scale. Intelligent tutoring systems, for instance, have demonstrated positive effects on learning outcomes when designed to promote active engagement and metacognitive reflection (Graesser et al., 2018). These systems function as scaffolds, guiding learners through problem-solving processes rather than replacing them.

However, the emergence of generative AI marks a qualitative shift in educational technology. Generative systems can produce complete essays, explanations, and solutions with minimal user input. While this capability enhances efficiency, it also raises concerns about reduced learner agency. Scholars argue that when technology performs complex cognitive tasks on behalf of learners, opportunities for intellectual development may be diminished (Carr, 2010).

The theory of cognitive offloading provides a useful framework for understanding these concerns. Risko and Gilbert (2016) argue that humans naturally offload cognitive tasks to external aids when available. Although offloading reduces mental effort in the short term, long-term reliance may weaken memory, reasoning, and problem-solving skills. Empirical studies have shown that easy access to information reduces individuals' tendency to remember information themselves, a phenomenon famously described as the "Google effect" (Sparrow et al., 2011).

Another relevant concept is automation bias, which refers to the tendency to over-trust automated systems and accept their outputs uncritically (Parasuraman & Riley, 1997). In educational contexts, automation bias may lead students to accept AI-generated responses without evaluating their accuracy, coherence, or underlying assumptions. This undermines epistemic vigilance and critical scrutiny, both of which are essential components of higher-order thinking.

Empirical research on technology and cognition presents mixed findings. Studies indicate that technology can enhance learning when it promotes active engagement, reflection, and problem-solving. Conversely, when technology encourages passive consumption or replaces cognitive effort, it is associated with surface learning and reduced analytical depth **(OECD, 2021)**. Despite these insights, few studies have quantitatively examined AI usage intensity and multiple cognitive outcomes simultaneously, particularly within higher education. This gap underscores the necessity of the present study.

**Objectives of the Study**

1. To examine whether there is a significant relationship between AI usage and critical thinking ability among university students.
2. To determine whether there is a significant difference in critical thinking among low, moderate, and high AI users of university students.
3. To assess whether AI usage significantly predicts critical thinking and cognitive engagement among university students.

**Hypotheses of the Study**

**$H_{01}$:** There is no significant relationship between AI usage and critical thinking ability among university students.

**$H_{02}$:** There is no significant difference in critical thinking among low, moderate, and high AI users of university students.

**$H_{03}$:** AI usage does not significantly predict critical thinking and cognitive engagement among university students.

**Methodology**

**Research Design**: A **descriptive correlational and causal-comparative design** was employed.

**Sample**: The sample comprised **420 university students** selected through stratified random sampling (see. Table 1).

**Table 1** *Distribution of Sample*

| Level | Male | Female | Total |
|---|---|---|---|
| Undergraduate | 110 | 120 | 230 |
| Postgraduate | 90 | 100 | 190 |
| **Total** | **200** | **220** | **420** |

*Note. n = 420*

**Variables**

Independent Variable: AI Usage

Dependent Variables: Critical Thinking Ability, Cognitive Engagement

Control Variables**:** Gender, Academic level

**Tools Used**

- **AI Usage Inventory** (Self-developed, 25 items, 5-point scale)

Reliability (Cronbach's α = 0.89)

- **Critical Thinking Ability Test** (Facione, 2015)

Reliability (α = 0.83)

- **Cognitive Engagement Scale** (adapted from Fredricks et al., 2004)

Reliability (α = 0.81)

**Statistical Techniques**

- Mean and Standard Deviation
- Pearson's Correlation
- Independent Samples *t-test*
- One-way ANOVA
- Multiple Regression

## Data Analysis and Interpretation

**Table 2** *Descriptive Statistics of Major Variables*

| Variable | Mean | SD |
|---|---|---|
| AI Usage | 76.82 | 11.24 |
| Critical Thinking | 65.40 | 9.18 |
| Cognitive Engagement | 67.22 | 8.95 |

*Note. SD = standard deviation*

### Interpretation

The descriptive statistics indicate that the participants demonstrate a relatively high level of AI usage (M = 76.82, SD = 11.24), suggesting that AI tools are frequently integrated into their academic activities, with moderate variability among students. Critical thinking ability shows a moderately high mean score (M = 65.40, SD = 9.18), reflecting an overall adequate level of analytical and evaluative skills, though individual differences are evident. Similarly, cognitive engagement records a fairly high mean (M = 67.22, SD = 8.95), indicating that most students are actively involved in learning tasks and mental effort.

**Table 3** *Correlation Matrix among AI Usage, Critical Thinking, and Cognitive Engagement*

| Variables | AI Usage | Critical Thinking | Cognitive Engagement |
|---|---|---|---|
| AI Usage | 1.00 | –0.49** | –0.42** |
| Critical Thinking | –0.49** | 1.00 | 0.61** |
| Cognitive Engagement | –0.42** | 0.61** | 1.00 |

*Note. p < .01 (two-tailed)*

### Interpretation

The results indicate a significant moderate negative relationship between AI usage and critical thinking ($r = –0.49$, $p < .01$) and between AI usage and cognitive engagement ($r = –0.42$, $p < .01$). In contrast, critical thinking and cognitive engagement are strongly and positively related ($r = 0.61$, $p < .01$). These findings suggest that higher AI usage is associated with reduced higher-order cognitive functioning, particularly when engagement is low; therefore, $\mathbf{H_{01}}$ is rejected.

**Figure 1:**

*Relationship between AI Usage and Critical Thinking*

**Critical Thinking**

**80 |** ●

**75 |** ●

**70 |** ●

**65 |** ●

**60 |** ●

**55 |** ●

**-------------------------**

**Low Moderate High**

### Interpretation

Figure 1 demonstrates a clear inverse relationship between AI usage and critical thinking ability. The progressive decline in critical thinking scores from low to high levels of AI usage suggests that increased dependence on AI tools is associated with reduced higher-order cognitive performance. This visual trend corroborates the statistical correlation results, suggesting that excessive AI use may be associated with diminished analytical and evaluative thinking skills in academic contexts.

**Table 4** *One-Way ANOVA for Critical Thinking by AI Usage Level*

| Source | SS | df | MS | F | p |
|---|---|---|---|---|---|
| Between Groups | 2480.5 | 2 | 1240.25 | 18.64 | .001 |
| Within Groups | 27645.2 | 417 | 66.30 | | |
| Total | 30125.7 | 419 | | | |

*Note.* SS = sum of square, df = degree of freedom, MS = mean square

**Interpretation**

The one-way ANOVA results indicate a statistically significant difference in critical thinking scores across different levels of AI usage, $F = 18.64$, $p = .001$. This suggests that students' critical thinking ability varies depending on whether they are low, moderate, or high AI users, with higher AI usage generally associated with lower critical thinking scores. Therefore, the null hypothesis $\mathbf{H_{02}}$, which stated that there is no difference in critical thinking among AI usage groups, is rejected.

**Table 4** *Post-Hoc Comparison (Tukey HSD)*

| Group Comparison | Mean Difference | p |
|---|---|---|
| Low vs Moderate | –1.84 | .12 |
| Moderate vs High | –5.96 | .001 |
| Low vs High | –7.80 | .001 |

**Interpretation**

Significant differences exist between moderate and high AI users and between low and high AI users**,** with high AI users scoring significantly lower in critical thinking. No significant difference is observed between low and moderate users, suggesting that cognitive decline becomes evident mainly at excessive AI usage levels.

**Table 5** *Multiple Regression Analysis*

**Dependent Variable:** Critical Thinking

| Predictor | B | SE | β | t | p |
|---|---|---|---|---|---|
| Constant | 96.44 | 3.88 | — | 24.86 | .001 |
| AI Usage | –0.51 | 0.05 | –0.48 | –9.92 | .001 |
| Cognitive Engagement | 0.39 | 0.07 | 0.32 | 5.57 | .001 |

**Interpretation**

The multiple regression analysis reveals that AI usage is a significant negative predictor of critical thinking ability ($\beta = –0.48, p < .001$), indicating that increased reliance on AI is associated with lower critical thinking among university students, whereas cognitive engagement is a significant positive predictor ($\beta = 0.32$, $p < .001$), suggesting that higher engagement enhances critical thinking. As AI usage significantly predicts critical thinking outcomes, the null hypothesis $\mathbf{H_{03}}$ is rejected.

**Findings of the Study**

- High levels of artificial intelligence usage are significantly associated with lower critical thinking ability among university students.
- Students who rely excessively on AI tools demonstrate reduced capacity for analysis, evaluation, and independent reasoning.
- Cognitive engagement shows a strong and positive relationship with critical thinking ability.
- Students who actively invest mental effort in learning tasks consistently perform better on critical thinking measures.

- Moderate users of AI outperform excessive users in cognitive outcomes.
- Selective and purposeful use of AI supports learning without undermining intellectual effort.
- AI usage alone does not determine an individual's intelligence or cognitive capacity.
- The impact of AI on critical thinking is mediated by the level of cognitive engagement maintained by learners.
- Students who remain cognitively engaged while using AI do not experience significant cognitive decline.

**Discussion**

The present study was undertaken to empirically examine the relationship between AI usage, critical thinking ability, and cognitive engagement among university students, with specific reference to the stated objectives. The findings are discussed below, objective-wise and interpreted in light of existing theories and empirical literature.

**Objective 1: To examine whether there is a significant relationship between AI usage and critical thinking ability among university students.**

The results revealed a statistically significant and moderate negative relationship between AI usage and critical thinking ability. This finding suggests that as students' reliance on AI tools increases, their capacity for analysis, evaluation, and independent reasoning tends to decline. This outcome aligns strongly with the theory of **cognitive offloading** (Risko & Gilbert, 2016), which posits that frequent delegation of mental tasks to external tools can reduce the engagement of internal cognitive processes. When AI systems provide ready-made explanations, arguments, or solutions, students may bypass the effortful reasoning processes that are essential for the development of critical thinking. Similar concerns have been echoed by Sparrow et al. (2011), who observed that easy access to external information sources diminishes individuals' tendency to actively process and retain knowledge. Thus, the present findings provide empirical support to the argument that unreflective and excessive AI use may be detrimental to higher-order cognitive development.

**Objective 2: To determine whether there is a significant difference in critical thinking among low, moderate, and high AI users among university students.**

The ANOVA results demonstrated significant differences in critical thinking ability across different levels of AI usage. Post-hoc comparisons further clarified that students categorized as high AI users scored significantly lower in critical thinking than both low and moderate users, while no significant difference was found between low and moderate AI users. This pattern indicates that AI usage is not inherently harmful; rather, its negative impact becomes evident at excessive levels of dependence. Moderate AI use may function as a supportive learning aid, enhancing efficiency without replacing cognitive effort. However, when AI becomes a substitute for thinking rather than a tool for thinking, critical reasoning skills appear to suffer. These findings resonate with prior research suggesting that technology enhances learning only when it promotes active engagement and reflection, but leads to surface learning when it encourages passive consumption (OECD, 2021). Hence, the study underscores the importance of balanced and purposeful AI use in academic contexts.

**Objective 3: To assess whether AI usage significantly predicts critical thinking and cognitive engagement among university students.**

The multiple regression analysis revealed that AI usage is a strong negative predictor of critical thinking, even when cognitive engagement is taken into account, whereas cognitive engagement emerged as a significant positive predictor. This indicates that increased AI reliance independently contributes to lower critical thinking ability, while active mental involvement in learning tasks enhances it. The stronger predictive influence of AI usage compared to cognitive engagement highlights the potential risk of cognitive displacement caused by AI-driven automation of reasoning processes. At the same time, the positive role of cognitive engagement suggests that students who consciously invest effort, reflect on content, and actively process information are better able to maintain critical thinking skills, even in AI-rich environments. This finding aligns with research on **automation bias** (Parasuraman & Riley, 1997), which warns that unquestioned acceptance of automated outputs can undermine judgment and critical evaluation. Therefore, the study emphasizes that the cognitive consequences of AI depend not merely on access to technology but on how learners engage with it.

## Educational Implications

The findings of this study carry important implications for higher education policy, pedagogy, and curriculum design.

- First, the results highlight the urgent need to integrate **AI literacy** into higher education curricula. AI literacy should go beyond technical proficiency to include critical awareness of AI's cognitive limitations, biases, and epistemic risks. Students must be trained to view AI as a fallible tool that requires human judgment, rather than as an infallible source of knowledge.
- Second, the study underscores the necessity of **rethinking assessment practices** in the age of AI. Traditional assessment models that emphasize final products such as essays or problem solutions are increasingly vulnerable to automation. To preserve the cultivation of critical thinking, assessments should prioritize reasoning processes, justification of arguments, reflective commentary, and oral or applied demonstrations of understanding. Such designs encourage cognitive engagement and reduce incentives for uncritical AI reliance.
- Third, the findings suggest that **reflective AI use must be explicitly taught**. Educators should model and scaffold strategies for using AI as a support for brainstorming, clarification, or feedback, while ensuring that core reasoning tasks remain human-driven. Pedagogical approaches such as guided AI use, metacognitive prompts, and reflective logs can help students maintain intellectual ownership of their learning. In this way, education can harness the benefits of AI without sacrificing cognitive development.

## Conclusion

The study concludes that artificial intelligence usage significantly influences critical thinking and cognitive engagement among university students. Excessive dependence on AI is associated with reduced critical thinking ability, whereas moderate and purposeful use does not adversely affect cognitive outcomes. Cognitive engagement emerges as a crucial positive factor that enhances critical thinking and mitigates the negative effects of AI reliance. These findings suggest that AI does not inherently diminish intellectual capacity; rather, uncritical substitution of human reasoning by AI leads to cognitive disengagement. Therefore, promoting reflective, balanced, and pedagogically guided AI use is essential to ensure that higher education continues to foster higher-order thinking skills.

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# EXPLORING THE ROLE OF DIGITAL TECHNOLOGY IN SOCIAL BEHAVIOUR DEVELOPMENT AMONG LATE ADOLESCENTS

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**Abstract**

In recent years, digital technology has become deeply embedded in the daily lives of adolescents, significantly influencing their patterns of communication, social interaction, and relationship formation. The widespread use of mobile devices, social media platforms, and instant messaging applications has led to an increased integration of online and offline social experiences. Digital technology not only expands adolescents' social networks but also provides opportunities for self-expression, identity construction, and participation in diverse social environments. Apart from these advantages, the growing reliance on digital platforms has raised concerns regarding reduced face-to-face interaction, increased dependency on digital communication, and evolving norms of interpersonal behaviour. This study aims to examine the role of digital technology in shaping adolescent social behaviour by exploring adolescents' perceptions and lived experiences of digital engagement. The study adopts a qualitative exploratory research design, utilizing open-ended questionnaires to collect descriptive data on adolescents' digital practices, social interactions, and behavioural changes. The collected data are analysed using thematic analysis to identify key themes and patterns related to social behaviour within digital contexts. The findings of the study are expected to highlight the dual impact of digital technology, demonstrating both its potential to enhance social connectivity and its challenges in influencing behavioural patterns. The study emphasizes the importance of balanced and responsible digital engagement to support healthy social development among adolescents.

***Keywords:*** *Adolescent Social Behaviour, Digital Technology, Digital Communication, Social Interaction,*

## Introduction

Rapid advancements in digital technology have transformed adolescents' communication, interaction, and relationships. Smartphones, internet access, and social media enable continuous connectivity, shaping identity and social perceptions. Late adolescence (18–21 years) is a crucial stage for identity formation and peer relationships, making digital engagement highly influential. While digital platforms enhance connectivity, access to information, and self-expression, excessive use may reduce face-to-face interaction and increase social comparison. The impact is therefore complex and multidimensional. This study is significant as it examines both opportunities and challenges of digital engagement, providing insights to support balanced and responsible technology use among adolescents and guide educators and policymakers.

## Objectives

1. To understand how late adolescents, use digital technology for social interaction and communication in daily life.
2. To examine how digital platforms shape identity expression and self-presentation among late adolescents.
3. To explore perceived changes in relationships and interpersonal behaviour due to digital engagement.

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4. To identify perceived benefits and challenges of digital technology for late adolescents' social development.

**Research Questions**

1. How do late adolescents (18–21 years) describe their digital technology use for social interaction and communication?
2. How do late adolescents perceive digital platforms influencing their identity expression and self-presentation?
3. What changes in relationships and social behaviour do late adolescents report since engaging with digital technology?
4. What benefits and challenges do late adolescents experience regarding digital technology's influence on their social development?

**Review of Literature**

Digital technology, including smartphones and social media platforms, enables adolescents to communicate, share information, and build relationships beyond physical boundaries (Boyd, 2014). These platforms have reshaped traditional forms of interaction, making communication more immediate and continuous (Valkenburg & Peter, 2011).

Social Learning Theory suggests that adolescents learn behaviours through observation and imitation in digital environments (Bandura, 1977). Erikson's Psychosocial Development Theory highlights adolescence as a stage of identity formation, where digital platforms support self-expression (Erikson, 1968). Social Comparison Theory explains how exposure to others online influences self-perception and behaviour (Festinger, 1954).

Digital technology has both positive and negative effects on adolescent social behaviour. It enhances connectivity, supports relationships, and enables identity exploration (Boyd, 2014). However, excessive use may reduce face-to-face interaction, increase social comparison, and affect interpersonal skills (Twenge, 2019; Keles et al., 2020). The impact largely depends on usage patterns and context (Odgers & Jensen, 2020).

***Research Gap***

Most studies focus on general adolescent populations and quantitative methods, with limited emphasis on late adolescents and their lived experiences. There is a need for qualitative research to better understand how digital engagement influences social behaviour. The literature indicates that digital technology plays a significant role in shaping adolescent social behaviour, offering both opportunities and challenges. This highlights the importance of exploring adolescents' perspectives through qualitative approaches.

**Research Methodology**

The study adopts a qualitative exploratory design to examine the influence of digital technology on the social behaviour of late adolescents (18–21 years). Participants were college students selected through non-probability sampling, specifically combining purposive and convenience sampling techniques. This ensured that participants met the inclusion criteria, were accessible, willing to participate, and had adequate experience with digital engagement to provide meaningful insights. The data collected were analyzed using thematic analysis, which enabled the identification and interpretation of recurring patterns and themes within participants' responses. The sample size for this study consisted of 52 participants, allowing for rich, in-depth qualitative data and comprehensive thematic interpretation.

***Variables of the Study and Research Tools***

The study conceptually identifies digital technology use as the independent variable and the social behaviour of late adolescents as the dependent variable, with demographic factors serving as contextual variables. Data were collected using an open-ended questionnaire, which included demographic details and questions related to digital engagement, communication patterns, interpersonal relationships, perceived behavioural changes, as well as the benefits and challenges of digital technology use. The instrument was developed based on an extensive review of existing literature and was framed in simple and clear language suitable for late adolescents. This approach was adopted to encourage detailed responses and to effectively capture participants' perceptions, experiences, and viewpoints.

**Interpretation and Analysis of Data / Findings**

The table 1 the demographic characteristics of participants are analysed after collecting the data from the participants shows the findings as organised into demographic profile and thematic analysis sections. Demographic information such as age, gender, educational status, and digital access provides context for interpreting responses. The thematic section examines patterns related to digital technology use and its influence on the social behaviour of late adolescents.

**Table 1:** ***Demographic Characteristics of Participants***

| Demographic Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| **Age (years)** | 18 | 15 | 34.1 |
| | 19 | 15 | 34.1 |
| | 20 | 6 | 13.6 |
| | 21 | 8 | 18.2 |
| **Gender** | Male | 35 | 79.5 |
| | Female | 9 | 20.5 |
| **Educational Status** | Undergraduate | 43 | 97.7 |
| | Diploma | 1 | 2.3 |
| **Course / Discipline** | Engineering (CSE/IT) | 29 | 65.9 |
| | Engineering (General) | 9 | 20.5 |
| | Engineering (Civil) | 3 | 6.8 |
| | Engineering (EEE) | 1 | 2.3 |
| | BCA | 1 | 2.3 |
| | Pharmacy | 1 | 2.3 |
| **Type of Institution** | Autonomous | 23 | 52.3 |
| | Private | 20 | 45.5 |
| | Government | 1 | 2.3 |
| **Area of Residence** | Urban | 36 | 81.8 |
| | Semi-urban | 5 | 11.4 |
| | Rural | 3 | 6.8 |
| **Living Arrangement** | With family | 21 | 47.7 |
| | With parents | 16 | 36.4 |
| | Rented accommodation | 6 | 13.6 |
| | Hostel | 1 | 2.3 |
| **Socio-economic Background** | Middle class | 37 | 84.1 |
| | High class | 5 | 11.4 |
| | Low class | 2 | 4.5 |
| **Primary Digital Device** | Multiple devices | 21 | 47.7 |
| | Smartphone | 19 | 43.2 |
| | Laptop | 2 | 4.5 |
| | Tablet | 1 | 2.3 |
| | Desktop computer | 1 | 2.3 |
| **Average Daily Screen Time** | ≤ 2 hours | 3 | 6.8 |
| | 3–4 hours | 7 | 15.9 |
| | 5–6 hours | 12 | 27.3 |
| | 7–8 hours | 10 | 22.7 |
| | 9–10 hours | 7 | 15.9 |
| | > 10 hours | 5 | 11.4 |

**Interpretation:**

- Participants were late adolescents (18–21 years, mean ≈19), predominantly male, and almost all undergraduates, mainly from engineering disciplines, especially Computer Science and IT.
- Most respondents studied in autonomous or private institutions and were largely from urban areas, reflecting limited rural and government college representation.
- The majority belonged to middle socio-economic backgrounds and lived with family, indicating relatively stable living environments.
- Digital access was high, with smartphones as the primary device and many participants using multiple digital technologies.
- Daily engagement was typically 5–8 hours or more, mainly for academics, followed by social media, entertainment, and communication, showing strong digital involvement.

**Thematic Analysis of Data:**

To address the research objectives, a semi-structured interview schedule was developed in alignment with the study's research questions. The questions focused on late adolescents' use of digital technology, social interaction and communication, identity expression, and perceived changes in relationships. The alignment between the research objectives, research questions, and interview questions is presented.

**Objective***: To understand how late adolescents use digital technology for social interaction and communication in daily life*

**Research Question:** How do late adolescents (18–21 years) describe their digital technology use for social interaction and communication?

**Theme 1: Digital Life Companion**

Participants consistently described digital technology as an inseparable component of their everyday routines. Smartphones, laptops, and internet-based platforms were used continuously for academic work, communication, entertainment, and task management. Many participants expressed that daily functioning—such as studying, staying informed, or communicating with peers—was difficult to imagine without digital technology.

**Theme 2: Multifunctional Platforms**

Digital platforms were used for multiple purposes simultaneously. Messaging applications and social media were primarily used for maintaining social connections, while video platforms and search engines supported learning and information-seeking. Participants highlighted the convenience of accessing academic resources, notes, and group discussions through digital means, indicating the blending of academic and social use.

**Theme 3: Habitual Screen Use**

Most participants reported limited conscious regulation of screen time. Usage was often described as habitual, routine-driven, or mood-dependent rather than planned. While a few participants mentioned setting timers or prioritising tasks, many acknowledged excessive or uncontrolled usage, especially during free time or periods of stress.

**Objective:** To examine how digital platforms shape identity expression and self-presentation among late adolescents

**Research Question:** How do late adolescents perceive digital platforms influencing their identity expression and self-presentation?

**Theme 4: Digital Self-Expression**

Participants reported that digital platforms provided greater flexibility in expressing thoughts and emotions. The use of text, emojis, gifs, images, and status updates enabled creative and selective self-expression. Several participants felt that online communication allowed more time to think before responding, resulting in clearer or more confident expression.

**Theme 5: Selective Online Identity**

Many participants acknowledged that digital technology encouraged selective self-presentation. They described consciously choosing what aspects of themselves to share online, often presenting a controlled or polished version of their identity. While this made expression feel safer, some participants felt it reduced authenticity compared to face-to-face interactions.

**Objective:** To explore perceived changes in relationships and interpersonal behaviour due to digital engagement

**Research Question:** What changes in relationships and social behaviour do late adolescents report since engaging with digital technology?

**Theme 6: Distant Connections**

Digital technology was widely perceived as facilitating the maintenance of friendships and family relationships, particularly across physical distance. Messaging apps and social media enabled frequent contact, helping participants stay connected with people they could not meet regularly.

**Theme 7: Shift to Digital Interaction**

Participants reported a noticeable shift from in-person interactions to digital communication. While online interaction was considered faster and more convenient, many participants felt it reduced the depth and emotional richness of relationships. Some expressed concern that digital interaction had replaced meaningful face-to-face conversations.

**Theme 8: Communication Preferences**

Comfort levels varied across participants. Some felt more confident communicating online due to reduced social pressure, while others preferred face-to-face interaction for emotional clarity and genuine connection. This theme highlights individual differences in interpersonal behaviour shaped by digital engagement.

**Objective:** To identify perceived benefits and challenges of digital technology for late adolescents' social development

**Research Question:** What benefits and challenges do late adolescents experience regarding digital technology's influence on their social development?

**Theme 9: Social Growth Opportunities**

Participants reported several benefits, including improved access to information, academic support, social awareness, emotional support, and opportunities to form new social connections. Digital platforms were also credited with enhancing confidence, humour, and communication skills for some participants.

**Theme 10: Psychosocial Challenges**

Despite benefits, participants identified multiple challenges such as distraction, addiction, reduced attention span, misunderstandings in communication, social comparison, and reduced in-person interaction. Some participants associated excessive digital use with stress, anxiety, and emotional exhaustion.

**Theme 11: Mindful Technology Use**

A strong theme across responses was the need for balanced digital usage. Participants emphasised self-control, time management, limiting screen time, and prioritising face-to-face interactions. Many believed digital technology should support, rather than replace, real-life relationships to promote healthy social development.

## Results and Discussion

This study explored how late adolescents (18–21 years) perceive digital technology in relation to social interaction, identity expression, relationships, and social development. The demographic profile reflects individuals in a transitional stage where academic demands, peer relationships, and identity exploration are significant, explaining the central role of digital technology. Findings indicate that digital technology is deeply embedded in daily routines, supporting academics, communication, and entertainment. Participants viewed digital platforms as essential tools for both learning and maintaining social connections.

For digital platforms influenced identity expression by enabling creative and flexible communication through multimedia formats. However, participants reported selective self-presentation, suggesting curated identities that may limit authenticity. Regarding digital technology facilitated maintaining relationships across distance but contributed to reduced face-to-face interaction. While some participants preferred online communication for comfort, others valued in-person interaction for emotional clarity.

For participants identified benefits such as improved access to information, social awareness, and new connections, alongside challenges including distraction, excessive screen time, and emotional strain. Overall, late adolescents demonstrated awareness of both advantages and drawbacks, emphasizing the need for balanced and mindful digital engagement.

## Conclusion

The findings of the present study indicate that digital technology has become an integral part of the social, academic, and personal lives of late adolescents (18–21 years). Participants reported that digital platforms support learning, communication, identity exploration, and relationship maintenance, while also presenting challenges such as distraction, reduced face-to-face interaction, and emotional strain when used excessively. These findings highlight the dual role of digital technology in contemporary adolescent development.

The results align with the principles of the National Education Policy (NEP) 2020, which emphasises meaningful integration of technology in education while promoting holistic development. Participants' experiences of improved academic access and connectivity support NEP 2020's focus on enhancing learning through digital tools. At the same time, concerns about overuse and weakened interpersonal relationships reflect the policy's emphasis on balanced and ethical technology use. The study also reinforces the importance of life skills, emotional intelligence, and digital literacy, as participants recognised the need for self-regulation and mindful engagement.

Contribution of the Study: This study contributes by providing qualitative insights into how late adolescents perceive digital technology's influence on social behaviour, identity, and relationships. It highlights the need for educational strategies that integrate digital literacy, socio-emotional learning, and responsible technology use. The findings support policymakers, educators, and institutions in aligning practices with NEP 2020 to promote healthy digital engagement and overall well-being.

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# LIBRARY USERS' AWARENESS AND USES OF ARTIFICIAL INTELLIGENCE FOR ACADEMIC AND RESEARCH PURPOSES

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**Abstract**

Artificial intelligence (AI) is revolutionizing library services and enhancing user experience, ushering in a new era of efficiency, accessibility, and innovation. To examine the awareness on AI-Tools – Generative AI, Educational planning, literature mapping, bibliography/reference – by the faculty members, research scholars and students; frequency of AI application in different academic contexts and obstacles in using artificial intelligence to research projects or college libraries. A survey method was used. The data was collected administering a research questionnaire using simple random sampling technique among 99 stakeholders. The collected data was anzlysed using simple percentage analysis using SPSS. Academic groups like faculty (86.3% aware), research scholars (100%), and students (86.7%) know AI tools well, such as ChatGPT, Gemini, TeacherMatic, and Shikshana Foundation, plus literature ones like Litmaps, Semantic Scholar, Research Rabbit, Zotero, and Mendeley—mostly learned from social media (26.3%), workshops (9.1%), and friends (8.1%). Faculty use AI often (>90%) for lessons, grading, and fun learning activities, but only sometimes due to lack of training, and worry it might replace teachers. More training workshops can fix these gaps and help everyone use AI better. In light of evolving educational environments, this research study positions scholars to effectively leverage AI's promise.

***Keywords**: Artificial Intelligence, Teacher Education Institutions, Library Users, Awareness, Usefulness.*

## Introduction

A new era of efficiency, accessibility, and creativity is being ushered in by artificial intelligence (AI), which is transforming library services and improving user experience. As a result, AI currently has a significant impact on how knowledge is handled and library services are delivered. With the use of technologies like machine learning, natural language processing, and data analytics, AI therefore makes categorizing and organizing easier, freeing up library workers' precious time for functional value addition (Preethi, 2024; Kumar & Jyoti, 2024). Furthermore, AI solutions that are changing the paradigm of user interfaces and improving user pleasure and engagement include intelligent search systems, virtual assistant agents, and personal recommender systems (Anandraj & Aravind, 2024; Sivasankari et al., 2024).

Library chores are now simpler and more user-focused thanks to the incorporation of AI tools. Although the usage of AI technologies in libraries is growing, many patrons are not familiar with this technology. Users' ignorance of AI's capabilities and limits prevents them from making the most of these tools. To properly utilize AI tools, library patrons must be aware of this technology. AI-powered chatbots, search engines, and data analysis tools offer users quick and precise information. It is crucial to provide users with guidance regarding ethical concerns, training AI tools, and accurate information evaluation.

## Review of Literature

Dhar and Das (2025) sought to analyse the evolving role of AI in traditional library operations as well as its potential in the areas of user engagement, classification, personalized searching, and archiving. The substantial potential of AI-based ITS to revolutionize education through personalized and flexible learning experiences was emphasized in this review research by Soma Shekhar (2025). Harde (2025) looked into

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library patrons' understanding of AI and their propensity to employ it in library services. Using a qualitative methodology, Bakiri, Mbembati, and Tinabo (2023) examined the degree of awareness and potential for AI adoption in Tanzanian academic libraries. According to Lund and Wang (2023), the appropriate application of AI technology, particularly chatGPT, improves library services like search and discovery, reference, information services, catalogue, and content creation while upholding moral principles like bias and privacy. According to a different study, artificial intelligence (AI) automates and streamlines certain tasks in academic libraries that could lead to the loss of librarian jobs. Nevertheless, some librarians feel that AI offers numerous tools to improve the functionality of academic libraries, freeing them up to concentrate on more complex and valuable tasks (Adetayo, 2023).

**Objectives of the study**

1. To know the frequency of library visit by the respondents.
2. To examine the awareness on AI-Tools – Generative AI, Educational planning, literature mapping, bibliography/reference – by the faculty members, research scholars and students.
3. To find out the frequency of AI applied in different academic contexts.
4. To analyze the obstacles in using artificial intelligence to research projects or college libraries.

**Methodology**

A survey method was used for the present study. The awareness of AI technologies among the different library users of teacher educational institutes Hyderabad, was surveyed. To select from a diverse community of faculty members (N=51), research scholars N=3), and students (N=45), the study used a stratified random selection technique.  A well-structured questionnaire on dimensions like, AI Tools awareness, usage of AI in teaching and user perceptions, was sent to the respondents through Google Forms, in turn the respondents sent back filled-in forms.  The data was analysed using SPSS and the descriptive statistics, such as percentage analysis and chi-square results were presented in tables.

**Data Analysis and Interpretation**

**Table 1**

*Respondents' Demographics*

| Sl. No. | Variable | Category | Frequency | Percentage |
|---|---|---|---|---|
| 1 | Gender | Female | 67 | 67.7 |
| | | Male | 32 | 32.3 |
| | | Prefer not to say | 0 | 0.0 |
| | | Total | 99 | 100.0 |
| 2. | Current role | Faculty Member | 51 | 51.5 |
| | | Research Scholar | 3 | 3.0 |
| | | Student | 45 | 45.5 |
| | | Total | 99 | 100.0 |
| 3. | Specialization | Elementary Education | 10 | 10.1 |
| | | Other | 44 | 44.4 |
| | | Secondary Education | 34 | 34.3 |
| | | Special Education | 11 | 11.1 |
| | | Total | 99 | 100.0 |
| 4, | Library visits | Daily | 25 | 25.3 |
| | | Monthly | 20 | 20.2 |
| | | Rarely | 29 | 29.3 |
| | | Weekly | 25 | 25.3 |
| | | Total | 99 | 100.0 |

**Source:** Primary data

The distribution of the respondents on the basis of gender female (N=67; 67.7%) are higher than male (N=32; 32.3%). Based on their current role faculty members (N=51; 51.5%) are more compared to students (N=45; 45.5%) and research scholars (N=3, 3.0%). The respondents visit the library rarely (N=29; 29.3%), daily (N=25; 25.3%), weekly (N=25; 25.3%) and monthly (N=20; 20.2%), so majority of respondents visit library rarely.

**Awareness on AI Tools**

**Table 2** *Awareness of AI-powered Research and Education Tools*

| Do you know of any AI-powered research and education tools? | | | Current Role | | | Total |
|---|---|---|---|---|---|---|
| | | | Faculty Member | Research Scholar | Student | |
| 1. | Yes | N | 44 | 3 | 39 | 86 |
| | | % | 86.3% | 100.0% | 86.7% | 86.9% |
| 2. | No | N | 7 | 0 | 6 | 13 |
| | | % | 13.7% | 0.0% | 13.3% | 13.1% |
| Total | | N | 51 | 3 | 45 | 99 |
| | | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

From the above table it is observed that majority faculty members (N=44; 86.3%), research scholars (N=3; 100%) and students (N=39; 86.7%) know artificial intelligence tools in research and education. Therefore, it is said that out of 99 respondents, majority respondents (N=86; 86.9%) of them know AI powered research and education tools. Further, it is also found that 100% research scholars know AI tools.

Using patterns found in data, generative AI produces new material, such as text or graphics. Its influence is indisputable, with programs like ChatGPT, Gemini, and ClaudeAI, etc., reaching millions of users.

**Table 3** *Generative AI Tools Known by Respondents*

| Generative AI tools | | | Current Role | | | Total |
|---|---|---|---|---|---|---|
| | | | Faculty Member | Research Scholar | Student | |
| 1. | ChatGPT | N | 13 | 0 | 15 | 28 |
| | | % | 25.5% | 0.0% | 33.3% | 28.3% |
| 2. | ChatGPT, Claude | N | 2 | 0 | 2 | 4 |
| | | % | 3.9% | 0.0% | 4.4% | 4.0% |
| 3. | ChatGPT, Claude, Gemini | N | 8 | 0 | 5 | 13 |
| | | % | 15.7% | 0.0% | 11.1% | 13.1% |
| 4. | ChatGPT, Claude, Gemini, Others | N | 11 | 0 | 0 | 11 |
| | | % | 21.6% | 0.0% | 0.0% | 11.1% |
| 5. | ChatGPT, Gemini | N | 8 | 2 | 16 | 26 |
| | | % | 15.7% | 66.7% | 35.6% | 26.3% |
| 6. | ChatGPT, Gemini, Others | N | 5 | 1 | 2 | 8 |
| | | % | 9.8% | 33.3% | 4.4% | 8.1% |
| 7. | ChatGPT, Others | N | 2 | 0 | 1 | 3 |
| | | % | 3.9% | 0.0% | 2.2% | 3.0% |
| 8. | Gemini | N | 0 | 0 | 2 | 2 |
| | | % | 0.0% | 0.0% | 4.4% | 2.0% |
| 9. | Others | N | 2 | 0 | 2 | 4 |
| | | % | 3.9% | 0.0% | 4.4% | 4.0% |
| Total | | N | 51 | 3 | 45 | 99 |
| | | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

Table shows that among 51 faculty members, 13 (25.5%) respondents know ChatGPT AI tool, 2 (66.7%) research scholars know ChatGPT and Gemini AI tool and similarly, 16 (35.6%) of students also know Generative AI tools like ChatGPT and Gemini. From this, it is found that faculty members (25.5%) know ChatGPT only, whereas majority research scholars (66.7%) and students (35.6%) know both ChatGPT and Gemini Generative AI tools.

By automating time-consuming procedures, educational planning AI tools like - MagicSchool.ai, Eduaide.AI, Diffit, Brisk Teaching, TeacherMatic, Curipod and Shikshana Foundation are revolutionizing how teachers develop curricula, produce educational materials, and oversee classrooms. Lesson planning, subject differentiation, assessments, and individualized learning experiences can all be produced by these tools. The following table provides the information on various educational planning AI tools used.

**Table 4**
*Educational Planning AI Tools Known by Respondent*

| Educational Planning AI tools | | Current Role | | | Total |
|---|---|---|---|---|---|
| | | **Faculty Member** | **Research Scholar** | **Student** | |
| 1. Shikshana Foundation | N | 6 | 0 | 8 | 14 |
| | % | 11.8% | 0.0% | 17.8% | 14.1% |
| 2. TeacherMatic | N | 11 | 0 | 3 | 14 |
| | % | 21.6% | 0.0% | 6.7% | 14.1% |
| 3. TeacherMatic, Shikshana Foundation | N | 5 | 0 | 3 | 8 |
| | % | 9.8% | 0.0% | 6.7% | 8.1% |
| 4. TeacherMatic, Shikshana Foundation, Others | N | 1 | 0 | 0 | 1 |
| | % | 2.0% | 0.0% | 0.0% | 1.0% |
| 5. Others | N | 28 | 3 | 31 | 62 |
| | % | 54.9% | 100.0% | 68.9% | 62.6% |
| Total | N | 51 | 3 | 45 | 99 |
| | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

In above table, the investigators presented the respondents opinions on awareness of educational planning AI Tools. The AI Tool which is known by Faculty members (N=11; 21.6%) is TeacherMatic and research scholars (N=3; 100.0%) and students (N=31; 68.9%) known is Shikshana Foundation. Further, the study also found that out of 99 respondents, three-fourths of the respondents know many other educational planning AI Tools, such as Magic School. ai, Eduaide. AI, Diffit, Brisk Teaching, and Curipod.

Top tools include Connected Papers for creating visual graphs, Litmaps for tracking citations, and ResearchRabbit for mapping networks.

**Table 5**
*Literature Mapping AI Tools Known by Respondents*

| Literature Mapping AI tools | | Current Role | | | Total |
|---|---|---|---|---|---|
| | | **Faculty Member** | **Research Scholar** | **Student** | |
| 1. Consensus | N | 4 | 1 | 4 | 9 |
| | % | 7.8% | 33.3% | 8.9% | 9.1% |
| 2. Litmaps | N | 8 | 0 | 10 | 18 |
| | % | 15.7% | 0.0% | 22.2% | 18.2% |
| 3. Litmaps, Others | N | 0 | 0 | 1 | 1 |
| | % | 0.0% | 0.0% | 2.2% | 1.0% |
| 4. Litmaps, Semantic Scholar | N | 2 | 0 | 0 | 2 |
| | % | 3.9% | 0.0% | 0.0% | 2.0% |
| 5. Litmaps, Semantic Scholar, Consensus | N | 0 | 1 | 1 | 2 |
| | % | 0.0% | 33.3% | 2.2% | 2.0% |

**Table 5**
*Literature Mapping AI Tools Known by Respondents*

| Literature Mapping AI tools | | Current Role: Faculty Member | Current Role: Research Scholar | Current Role: Student | Total |
|---|---|---|---|---|---|
| 6. Litmaps, Semantic Scholar, Consensus, Others | N | 1 | 0 | 0 | 1 |
| | % | 2.0% | 0.0% | 0.0% | 1.0% |
| 7. Others | N | 22 | 1 | 24 | 47 |
| | % | 43.1% | 33.3% | 53.3% | 47.5% |
| 8. Semantic Scholar | N | 9 | 0 | 3 | 12 |
| | % | 17.6% | 0.0% | 6.7% | 12.1% |
| 9. Semantic Scholar, Consensus | N | 2 | 0 | 0 | 2 |
| | % | 3.9% | 0.0% | 0.0% | 2.0% |
| 10. Semantic Scholar, Consensus, Others | N | 1 | 0 | 0 | 1 |
| | % | 2.0% | 0.0% | 0.0% | 1.0% |
| 11. Semantic Scholar, Others | N | 2 | 0 | 2 | 4 |
| | % | 3.9% | 0.0% | 4.4% | 4.0% |
| Total | N | 51 | 3 | 45 | 99 |
| | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

With regard to literature mapping AI tools, 9 (17.6%) faculty members know 'Semantic Scholar' Literature Mapping AI tool, 8 (15.7%) know 'Litmpas' and 4 (7.8%) 'Consensus'. The only research scholar (N=1, 33.3%) know 'Consensus'. Ten (22.2%) students aware of 'Litmaps', 4 (8.9%) know 'Consensus' and 3 (6.7%) know 'Semantic Scholar' literature mapping AI Tool. On the whole, the results indicates that majority know 'Litmaps' (18.2%), 'Semantic scholar' (12.1%) and 'Consensus' 9 (9.1%) AI tool. Further, 43.1% faculty members, 53.3% students and 33.3% research scholars also aware other literature mapping AI tools like: 'Research rabbit', Inciteful: SciSpace Sourcely, etc.

Citation creation, finding, and formatting for academic writing are automated by top AI bibliography and reference software like Paperpal, Sourcely, and Zotero. Important choices are Scite.ai for citation context validation and ZoteroBib for rapid, free citations. The following table illustrates respondents' interests on Bibliography/Reference AI Tools.

**Table 6**
***Bibliography/Reference AI Tools Known by Respondents***

| Bibliography/Reference AI tools | | Current Role: Faculty Member | Current Role: Research Scholar | Current Role: Student | Total |
|---|---|---|---|---|---|
| 1. Mendeley | N | 17 | 0 | 4 | 21 |
| | % | 33.3% | 0.0% | 8.9% | 21.2% |
| 2. Mendeley, Others | N | 1 | 1 | 1 | 3 |
| | % | 2.0% | 33.3% | 2.2% | 3.0% |
| 3. Mendeley, Zotero | N | 5 | 0 | 1 | 6 |
| | % | 9.8% | 0.0% | 2.2% | 6.1% |
| 4. Mendeley, Zotero, Others | N | 2 | 0 | 0 | 2 |
| | % | 3.9% | 0.0% | 0.0% | 2.0% |
| 5. Zotero | N | 6 | 1 | 5 | 12 |
| | % | 11.8% | 33.3% | 11.1% | 12.1% |
| 6. Others | N | 20 | 1 | 34 | 55 |
| | % | 39.2% | 33.3% | 75.6% | 55.6% |
| Total | N | 51 | 3 | 45 | 99 |
| | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

Table 6 indicates the results on respondents knowing about bibliography or reference AI tools for the library users. Majority faculty members (N=37; 33.3%) know the bibliography/ reference AI tool i.e., Mendeley. Out of 3 research scholars, each research scholar (33.3%) knows one AI tool i.e., Zotero, Mendeley and others. More than 75% of the students know other than Mendeley/Zotero, they are: Paperpal, Sourcely, etc.

In the following table the researchers explained about the source of information available for the respondents on AI Tools.

**Table 7**
*Main Source of Information on AI Tools*

| Main Source of Information | | | Current Role | | | Total |
|---|---|---|---|---|---|---|
| | | | Faculty Member | Research Scholar | Student | |
| 1. | Library workshops | N | 3 | 0 | 6 | 9 |
| | | % | 5.9% | 0.0% | 13.3% | 9.1% |
| 2. | Peer discussion | N | 5 | 0 | 3 | 8 |
| | | % | 9.8% | 0.0% | 6.7% | 8.1% |
| 3. | Social media | N | 13 | 0 | 13 | 26 |
| | | % | 25.5% | 0.0% | 28.9% | 26.3% |
| 4. | Peer discussion, Library workshops | N | 1 | 1 | 1 | 3 |
| | | % | 2.0% | 33.3% | 2.2% | 3.0% |
| 5. | Peer discussion, Library workshops, Others | N | 1 | 0 | 1 | 2 |
| | | % | 2.0% | 0.0% | 2.2% | 2.0% |
| 6. | Peer discussion, Others | N | 0 | 0 | 1 | 1 |
| | | % | 0.0% | 0.0% | 2.2% | 1.0% |
| 7. | Social media, Library workshops | N | 4 | 0 | 3 | 7 |
| | | % | 7.8% | 0.0% | 6.7% | 7.1% |
| 8. | Social media, Peer discussion | N | 4 | 1 | 4 | 9 |
| | | % | 7.8% | 33.3% | 8.9% | 9.1% |
| 9. | Social media, Peer discussion, Library workshops | N | 5 | 0 | 4 | 9 |
| | | % | 9.8% | 0.0% | 8.9% | 9.1% |
| 10. | Social media, Peer discussion, Library workshops, Others | N | 1 | 1 | 2 | 4 |
| | | % | 2.0% | 33.3% | 4.4% | 4.0% |
| 11. | Social media, Peer discussion, Others | N | 3 | 0 | 2 | 5 |
| | | % | 5.9% | 0.0% | 4.4% | 5.1% |
| 12. | Others | N | 11 | 0 | 5 | 16 |
| | | % | 21.6% | 0.0% | 11.1% | 16.2% |
| Total | | N | 51 | 3 | 45 | 99 |
| | | % | 100.0% | 100.0% | 100.0% | 100.0% |

**Source:** Primary data

The observations from the table 7 tells us that major source of information for faculty members, out of 51, is social media (N=13; 25.5%), peer discussion (N=5; 9.8%) and library workshops (N=3, 5.9%). The research scholars, among three, expressed their source of information is peer discussion and library workshops (N=1, 33.3%), Social media and Peer discussion (N=1, 33.3%) and Social media, Peer discussion, Library workshops, Others (N=1, 33.3%). Similarly, for 45 students' main source of information on AI tools is social media (N=13, 28.9%), library workshops 6 (13.3%) and peer discussion (N=3; 6.7%). As such, this research study indicates the main source of information for all types of respondents on AI tools is social media (26.3%), library workshops (9.1%) and peer discussion (8.1%).

## AI Usage in Teaching

AI in education streamlines administrative work, customizes instruction, and offers round-the-clock assistance via intelligent tutoring programs. In the following table, it is described how frequently the faculty members apply AI tools in academic contexts: (i) to prepare lesson plans, (2) to write summaries for journal papers, (3) to automate student grading, (4) to find relevant literature for thesis/projects.

**Table 8**

*Application of AI in Various Academic Contexts (Faculty members: N=51)*

| Academic Context | | Choice of Faculty members | | | | |
|---|---|---|---|---|---|---|
| | | **Never** | **Rarely** | **Some-times** | **Often** | **Always** |
| 1. Preparing lesson plans and instructional materials | N | 2 | 6 | 18 | 14 | 11 |
| | % | 3.9 | 11.8 | 35.3 | 27.5 | 21.6 |
| 2. Research paper or journal summaries | N | 2 | 6 | 18 | 15 | 10 |
| | % | 3.9 | 11.8 | 35.3 | 29.4 | 19.6 |
| 3. Automating grading or student feedback | N | 5 | 5 | 17 | 15 | 9 |
| | % | 9.8 | 9.8 | 33.3 | 20.4 | 17.6 |
| 4. Finding relevant literature for thesis/ projects | N | 1 | 5 | 18 | 16 | 11 |
| | % | 2.0 | 9.8 | 35.3 | 31.4 | 21.6 |

**Source:** Primary data

The results from the above table shows that about 35.3% of faculty members apply artificial intelligence tool sometimes (i) in preparation of lesson plans and instructional materials, (ii) to prepare a paper or journal summaries, (iii) to find out relevant literature for thesis/projects. Further, 33.3% of them apply AI tool sometimes in automation of student grading or feedback.

**Table 9**

*Utilization of Artificial Intelligence (Faculty members: N=51)*

| Utilization of AI | | Opinion | | |
|---|---|---|---|---|
| | | **Yes** | **No** | **Total** |
| 1. In teaching practice or to develop interactive learning experiences for students | N | 46 | 5 | 51 |
| | % | 90.2 | 9.8 | 100.0 |
| 2. To confirm original ideas in student assignments | N | 40 | 11 | 51 |
| | % | 78.4 | 21.6 | 100.0 |

**Source:** Primary data

Out of 51 faculty members, more than 90 per cent of the respondents (i.e., N=46; 90.2%) stated that they utilise the AI in teaching practice or to develop interactive learning experiences for students. In addition, 40 (78.4%) respondents specified that they utilize the AI tools sometimes to confirm original ideas in student assignments.

**Table 10: Comfortability to Incorporate AI Tools into Classroom Instruction**

| Sl. No. | Comfortability | Frequency | Percent |
|---|---|---|---|
| 1. | Not comfortable at all | 3 | 5.9 |
| 2. | Not very comfortable | 3 | 5.9 |
| 3. | More or less comfortable | 14 | 27.5 |
| 4. | Very comfortable | 23 | 45.1 |
| 5. | Totally comfortable | 8 | 15.7 |
| | Total | 51 | 100.0 |

**Source:** Primary data

**User Perception**

The faculty members expressed that they are either very comfortable (N=23; 45.1%) or totally comfortable (N=8, 15.7%) to incorporate AI Tools into classroom instructions and 14 (27.5%) of them are more or less comfortable. A smaller number of respondents 3 (5.9%) felt either not comfortable at all or not very comfortable. So, more than sixty per cent of faculty members are comfortable to incorporate AI tools into classroom instruction.

**Table 11**

*Obstacles to Use AI to Research Projects*

| Sl. No. | Obstacles to Use AI | Frequency | Percent |
|---|---|---|---|
| 1. | Lack of formal training/workshops | 24 | 47.1 |
| 2. | Concerns about academic integrity and plagiarism | 17 | 33.2 |
| 3. | Limited access to high-quality/paid AI tools | 7 | 13.8 |
| 4. | Ethical concerns regarding data privacy | 3 | 5.9 |
| | Total | 51 | 100.0 |

**Source:** Primary data

The results shows that major obstacle to use AI is lack of formal training, it is opined by 24 (47.1%) respondents and it is followed by concern about academic integrity and plagiarism with 17 (33.2%) faculty members. The other obstacles are: (i) limited access to high-quality/paid AI tools (N=7; 13.8%) and ethical concerns regarding data privacy (N=3; 5.9%). Hence, it is concluded that the major obstacle to use AI to research projects or college libraries is lack of formal training.

**Table 12**

*Respondents Opinion on AI Replaces Traditional Teaching Profession*

| Sl. No. | Respondents' opinion | Frequency | Percent |
|---|---|---|---|
| 1. | Yes | 20 | 39.2 |
| 2. | No | 21 | 41.2 |
| 3. | Uncertain | 10 | 19.6 |
| | Total | 51 | 100.0 |

**Source:** Primary data

To a question "Do you think some traditional teaching professions will be replaced by AI?", there is ambiguous among them. In this regard, 20 (39.2%) said 'Yes' and 21 (41.2%) said 'No' and uncertainty remaining 10 (19.6%) respondents.

**Table 13**

*College Library Support to AI Needs*

| Sl. No. | Library support | Frequency | Percent |
|---|---|---|---|
| 1. | Organising hands-on "AI for Teachers" workshops | 30 | 59.0 |
| 2. | Providing access to premium academic AI software | 11 | 21.5 |
| 3. | Creating guides on ethical AI usage in research | 10 | 19.5 |
| | Total | 51 | 100.0 |

**Source:** Primary data

About 59.0% of the faculty members expressed their view regarding college library best support to AI tools is by organising hands-on "AI for Teachers" workshops. 11 (21.5%) of them requires a support from college library is providing access to premium academic AI software and 10 (19.5%) needs support by creating guides n ethical AI usage in research. The findings shows that majority faculty members want support such as hands on practice on "AI for Teachers" workshops.

## Findings

Based on the results presented in the above section, the following results were drawn on library users' awareness and utilization of AI tools in teacher training institutes:

It is found from the study that all type of respondents, such as faculty members (86.3%), research scholars (100%) and students (86.7%) have awareness on AI tools.

The results indicate that faculty members (25.5%) know **ChatGPT**, whereas majority research scholars (66.7%) and students (35.6%) know both ChatGPT and Gemini Generative AI tools.

The faculty members (21.6%) know "TeacherMatic", research scholars (100.0%) and students (68.9%) know "Shikshana Foundation". Further, it is also found that three-fourths of the respondents know many other ***educational planning AI Tools***, such as MagicSchool.ai, Eduaide.AI, Diffit, Brisk Teaching, and Curipod.

- The results indicate that majority know 'Litmaps' (18.2%), 'Semantic scholar' (12.1%) and 'Consensus' 9 (9.1%) AI tool. Further, 43.1% faculty members, 53.3% students and 33.3% research scholars aware other ***literature mapping AI tools*** like: 'Research rabbit', Inciteful: SciSpace Sourcely, etc.
- The findings of the study shows that faculty members (33.3%) know Mendley and research scholar and students aware of Zotero and Mendeley. In addition, the respondents also aware of Paperpal, Sourcely, etc.
- This research also indicated that the main source of information for all types of respondents on AI tools is social media (26.3%), library workshops (9.1%) and peer discussion (8.1%).
- About 35.3% of faculty members apply artificial intelligence tools "sometimes" (i) in preparation of lesson plans and instructional materials, (ii) to prepare a paper or journal summaries, (iii) to find out relevant literature for thesis/projects. Further, 33.3% of them apply AI tool sometimes in automation of student grading or feedback.
- Most (90.2%) of the faculty members utilise AI in teaching practice to develop interactive learning among students, and 78.4% they utilize AI to confirm original ideas in student assignments.
- More than sixty per cent of faculty members are comfortable to incorporate AI tools into classroom instruction.
- It is found that the major obstacle to use AI to research projects or college libraries is "lack of formal training".
- The respondents are ambiguous/uncertain regarding "Traditional teaching professions will be replaced by AI".
- The findings shows that majority faculty members want support such as hands on practice on "AI for Teachers" workshops.

## Conclusion

This study shows that academic stakeholders have a strong understanding of AI tools, but there are usage gaps that can be filled with focused training. With technologies like ChatGPT, Gemini, TeacherMatic, and Shikshana Foundation demonstrating varying group-specific familiarity, high baseline awareness—86.3% for faculty, 100% for research researchers, and 86.7% for students—indicates preparedness for AI integration. Specialized knowledge is further highlighted by literature and reference materials including Litmaps, Semantic Scholar, Research Rabbit, Zotero, and Mendeley, which are mainly obtained through social media (26.3%), workshops (9.1%), and peers (8.1%). Although over 90% of faculty use AI for lesson preparation, grading, and interactive learning, they encounter obstacles including inadequate training, which raises concerns about AI replacing conventional responsibilities.

## Implications

Although over 60% of teachers feel comfortable using AI in the classroom, preferences for practical "AI for Teachers" seminars highlight the need for institutional support to increase consistent implementation and ethical use. Without replacing human knowledge, bridging training shortfalls can improve research, teaching, and student outcomes by converting irregular interaction into regular practice. This puts academics in a position to appropriately utilize AI's promise in the face of changing educational environments.

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# PLAGIARISM AWARENESS AND RESEARCH INTEGRITY IN HIGHER EDUCATION

**Dr. S. Irfan Sadaq** [1]

**Abstract**

Academic integrity is a fundamental pillar of education, ensuring the reliability and authenticity of academic work. Plagiarism is one of the most serious forms of academic dishonesty and continues to challenge institutions of higher learning worldwide. Despite its significance, perceptions of plagiarism often differ between students and faculty, influencing the effectiveness of institutional policies and educational interventions. This study examines perceptions of plagiarism and their impact on research integrity in higher education institutions. It identifies key determinants of academic dishonesty, including students' awareness, faculty involvement, institutional policies, and the use of plagiarism-detection tools. The findings reveal a significant knowledge gap between students and faculty, with students often underestimating the consequences of plagiarism. The study emphasizes the need for comprehensive educational programs, clear and consistent policies, and active faculty participation to promote academic integrity. Through statistical analysis and survey data, the research provides recommendations for strengthening research integrity in higher education.

***Keywords:*** *Plagiarism, Academic integrity, Research integrity, Plagiarism detection tools, Faculty involvement, student awareness*

## Introduction

Although academic integrity is a well-investigated area, the effects of plagiarism on higher learning and how students along with faculty members respond to it remain largely uninvestigated, and their responses to research integrity practices are less clear. The main aim of previous studies is to determine the prevalence of plagiarism or institutions' responses to misconduct (Bretag et al., 2011; McCabe et al., 2006). Nevertheless, the intricacy of how different groups perceive the severity of plagiarism and how institutional policies are conveyed and interpreted remains to be understood.

The majority of the revisions have been ended about faculty perception on plagiarism and how they can alleviate academic dishonesty; very limited studies have been completed on the student perspective, in terms of awareness of the policies on academic dishonesty and what educational interventions are required to enhance academic integrity (Jordan, 2001). Furthermore, in-depth research comparing perceptions of plagiarism across various cultural and academic settings is also required, as international students may encounter specific challenges in interpreting Western norms of citation and plagiarism (Sutherland-Smith, 2008).

Furthermore, the efficacy of the plagiarism detection tools is frequently examined through the prism of the technical aspect of the matter, until now diminutive has done to determine the perception of these tools by the students and whether their usage produces the effect of a better comprehension of the plagiarism concept or merely the punitive behavior (Eaton, 2017). Insufficient workings out have likewise been directed on the long-term effects of educational interventions (e.g., plagiarism workshops) on student behavior.

## Research Objectives

The present research will seek to fill these gaps through the following research questions:

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1. To examine perceptions of plagiarism among students and faculty, including understanding, consequences, and detection tools awareness.
2. To analyse institutional plagiarism policies, communication effectiveness, and awareness levels among diverse academic groups within institutions.
3. To evaluate effectiveness of Turnitin plagiarism detection tools in improving knowledge and pedagogical versus disciplinary perceptions.
4. To assess educational interventions, workshops, training programs, and their long-term impact on academic honesty perceptions among.
5. To investigate cultural differences in plagiarism perceptions and influence of cultural backgrounds on citation practices attitudes.

**Literature Review**

Perception is usually rooted in differences in educational and cultural backgrounds, rather than in an effort to lie (Holbeck et al., 2025). Some studies advise that plagiarism is culturally determined and that notions of ownership and intellectual property may differ across academic cultures (Khoii & Atefi, 2019). It can cause considerable difficulties for scholars from different circumstances, who might struggle to reconcile their prior socialization into academic practices in the West with citation norms (Alhashmi et al., 2023; Chan, 2023; Zafarghandi et al., 2012). The latter are especially acute among international students whose previous educational backgrounds may not emphasize the high standards of citation required in American or European academic institutions (Adhikari, 2018). These studies include the work by Pecorari, who explains that textual similarities in work by students are sometimes owing to the dearth of opportunities to train in skills related to citing the data and sometimes the problem of proficiency in the language (Orim, 2017; Thompson et al., 2017). In addition, they are unable to prevent unintentional plagiarism for the reason that they are not acquainted with academic writing conventions and with how to properly paraphrase and synthesize sources (Isbell et al., 2018; Waigand, 2019).

**Institutional Comparative Analysis**

The proposed study attempts to fill this gap by conducting a comparative study of plagiarism policies, perceptions, and practices in research-intensive and teaching-oriented universities. Such a strategy will illuminate the impact of institutional missions on the cognition and application of academic honesty, particularly the rigor of the detection strategies employed and the thoroughness of the ethics training offered to students and faculty (Alhashmi et al., 2023). This inquiry is essential, as the difficulties institutions experience in navigating the intricacies of academic integrity policies and their implementation are documented, particularly amid the growing forms of plagiarism (Alsharefeen and Sayari, 2025). In particular, this virtual study drive observe whether institutions that place strong emphasis on research use more rigorous plagiarism-detection technologies and allocate more resources to high-level ethics education, and whether teaching-oriented institutions may focus on basic academic skills and an understanding of what plagiarism entails (Holbeck et al., 2025). In addition, the research will survey the variances in student views of AI-assisted writing and AI-giarism amid these two types of institutions, acknowledging that developing new forms of technology are adding new dimensions to the conventional concept of academic dishonesty (Chan, 2023).

**Digital Technologies and the Effects of Plagiarism**

Such an attitude underscores the importance of addressing the underlying causes of academic dishonesty, which, in most cases, involve inadequate knowledge of proper citation rules, ineffective research methods, and the pressures associated with academic publishing (Srinivas & Venkatesh, n.d.). Moreover, the complex problem is caused by many interrelated factors, including individual, social, cultural, institutional, and technological factors (Wyk & Makhafola, 2025). Rapid stress among students, a lack of awareness of academic honesty, and outdated honor codes contribute to the further increase in cheating and plagiarism in higher education institutions (Sozon et al., 2024). The fact that the volume of publications is considered a measure of individual and institutional effectiveness and that there are growing tendencies to apply principles of management to the academic field worsens the problem and leads to the creation of a favorable environment in which academic malpractice can thrive (Chaika et al., 2023). The first step to successfully fight such a widespread problem is to shift the focus of the institutions beyond the reactive approach and incorporate the proactive one in the form of specific coursework in the field of research ethics and scientific philosophy to help students develop a more profound perception of academic integrity (Чайка et al., 2023).

## Methodology

### Data Collection

Statistics used to demeanour the study remained collected via an online survey sent to students along with faculty members at five universities. The aim of the survey was to determine perceptions of plagiarism in higher education. It was done by the following ways:

1. **Survey Design:** It used a mixed method to address the study problem by integrating both quantitative (Likert scale, multiple-choice) and qualitative (open-ended) questions to understand the perception and knowledge of plagiarism in students and faculty.
2. **Sampling:**

    Students: 500 Pre and Post graduated students were chosen randomly to take part in it.

    Faculty: 100 faculty members in different disciplines were invited depending on their role in research and teaching.

    **Survey Distribution:**

Google Forms allowed administering the survey electronically, so it is easy to access, anonymous, and all data is captured in real-time. The response rate was 75 per cent, and 375 students and 85 faculty members took part in the survey.

### Data Analysis:

IBM SPSS Statistical tool was used to analyse the quantifiable data, which was castoff to conduct descriptive and inferential statistical tests (e.g., Chi-square tests, correlation analysis).

NVivo software was used to code the qualitative data obtained through open-ended questions in order to identify common themes.

## Results and Discussion

Students: 375 responses were obtained from students. Out of them, 60 percent were undergraduates and 40 percent were graduate students.

Faculty: 85 faculties out of diverse disciplines were sampled, and 70 percent of them were PhD-holders, with the remaining 30 percent possessing a master's degree.

**Table 1:**

***Survey Data Summary***

| Demographic Information | Total Responses | Awareness of Plagiarism (%) | Perception of Plagiarism as Minor Infraction (%) | Awareness of Institutional Policies (%) | Use of Plagiarism Detection Tools (%) | Interest in Plagiarism Prevention Workshops (%) |
|---|---|---|---|---|---|---|
| **Undergraduate** | 225 | 60 | 50 | 55 | 80 | 60 |
| **Graduate** | 150 | 40 | 40 | 60 | 80 | 60 |
| **Faculty** | 85 | 95 | 10 | 90 | 100 | 80 |

This table 1 summarizes the survey results, showing how undergraduates, graduates, and faculty perceive plagiarism, use plagiarism detection tools, and their interest in plagiarism prevention workshops. It's key for providing a clear visual of the overall data trends.

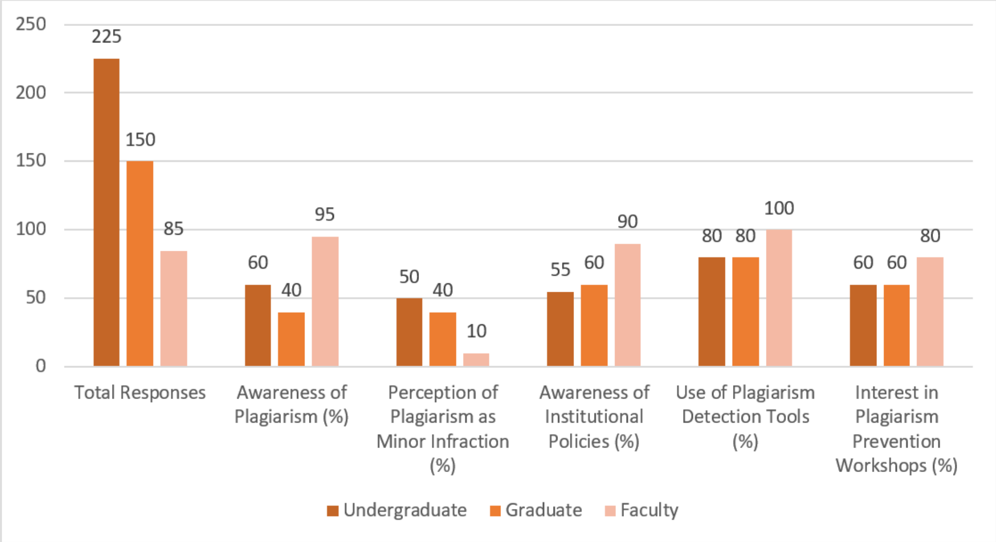


**Figure 1: Percentage of Awareness of Plagiarism (%)**

The bar chart will be comparing the perceptions, awareness and engagement among the undergraduates, graduates and the faculty on the issue of plagiarism as shown in figure 1. Members of the faculty are more aware of plagiarism, institutional policies and plagiarism detection tools usage, whereas undergraduates and graduates are less aware and more prone to thinking of plagiarism as a minor concern. Moreover, the plagiarism-prevention workshops are the most popular among faculty, and students are also very interested. The chart shows the disparities in comprehension and participation between these groups.

1. Awareness of Plagiarism:

    - 40 percent of the students failed to distinguish all the different types of plagiarism, particularly in paraphrasing and using improper citation.
    - A 95% of the faculty had correctly recognized different kinds of plagiarism and were concerned with the number of cases.

**Table 2:**

***Awareness of Plagiarism by Group***

| Group | Percentage of Awareness of Plagiarism (%) |
|---|---|
| **Undergraduate** | 60 |
| **Graduate** | 40 |
| **Faculty** | 95 |

This table 2 presents the awareness of plagiarism across the three demographic groups. This support detects how different academic groups understand plagiarism. Faculty members show the highest level of awareness, while undergraduates and graduates exhibit lower levels.

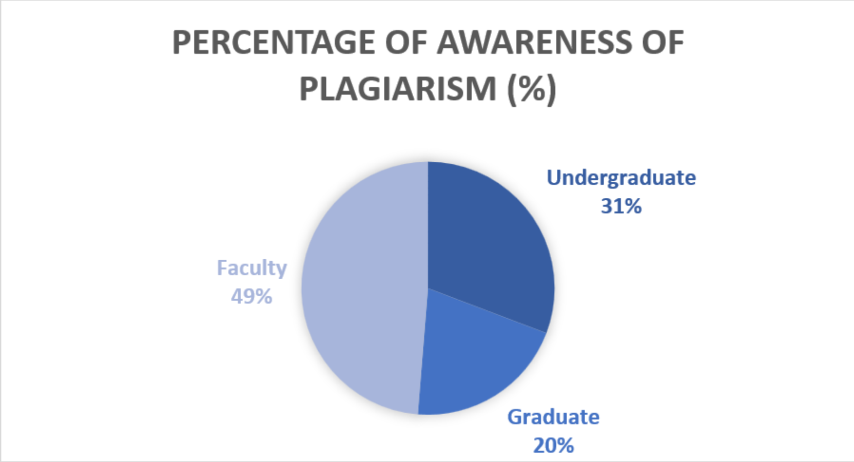


**Figure 2: Perception of Plagiarism as Minor Infraction (%)**

This pie chart will indicate the degree of awareness of plagiarism by faculty, undergraduates and graduates. The faculty members are the most aware (49), the undergraduates (31) and the least aware are the graduates (20). It shows a definite lack of awareness about plagiarism, with the faculty having considerably added information than students as shown in figure 2.

This table 3 indicates how the severity of plagiarism is perceived across the different groups. Undergraduates and graduates tend to view plagiarism as less severe, whereas faculty members consider it a serious violation of academic integrity.

**Table 3:** ***Perception of Plagiarism Severity***

| Group | Perception of Plagiarism as Minor Infraction (%) |
|---|---|
| **Undergraduate** | 50 |
| **Graduate** | 40 |
| **Faculty** | 10 |

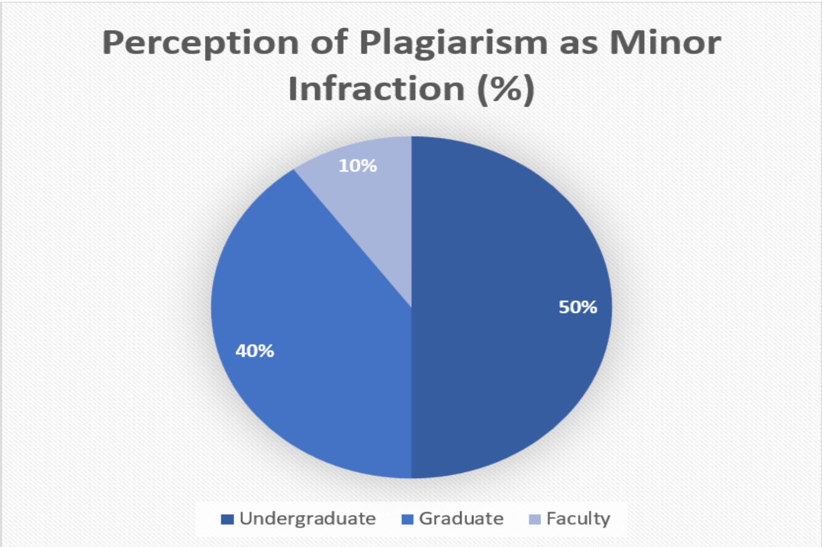


**Figure 3: Perception of Plagiarism as Minor Infraction (%)**

This pie chart shows in figure 3 perceptions of plagiarism as a minor offence among undergraduates, graduates, and faculty members; half of the undergraduates share the same perception as half of the graduates. On the contrary, 10 percent of the faculty believe that plagiarism is a minor offense, which resources that faculty adherents are much stricter towards plagiarism than the students.

Students and faculty demonstrated differing attitudes toward the consequences of plagiarism. About half of the students perceived plagiarism as a minor issue that could be corrected through proper referencing, whereas nearly eighty percent of faculty members considered it a serious academic violation with long-term consequences. Awareness of institutional policies also varied; only fifty-five percent of students reported being familiar with plagiarism policies, compared to ninety percent of faculty who stated they were aware and actively discussed them with students. Additionally, sixty-five percent of students indicated they had not received formal training on plagiarism or research integrity. Regarding plagiarism detection tools, eighty percent of students had used such tools at least occasionally, yet forty-five percent were unaware of how they functioned.

**Table 4:** ***Survey Data Summary***

| Category | Undergraduates (%) | Graduates (%) | Faculty (%) |
|---|---|---|---|
| **Awareness of Plagiarism** | 60% | 40% | 95% |
| **Perception as Minor Infraction** | 50% | 40% | 10% |
| **Awareness of Institutional Policies** | 55% | 60% | 90% |
| **Use of Plagiarism Detection Tools** | 80% | 80% | 100% |
| **Interest in Prevention Workshops** | 60% | 60% | 80% |

In contrast, faculty members reported regularly using these tools in teaching and research to maintain academic integrity. Educational interventions also showed promising outcomes, with sixty percent of students expressing interest in plagiarism prevention workshops when included in the curriculum. Faculty members strongly supported integrating academic integrity education into the curriculum, believing it would enhance understanding and reduce instances of plagiarism.

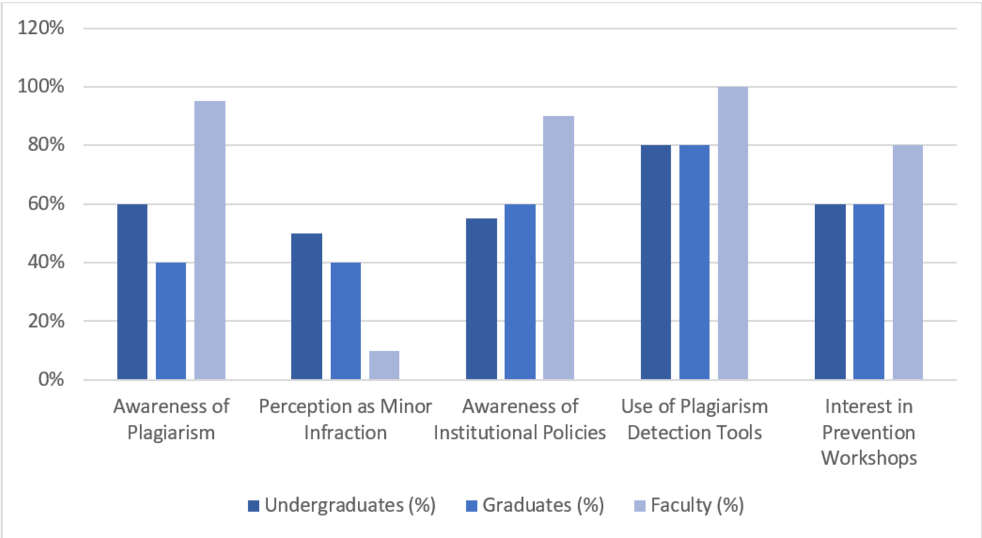


**Figure 4: Survey Data Summary**

The bar graph in figure 4 is a comparison of the awareness and perceptions of plagiarism among at least three groups of undergraduates, graduates and the faculty. The faculty members are the most aware of plagiarism and institutional policies, whereas undergraduates and graduates take plagiarism as a less serious problem. Plagiarism detection tools are highly used by all groups and most of the faculty uses it. The plagiarism prevention workshops of interest are comparable between the undergraduates and the graduates with the faculty experiencing a little bit of interest.

Findings of this research indicate a significant knowledge gap regarding the concept of plagiarism between students and faculty. Although the faculty members consistently showed a good comprehension of plagiarism, students tend to underestimate it and did not have the right knowledge of citation. This break point shows the necessity of continuous educational programs that teach students about the ethical consequences of plagiarism and proper research methods at the beginning of their academic lives.

It is also evident through uneven understanding of institutional policies by students that universities need to use more explicit means of communication. Policies must be designed in such a way that they indicate the effects of plagiarism as well as advice on how it can be avoided. Also, plagiarism detection tools, though essential, should be integrated into broader learning programs that help students develop and learn to avoid plagiarism on their own.

## Conclusion

This paper presents a case in which a combination of education, policy, and technology can be used to curb plagiarism in higher education institutions. The significant disparity in perceptions of plagiarism between students and faculty members necessitates stronger educational initiatives that incorporate academic integrity into the core curriculum. Institutions are required to make sure that the policies against plagiarism are clear, they are always communicated and reasonable training is provided. Research integrity as a culture should also be inculcated through faculty participation in mentoring and advising students. Detection software should not just be employed in plagiarism detection but they should also be utilized as a way of teaching students good research ethics.

This study contributes to the field of academic integrity by highlighting the importance of a multi-dimensional approach to reduce plagiarism in higher education. It emphasizes the integration of education, institutional policy, and technological tools as complementary strategies rather than independent solutions.

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# THE ROLE OF ARTIFICIAL INTELLIGENCE (AI) IN SYSTEMATIC LITERATURE REVIEWS (SLR) AND BIBLIOMETRIC ANALYSIS: A PARADIGM SHIFT IN EDUCATIONAL EVIDENCE SYNTHESIS

**Dr. Sayam Deepathi [1]**

**Abstract**

In the recent times, research landscape in the field of education is marked by a geometric curve of documentary production due to the high development of digital learning options and the change in pedagogical orientations. This flood of information has made increasingly questionable the concept of solely manual ways of performing Systematic Literature Reviews (SLRs) and bibliometric analyses developing a methodological bottleneck in the social sciences. The rise of artificial intelligence (AI) more specifically of Machine Learning (ML), Natural Language Processing (NLP), and Large Language Models (LLMs) has brought about a radical paradigm shift. The paper explains why the method of manual examination can be replaced by the process of human-machine collaboration in the process of developing evidence in the educational field. We offer a methodology-based approach towards the application of AI throughout the lifecycle of SLR, specific to the social sciences: developing protocols and semantic search to active learning-based screening of educational interventions. Moreover, we discuss how bibliometric science mapping can be improved with the help of generative AI to monitor disruptive technologies in education. Although AI has never been more efficient, it is raising serious ethical issues, such as biased pedagogy, hallucinations, and loss of accountability. This article gives a clear and detailed roadmap that can be followed by educational researchers to be responsible in utilizing AI to create rigorous, transparent, and equitable syntheses of educational literature through the establishment of adherence to reporting standards like PRISMA-trAIce and the changing policies of publishers.

***Keywords:*** *Artificial Intelligence, Systematic Literature Review, Bibliometric Analysis, Social Sciences, Higher Education, PRISMA-trAIce.*

## Introduction

A deeper information explosion is being witnessed in the social sciences and educational research more so. As research in the field of educational technology (EdTech) and curriculum development, as well as socio-emotional learning, is growing quickly, the classical, strictly manual resources used to perform systematic literature reviews (SLRs) and bibliometric analyses have reached a dead end. Such exponential increase in the volume of documentary works poses a threat to currency, exhaustiveness, and the soundness of the evidence synthesis in the education policy and practice.

In an effort to overcome this challenge, the academic community is looking at artificial intelligence (AI). The combination of machine learning (ML), natural language processing (NLP), and large language models (LLMs) is a paradigm shift that creates the model of human-machine cooperation. This development enables educational scholars to lose the exhaustive scrutinizer of individual files to the strategic manage of the review procedure, with the assistance of algorithmic effectiveness managing repetitive work and human mental skill directing on the important interpretation, theoretical framework examination, and pedagogical synthesis.

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**The Evolution of AI Integration in Educational Evidence Synthesis**

The years of progress in the field of computational linguistics lead to the inclusion of AI in the SLR workflow. The first uses in the social sciences were dealt with by simple deduplication schemes, or strict keyword matching.

In this day and era, AI models are often comparable to human intelligence at very specific tasks like relevance classification. In education research, AI has become extremely visible as a way to synthesize massive amounts of literature on the use of disruptive technologies in classrooms. The subject matter is actively transforming the traditional approach to sophisticated deep learning models with the ability to perform complex semantic search. This enables researchers to establish the underlying conceptual constructs like the concept of inclusive education or community service learning despite the fact that other authors may use different terms to denote the same phenomena in pedagogy.

**Comparative Efficiency of AI-Assisted SLR Tools in Social Sciences**

The choice of the tool stack is very important in the success of an AI-assisted SLR. Since no single platform has been able to cover the review lifecycle in the most ideal way, educational researchers have to resort to the integration of specialized tools most of the time. The cost-saving is high; the screening of qualitative and quantitative educational studies can be 90-fold faster with the help of the tools that require active modes of learning.

**Table 1:**

*Comparative Analysis of AI-Assisted SLR Tools for Social Sciences*

| Tool Name | Primary AI Capability | Key Strength | Efficiency/Impact in Education |
|---|---|---|---|
| **ASReview** | Active learning-based screening | Open-source; highly reproducible | 80-95% reduction in screening qualitative/quantitative studies |
| **Rayyan** | AI-powered screening & deduplication | Advanced deduplication; collaborative features | Up to 90% faster screening for multi-author research teams |
| **Covidence** | Workflow management & RoB support | Strong collaboration mechanics | Complete search-to-report workflow for educational interventions |
| **Elicit** | Semantic search & structured extraction | Exceptional data extraction from PDFs | Identifies theoretical frameworks missed by keyword searches |
| **EPPI-Reviewer** | Text mining & theme identification | Qualitative synthesis features | Crucial for scoping and rapid reviews of educational policy |

**Methodological Framework for AI-Assisted Educational SLRs**

A strong AI-aided SLR should have a predetermined and rigorous methodology to reduce bias. The advent of AI requires an advanced protocol clear in the consideration of the exchange between human reviewers and algorithmic agents in the interpretation of intricate social phenomena.

**Phase 1: Planning and Protocol Development**

An SLR is based on a clear research question, which is usually framed with the help of frameworks such as SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) or PICOS that are the most appropriate in social sciences. The protocol should predetermine the types of AI tools to be employed, the justification of their choice and the guidelines on how qualitative results will be examined by humans.

**Phase 2: Searching and Identification**

The search phase has been transformed by AI to incorporate the inflexible Boolean logic. Conventional search terms in the education field can be constrained by the changing vocabulary (e.g. distance learning vs. emergency remote teaching). The search tools that have been improved by AI are based on the so-called RAG (Retrieval-Augmented Generation) Fusion technology which helps to optimize queries by using natural language. AI enhances the thematic coherence of chosen publications by determining the semantic similarity between query and publication vectors, which is a better technique than conventional key-word-based data sets obtained after database search on databases such as Web of science or Scopus.

**Phase 3: Screening and Selection**

The screening stage is making more use of active learning. The AI learns to classify the training set of records as inclusive or excluded as an educational researcher designates a small training set of records (e.g., studies centered around foundational educational research) as included or excluded. It then re-ranked the rest of the records. Although this will significantly decrease workload, it is not advisable to fully end the work of human reviewers because of the complexity and interpretation of sociological and pedagogical studies.

**Phase 4: Data Extraction and Quality Assessment**

Information mining is customarily laborious. Automated extraction of structured dataincluding research methods, student demographics and learning outcomes, is now possible using AI tools, directly out of full-text PDFs. Although tools can help to evaluate the level of quality of the methods used, human control is the most essential factor of the methodology that can be used to make sure that the contexts of the learning environments are properly reflected.

**Bibliometric Analysis: Leveraging AI for Science Mapping in Education**

The bibliometric analysis offers a quantitative approach that can be used to assess the intellectual framework of the educational domains. The implementation of AI into bibliometric software (e.g., the bibliometrix R-package, VOSviewer) has allowed creating advanced visualizations of the world in research networks and pedagogical trends.

***AI-Enhanced Features in Educational Science Mapping***

The latest generation of bibliometric tools applies sophisticated algorithms in order to establish the frontiers of research. Mapping of co-occurrence relationships enables the researcher to trace the movement of the educational theories into classroom practices.

**Table 2:**

*AI Applications in Educational Bibliometric Indicators*

| Bibliometric Indicator | AI-Assisted Method | Purpose in Social Sciences |
|---|---|---|
| **Thematic Clustering** | LLM-based labeling | Assigning human-readable labels to clusters of pedagogical theories |
| **Trend Analysis** | Emerging themes detection | Pinpointing rising research hypotheses (e.g., AI in Higher Education) |
| **Keyword Normalization** | AI-powered bibliographic control | Correcting terminology inconsistencies across different educational eras |
| **Citation Mapping** | RAG-based search | Identifying foundational policy documents cited by influential works |

**LLM-Based Thematic Labeling**

One issue in educational bibliometrics that has been persistent is the need to give name to clusters mathematically determined. Conventional practices tend to lead to unfruity names. The currently generated descriptive labels by LLMs are used to summarize thematic contents and therefore resemble human expert annotation but have a drastic way of enhancing the interpretive usefulness of science mapping in complex issues, such as community work and social service.

**Methodological Integrity: The PRISMA-trAIce Framework**

To establish the confidence in AI-assisted evidence synthesis, the academic community created the PRISMA-trAIce checklist. This framework will make the use of AI rigorously documented and ease the transparency gap in the educational literature.

**Key PRISMA-trAIce Reporting Requirements:**

**Title & Abstract:** State AI assistance when relevant; outline what was used.

**Introduction:** This step entails a concise explanation of why particular AI-based tools have been selected to undertake qualitative or quantitative work.

**Methods:** Indicate whether the usage of AI was pre-specified; indicate the name and developer of the tool; disclose complete prompts used with LLMs.

**Results:** Provide performance measures related to report and describe human-AI interaction.

**Discussion:** Critically discuss limitations (including possible bias) and consider how the pedagogical findings were influenced by the algorithmism.

**Ethical Challenges in AI-Driven Educational Research**

Although the potential of AI is enormous, it involves significant ethical concerns that have to be maneuvered to maintain the elevation of the social science research.

**Bias and Global Equity in Educational Contexts**

One ethical issue that can be identified as critical is that of bias amplification. Models of AI based on historical data are likely to encode the stereotypes in society. There is a reported literature of a so-called Global North bias in educational bibliometrics, in which AI tools can be biased to prefer literature emphasizing Western pedagogical frameworks. These dangers of excluding essential research on local policies and frameworks by the Global South like the National Education Policy (NEP) 2020 of India, the Samagra Shiksha Abhiyan, or even independent methods of inclusive education in developing settings. This contravenes the motto of scientific fairness.

**Hallucinations and Scientific Integrity**

Big AI will be susceptible to hallucinations the creation of fake data. This in an SLR may be in the form of fabricated scholarly sources or false educational performance. To ensure that AI outputs have a foundation of trusted, peer-reviewed educational journals, mitigation measures and techniques like Retrieval-Augmented Generation (RAG) and strict human verification are needed.

**Accountability and the "Black Box" Problem**

The introduction of the lack of transparency in the way some AI algorithms make decisions questions the image of the peer-review process. Without a researcher giving a valid reason as to why an AI system omitted a qualitative study on student wellbeing, methodological accountability is destroyed. As a result, leading scientific publishers require that AI tools should not be listed as authors and the research should be carried out by human researchers with the final accountability.

**Navigating Publication Standards in Scopus Journals**

The publication of AI-assisted studies in social sciences must be compliant with new editorial policies on disclosure, responsibility of authors, and referencing style, applying such guidelines as the APA 7th Edition criteria on referencing generative AI models as algorithms or software.

## Case Studies: AI in Applied Educational Research

The efficacy of AI-aided SLR and bibliometric search can be best illustrated by the way it has been used to develop the educational disciplines.

### The Integration of Disruptive Technologies in Higher Education

Bibliometric analysis has created a giant leap in the field of AI in higher education research. Researchers have been able to monitor the integration of generative AI and adaptive learning systems into university curriculum using tools such as VOSviewer. This type of analysis is effective in outlining the way in which institutions of higher learning are shifting to meet the demands of AI literacy and academic honesty, which is the emergence of interactive and more personalized pedagogical platforms.

### Inclusive Education and Broad-Scale Educational Policy

Newer AI-assisted SLRs have reproduced extensive literature on the macro-level educational policies. Through text-mining technologies, scholars have succeeded in interpreting decades of research on the inclusion education and social work in the schools. The utilization of AI has played an important role in isolating the cross cultural comparisons enabling the researchers to quickly compare the implementation results of Western inclusion framework with localized initiatives in the emerging economies, therefore identifying gaps in the global literature.

### An Exemplar Study: "The Integration of Artificial Intelligence in Higher Education: A Decade of Disruption (2015–2025)"

This research paper will give a practical illustration on how to organize a bibliometric analysis and science mapping section in an educational research article. The data below is the simulation of the methodological application of R-package bibliometrix and VOSviewer.

### Overview of the Dataset and Methodology

The data of this exemplar was created with the help of a predefined search query related to the literature on artificial intelligence, machine learning, and generative AI in the field of higher education.

- **Database:** Scopus
- **Timespan:** 2015 – 2025
- **Document Types:** Peer-reviewed journal articles, conference papers, and book chapters.
- **Initial Yield:** 3,450 documents
- **Final Yield (Post AI-Assisted Screening):** 1,284 documents

### Performance Analysis (Descriptive Bibliometrics)

The performance analysis will give a macro-level picture of the research space with the growth trends of articles and the main contributors. Bibliometrix (Biblioshiny) interface was used to analyze it. The annual scientific production is determined by the number of publications released yearly by the institution.

### Annual Scientific Production

The annual scientific production will be calculated based on the number of publications published by the institution in a given year. Annual volume of a publication showed a slight, progressive increase between 2015 and 2021 (45 papers on average per year). There was however a sudden exponential peak after 2022, which coincided with the public release of the more advanced Large Language Models (LLMs), and has since then resulted in more than 400 publications in 2024 alone. It means that there is a fast development of the field beyond theoretical discussion to applied pedagogical research.

### Top Contributing Institutions and Geographies

**Leading Countries*:*** The United States, China and the United Kingdom are the leaders in the production, with the three countries contributing 55 percent of the total publications.

**Emerging Contributors***:* The contribution of institutions in India and Australia increases significantly after 2023 and is especially related to policy framework and adopting AI inclusively in multilingual contexts.

***Science Mapping (VOSviewer Visualizations)***

Science mapping brings out the intellectual organization and obscure relational networks in the data. The subsequent analyses are the textual analysis of VOSviewer network maps.

**Keyword Co-occurrence Network (Thematic Clustering)**

The analysis of the keywords co-occurrence (the minimum number of occurrences is 15) was performed to determine the main pedagogical themes. The VOSviewer algorithm clustered the literature in to three different color-coded clusters:

**Table. 3:**

*A1 VOSviewer Keyword Co-occurrence Clusters*

| Cluster (Color) | Central Theme | High-Frequency Keywords (Nodes) | Pedagogical Interpretation |
|---|---|---|---|
| **Cluster 1 (Red)** | Algorithmic Assessment & Analytics | Machine learning, predictive analytics, student retention, educational data mining. | Focuses on institutional use of AI to track student performance and predict dropout rates. |
| **Cluster-2 (Green)** | Generative AI & Academic Integrity | ChatGPT, large language models, plagiarism, critical thinking, assessment design. | Centers on the disruptive impact of generative tools on traditional essay writing and evaluation. |
| **Cluster 3 (Blue)** | Adaptive Learning & Personalization | Intelligent tutoring systems, personalized learning, virtual reality, student engagement. | Highlights the development of AI tools designed to tailor content delivery to individual learning paces. |

**Co-authorship Network (Collaboration Mapping)**

The co-authorship analysis identifies the social network of the research fraternity. The network map has a low general density meaning that the research is mostly pursued in isolated institutional silos but not on large, cross-border mega-teams. The best collaboration relationships are found between the computer science departments and education schools in the same universities, which highlights the interdisciplinary nature of the domain.

**Trend Analysis and Future Directions (AI-Assisted Synthesis)**

Using AI-based trend discovery (e.g., in VOSviewer, the nodes are colored by average publication year, which shows the leakage frontier of the field), the study determines the frontier of the field.

**Mature Themes (*2015–2020):*** "Intelligent tutoring systems" and "predictive modeling" are shown in more mature shades, which is an indication of older research lines.

**Emerging Frontiers (2023–2025*):*** The colors of emerging frontiers are in bright yellow; they include such concepts as prompt engineering, AI literacy, and ethical AI structures.

**Closing note of the Case Study**

This bibliometric mapping shows that the debate on AI in higher education is going in a completely different direction. It has not only abandoned the technical applications of predictive analytics (Cluster 1), but also been controlling the pedagogical disturbance of generative models and reconsidering the paradigms of assessment (Cluster 2). The future studies should focus heavily on the creation of effective, ethical models of incorporating these tools in an inclusive manner in the case of diverse groups of students.

## Conclusion

Artificial intelligence has transformed beyond reproach the behavior of systematic literature reviews and bibliometric analysis in the social sciences. The shift in the role of the educational researcher based on transforming him into a manual literature analyzer into an intelligent process manager would help AI to conduct a more agile view of the global educational environment. However, the effective implementation of technologies depends on a strict methodological approach, transparent reporting standards and the solid determination to overcome the possibilities of cultural and regional bias. The human factor that is characterized by critical thinking, situational awareness of new learning settings, and ethics judgment is the invaluable essence of the quality evidence synthesis in education as the academic community progresses.

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# GOVERNING ARTIFICIAL INTELLIGENCE IN EDUCATION: A LEGAL ANALYSIS OF DATA PRIVACY, ACCOUNTABILITY, AND STUDENT RIGHTS IN INDIA

**Ms. Nisha Agarwal [1]**

**Abstract**

The field of Artificial Intelligence (AI) has revolutionized education, particularly through the development of adaptive learning, assessment, and decision-making tools. Although the development of such tools has opened the door to greater accessibility and efficiency in learning, it has also created critical legal and ethical challenges for stakeholders. The development of AI in education in India has largely gone unregulated, creating critical challenges for students, particularly regarding the misuse of their personal data. This paper will critically analyse the challenges posed by the development of AI in education, particularly through a legal lens. It will also assess the relevance of the Digital Personal Data Protection Act, 2023, and Articles 14 and 21 of the Constitution of India to the challenges posed by the development of AI in education. The paper uses a doctrinal research methodology. The paper examines statutory provisions, judicial precedents, and policy documents, such as the National Education Policy 2020. The paper identifies gaps in the existing legal regime regarding accountability and student rights in AI-based educational settings. The paper argues for the development of a comprehensive legal regime that balances technological innovation with human rights. The paper concludes with policy recommendations for regulating AI in educational settings. The paper also recognizes the need to adopt a rights-based approach to ensure that technological innovation in education does not compromise student dignity, equality, and privacy.

***Keywords:*** *Algorithmic Bias, Artificial Intelligence, Data Privacy, DPDP Act 2023, Education Law, Student Rights*

## Introduction

The field of Artificial Intelligence (AI) has been a game-changer in the world of education by revolutionizing traditional methods of imparting knowledge by way of adaptive technology, computer-based assessments, and intelligent tools (Russell 2021). The implementation of artificial intelligence in the field of education has revolutionized the entire system with respect to accessibility and efficiency. Nevertheless, along with the advent of artificial intelligence in the field of education, there have been several ethical and legal issues related to AI that need to be addressed in the Indian legal framework.

With the increasing use of AI technology for education, huge amounts of data from students is collected and analysed by these companies using these technologies (OECD, 2021). In many cases, these companies do not provide their users with an appropriate mechanism of informed consent, thereby violating the basic rights of these individuals (Puttuswamy, 2021) The lack of an appropriate legal regime pertaining to AI is creating serious implications.

This research aims to examine the legal implications of introducing artificial intelligence in the Indian educational sector. For the purpose of the study, attention will be paid to the legal framework and guarantees provided by the constitution, which could resolve the problems by making use of the relevant legal framework, the Digital Personal Data Protection Act, 2023, and the constitutional guarantee under Article 14 and Article 21.

The research methodology to be used for the research will be doctrinal. For this research, statutory provisions, cases, and the policy guidelines such as the National Education Policy 2020 will be studied (UNESCO, 2021). The gaps in the legal regulatory framework in terms of introducing artificial intelligence

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will be explored and suggestions will be put forward to develop the legal framework for regulating AI in schools of India.

**Conceptual Framework – Artificial Intelligence in Education and Legal Concerns**

Artificial Intelligence (AI) in education implies the use of advanced computing techniques capable of performing actions typically undertaken by people, including learning, thinking, decision-making, and problem-solving. In the context of education, the implementation of AI technologies is likely to gain momentum since it helps enhance the quality of the educational process. It is worth acknowledging that AI is a critical aspect in rethinking traditionally organized education systems and building them as data-based systems with automated decision-making algorithms.

AI implementations in education include adaptive learning solutions, automated assessment solutions, and predictive analytics solutions. The most significant advantage of adaptive learning solutions is their ability to offer personalized education based on the analysis of learners' performance and development of educational materials specifically for them. Automated assessment solutions allow conducting assessment efficiently and delivering feedback to learners in time. Predictive analytics solutions help institutions anticipate future learners' performance and adopt necessary measures. Thus, despite offering numerous advantages for educational systems, they also generate some legal issues.

One of the first and many problems raised as a consequence of introducing AI into the educational process is the problem of personal privacy. AI systems require data input, including students' academic performance, behavioural traits, and even biometric data in some cases. The absence of ways of getting users' previous permission to use their data creates a great risk of improper usage of such information.

A similar problem that may lead to discriminatory practices against the students is algorithmic bias, that is, biased information used by the algorithm for the analysis or biased programming itself ( Wachter 2020) . Algorithmic bias is, in fact, a violation of students' equal right to education. Finally, the last issue associated with AI that can be addressed is its opacity, which means that there is a so-called 'black box' problem when the actions taken by the algorithm cannot be assessed.

Moreover, there is still an issue with accountability. When AI-based technologies generate false results, it becomes challenging to assign liability to either developers, educators, or policy makers. This uncertainty underscores the necessity of developing legislation that regulates the use of AI in education.

Consequently, although AI holds promise to transform the field of education, its unrestricted growth may give rise to several legal and ethical concerns. Having a proper conceptual understanding of the issues at stake is crucial in assessing whether the present legal framework is sufficient or not.

**Legal and Constitutional Framework in India**

The quick adoption of artificial intelligence (AI) in the education industry demands an evaluation of the existing legislative and constitutional stance in India. Despite the increasing deployment of AI technologies, there is no clear legal framework governing such applications. As a result, the absence of legislation pertaining to the implementation of AI in the education industry implies that other data protection statutes will have to be relied on (NitiAyog, 2018).

**Digital Personal Data Protection Act, 2023**

The Digital Personal Data Protection Act, 2023 (DPDP Act) is the primary statute in force in India regarding the protection of personal data (Digital Personal Data Protection Act, 2023). The DPDP Act focuses on the handling of digital personal data and the obligations of the data fiduciaries. Regarding the deployment of AI in education, educational organizations and ed-tech firms can be considered data fiduciaries under the legislation.

Data Processing on Consent is one of the key concepts of the Act. Under this concept, it is required that the data must be processed after obtaining free, clear, informed, and unequivocal consent. However, in an educational environment where minors are involved, some doubts arise about the freedom of such consent.

Moreover, the Act embraces the purpose limitation and data minimization concept, which involves collecting data for particular purposes and retaining the data only when necessary. Nevertheless, in some cases, AI systems require constant data collection for improved algorithms' accuracy.

Despite the fact that the DPDP Act provides the required structure, it does not cover fundamental issues like the use of algorithms, profiling, and the responsibility of the AI system. Therefore, the current problem associated with the regulatory process of using AI in education is clear.

**Constitutional Safeguards: Article 14 and Article 21**

The Indian constitution provides a strong foundation for protecting people's rights while applying AI in education.

**Article 14 – Equality Before Law and Equal Protection of Laws**

The Constitution of India guarantees the principles of equality before law and equal protection of laws via Article 14. In relation to AI, Article 14 becomes relevant with regard to the issue of bias or discrimination.

Considering that the data sets that go into AI training may be biased, using such AI systems for decision making regarding educational issues such as evaluation and admission can lead to discriminatory treatment of certain students. Such discriminatory effects would contradict the principle of non-arbitrariness under Article 14.

It has already been pointed out several times in Indian Supreme Court judgments that arbitrariness is not consistent with equality.

**Article 21: Right to Life and Personal Liberty**

The Constitution of India's Article 21 has been broadly construed to encompass the right to privacy, dignity, and liberty.

The significant decision in Justice K.S. Puttaswamy. Union of India declared the right to privacy as a fundamental right under Article 21. There are clear implications for the use of AI in education as large amounts of personal information about students are gathered and analyzed.

The AI-powered surveillance technologies, facial recognition software, and behavioral analysis systems deployed by educational institutions pose a threat to the privacy of students. The uncontrolled collection and monitoring of data can amount to a violation of the right to informational privacy and the right to personal liberty.

Additionally, the right to dignity, which is an essential component of Article 21, can be infringed upon when students are profiled and evaluated through AI systems. Consequently, the use of AI in education must conform to the provisions of the Constitution of India.

**Policy Framework: National Education Policy 2020**

The NEP 2020 acknowledges the significance of the employment of technologies, including artificial intelligence, in the sphere of education. Specifically, the focus is put on the use of digital technologies in the increase of effectiveness in teaching and learning and making education more available in terms of upgrading educational institutions. However, despite the recommendation by the policy to apply AI in education, there are no sufficient measures taken into account in terms of legal aspects related to the use of the aforementioned technology. In this regard, data protection, accountability of algorithms, and the rights of students are among issues not discussed in the policy document. It means that the policy overlooks several legal problems connected with the application of modern technology.

**The Need for a Dedicated Legal Framework**

An analysis of the existing legal framework demonstrates that there is no dedicated legal framework that can help manage artificial intelligence technologies in the educational sector within India today. While the DPDP

Act provides some form of data protection, and the Indian Constitution provides basic fundamental rights, but these cannot be considered sufficient.

**Challenges of AI in Education – A Legal Analysis**

Although AI implementation in education can be beneficial, there are some challenging legal concerns that require thorough discussion. First, such concerns involve data privacy, algorithmic bias, absence of accountability, and over-monitoring. All these matters have significant implications for the rights of learners.

**Data Privacy and Informed Consent**

Undoubtedly, the biggest concern about the application of AI in education relates to the gathering and processing of considerable amounts of student information. For AI systems to function correctly, they must receive steady streams of data of various types, including personal, educational, and behavioural. However, often, students are not provided with an opportunity to give their informed consent, particularly when they are minors under eighteen years old (UNICEF 2021).

Such a situation undermines the rights of students to informational privacy and autonomy. Moreover, the misuse and dissemination of the gathered information may lead to negative outcomes like data breaches.

**Algorithmic Bias and Discrimination**

Algorithmic bias is another issue related to artificial intelligence technology. The AI systems learn based on the data stored within the database, and this may represent some kind of societal discrimination. Therefore, applying AI in making decisions in an education environment would result in a discriminatory result (Barocas & Selbst 2016).

Such application would worsen the inequality as the underprivileged learners would become victims of discrimination. It raises an ethical concern because the utilization of artificial intelligence would violate the notion of equality.

**Lack of Accountability and Liability**

The implementation of AI in the field of education creates problems regarding accountability. If AI makes an incorrect or discriminatory decision, it remains unclear whose responsibility it is—the developers of the technology, the school, or the supplier (European Commission, 2019).

It results in a lack of regulation, which makes it challenging to establish accountability for the individuals responsible. In the absence of guidelines with regard to liability, there is no way to enforce any kind of protection.

**Surveillance and Erosion of Student Autonomy**

Illustrations of how artificial intelligence is applied in education include the application of surveillance technology such as facial recognition, behaviour analysis, and internet-based proctoring software. While these tools are designed to make the learning process easier and minimize any form of cheating, they could result in an overreliance on surveillance technology by teachers against the students.

Excessive surveillance may pose interference to the students' right to personal freedom and self-expression, and as a result, limit the environment in which they operate. Moreover, surveillance may affect the psychological well-being of the students.

**Digital Divide and Inequality**

Moreover, the use of artificial intelligence in the educational sector might widen the inequality gap between individuals. The reason behind this statement is that using AI-enabled tools in education demands certain infrastructure and funding. Poor economic backgrounds of students could deprive them of all these privileges.

This constitutes yet another issue we need to focus on when addressing matters concerning substantive equality and inclusion.

**Comparative Analysis**

There have been numerous attempts to regulate Artificial Intelligence (AI) in education in different legal contexts, including in Europe and the USA. A comparative analysis allows us to observe some deficiencies in the Indian legal regime and gives important suggestions regarding the further development of this issue.

The European Union shows its readiness to regulate AI in education via the rights-based regime. The GDPR imposes certain data protection standards, namely data minimization, restriction of purposes, and the obligation to provide information regarding automated decision-making. Moreover, the forthcoming EU Artificial Intelligence Act introduces classification of AI systems by risk levels and imposes additional requirements for high-risk systems, including AI systems in education.

On the contrary, the US applies the decentralization principle and focuses on the sectoral approach. Although there is no particular regulation of AI at the federal level in the US, some measures have been taken to guarantee the ethical usage of the technology. In terms of education, the adoption of best practices concerning data protection, ethics, and transparency is recommended for educational institutions. Nevertheless, lack of enforceable regulation makes the strategy useless.

One may observe that regulation in India is not as advanced as regulation in the discussed countries. Despite the existence of the Digital Personal Data Protection Act, 2023, the legislation does not address risks arising in the implementation of AI in education (automatic decision-making and biases). Based on the comparison provided above, it becomes evident that India does not yet have a special regulation of AI in education.

Consequently, international experiences show that India must develop its regulation further.

**Regulatory Gaps in AI Governance in Education**

However, an examination of the current legal and policy framework highlights several deficiencies in the regulation of Artificial Intelligence (AI) in the field of education in India. Although the general laws and provisions of the constitution offer a regulatory framework, they do not sufficiently address the problems arising out of the use of AI in education.

Firstly, there is no legal framework addressing AI applications in education. Unlike in countries such as the European Union, there is no regulation addressing the development and use of AI. Thus, problems like AI transparency and accountability, among others, remain unaddressed.

Another gap exists regarding the enforcement mechanism that can hold an individual accountable for his or her actions. The existing laws do not give clear guidance on who should be made liable for any harm done as a result of the operation of AI systems either due to the discriminatory effects or the misuse of the information. This ambiguity makes it difficult to pinpoint who should be made accountable for such actions, rendering the victims powerless in the process.

Finally, the issue of algorithmic transparency and fairness is poorly addressed. Algorithms have been described as "black boxes," which mean the decision-making process is not understood by those benefiting from it. With this lack of transparency, students cannot challenge any form of discrimination.

Also, the issue of insufficient protections for children is another relevant point. The group of students, especially children, can be viewed as a vulnerable category that requires additional protection under law. Nevertheless, there are no provisions related to protecting children in the process of using AI technologies and processing their personal data.

Lastly, there is no provision in the regulatory scheme regarding addressing the issue of the digital divide. In the absence of any inclusivity policy, poor layers of population will remain outside of the use of AI, thus creating even bigger access gap between individuals and opportunities for education.

In summary, the abovementioned difficulties indicate that the current legal framework is incapable of dealing with the peculiarities of regulation associated with the use of AI technologies in education. For this reason, a special regulatory model needs to be introduced.

**Suggestions and Policy Recommendations**

Considering the aforementioned problems and gaps in regulations, there is an immediate need to formulate an integrated set of laws and policies for the application of Artificial Intelligence (AI) in Indian education. Below are the recommendations made with the aim of adopting a balanced perspective, promoting innovation and protecting the rights of students.

***Enactment of a Dedicated Legal Framework***

Indeed, it would be prudent for India to come up with legislation governing the application of the technology in the field of education with respect to such issues as transparency, liability, and automated decision-making.

***Improving Data Protection Measures and Consent Requirement***

There is a need for improving data protection measures in accordance with the Digital Personal Data Protection Act, 2023, particularly with respect to educational institutions. In particular, there needs to be a special provision for protecting children, requiring additional consent measures.

***Ensuring Algorithmic Transparency and Fairness***

The government needs to ensure that transparency in the decision-making process involving AI tools is assured, thus allowing the students to be aware of how the entire process works. Audits must also be carried out on these tools to prevent discrimination in terms of algorithms employed.

***Establishment of Accountability and Liability Guidelines***

To determine the people who may be held accountable for damages caused through AI systems, guidelines need to be put in place. These guidelines must clearly state the measures to be taken when any damage occurs to a user of these systems.

***Promoting Inclusivity and Tackling the Digital Divide***

It is crucial that equality be promoted in terms of access to educational resources through artificial intelligence. To this end, the government must invest in technology and assist weaker economic classes from exacerbating educational disparities (World Bank, 2020).

All of the above recommendations imply the significance of embracing a rights-based regulatory framework for AI technology in education.

**Conclusion**

The rapid integration of AI in education poses a paradigm shift when it comes to the provision of educational services. There is no doubt that AI technology in education presents many advantages as far as increasing efficiency, enhancing access to information, and making the learning experience more personalized. However, the use of this technology without proper oversight raises several important legal and ethical issues that cannot be easily resolved through legislation and policies alone.

In this research, various approaches, such as the proposed Digital Personal Data Protection Act of 2023 and the constitutional guarantees under Articles 14 and 21, have been considered as possible remedies to the issues brought about by AI in education. Based on the discussion provided herein, it is clear that while these measures constitute a good way to start regulating AI in education, they are not enough.

It is important to note that the comparative analysis demonstrates that the jurisdictions such as the European Union have taken a more systematic approach towards the issue, being oriented towards transparency, accountability, and the protection of human rights. In contrast, India still retains high fragmentation regarding regulation, allowing numerous loopholes to emerge.

In light of the above, it is clear that there should be an immediate adoption of a certain regulatory regime, designed to address the use of AI within the educational environment. It is necessary to establish transparency guarantees, accountability, and student data protection, paying special attention to data pertaining to children.

As for a conclusion, one can state that any governance of the application of AI technologies in education should be grounded on human rights. Ensuring that the use of artificial intelligence technologies will become an instrument ensuring equitable and equal access to education, rather than discrimination and control, is crucial in this regard.

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# ARTIFICIAL INTELLIGENCE IN INCLUSIVE EDUCATION: AN INDIAN PERSPECTIVE WITH GLOBAL INSIGHTS

**Ms. Wafaa** [1]

**Abstract**

Every child deserves an education that works for them - not just the ones who fit neatly into a standard classroom. Yet across India's 1.5 million schools, millions of students with disabilities, learning differences, or diverse linguistic backgrounds continue to be under-served by systems built for uniformity. This paper explores a question that matters deeply: can artificial intelligence finally change that? India's National Education Policy 2020 (NEP 2020) sets out a bold vision for technology-enabled, equity-driven learning, (MoE, GOI, 2020) and the Central Board of Secondary Education (CBSE) is the institutional channel through which that vision must reach classrooms. AI - through adaptive learning platforms, intelligent tutoring systems, speech-language tools, and early-warning analytics - is emerging as the most consequential enabler of inclusive education that educators have ever had access to. Drawing on evidence from the United States, United Kingdom, the UAE, Saudi Arabia, Japan, South Korea, and China, this paper makes the case that thoughtful, policy-aligned integration of AI within India's educational framework can narrow learning gaps, support overstretched teachers, and deliver on the promise that no child is left behind (UNESCO, 2017). It closes with a practical phased roadmap and stakeholder-specific recommendations grounded in what the evidence actually shows works.

***Keywords:*** *Artificial Intelligence, Inclusive Education, NEP 2020, Adaptive Learning, Assistive Technology*

**Introduction**

India is home to over 250 million school-age students across 1.5 million schools. Ensuring every learner - regardless of disability, language, or socioeconomic background - receives quality education remains a defining challenge. Traditional classrooms, constrained by large class sizes and a single-paced curriculum, cannot adequately serve a heterogeneous student population.

NEP 2020, India's most comprehensive educational reform in three decades, directly addresses this challenge. It calls for technology to harness the full potential of each student and explicitly envisions AI as a support tool for learners with special needs *(MoE, GOI, 2020)*. The CBSE, serving approximately 28,000 affiliated schools and an estimated 20 million students, is the primary institutional vehicle for translating this vision into classroom reality. CBSE has already introduced AI as an elective from Grade 8, and its competency-based education (CBE) reforms align naturally with AI's pedagogical logic *(CBSE, 2021)*.

This paper makes the case that AI is not merely a supplementary tool - it is a systemic game changer for inclusive education. Drawing on global evidence from four contexts, it maps lessons applicable to India, identifies critical implementation challenges, and proposes a phased adoption roadmap.

**Policy and Theoretical Background**

***NEP 2020: A Vision for Inclusive, Technology-Enabled Learning***

NEP 2020 represents a paradigm shift in Indian educational philosophy. Its core tenets align directly with the principles of inclusive education as articulated in the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and the UNESCO Salamanca Statement. Key provisions relevant to AI-enabled inclusion include:

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- **Universal Design for Learning (UDL):** NEP 2020 mandates flexible teaching methods that accommodate diverse learners - a principle that AI-adaptive platforms are uniquely positioned to support.
- **Foundational Literacy and Numeracy (FLN):** The NIPUN Bharat initiative sets Grade 3 milestones that can be tracked and supported by AI-based early intervention systems.
- **Mother-Tongue Instruction:** NEP 2020's emphasis on home-language instruction up to Grade 5 requires AI tools capable of multilingual NLP across Indian languages including Hindi, Tamil, Telugu, Bengali, Marathi, and others *(Ministry of Electronics and Information Technology, GOI, 2023).*
- **Inclusion of Children with Disabilities:** NEP 2020 reinforces the RPWD Act 2016 and RTE Act 2009, obligating schools to eliminate physical, communicative, and pedagogical barriers to learning *(UNESCO, 2009).*
- **Technology Governance:** The National Educational Technology Forum (NETF), proposed under NEP 2020, is designated as the body for evidence-based technology adoption - the natural home for AI governance in education.

### The CBSE Framework: Existing AI Integration

CBSE has proactively embedded AI literacy into its curriculum through an AI elective in Classes 8, 9, and 10, developed with Intel and IBM. The curriculum covers AI concepts, ethics, data literacy, and real-world applications, positioning CBSE students to be both users and critical consumers of AI educational tools. CBSE's CBE reforms further align with AI's logic: rather than rote recall, CBE assesses applied knowledge - precisely what adaptive AI systems are designed to develop and measure. The Academic Bank of Credits (ABC) under NEP 2020 creates data infrastructure that AI can leverage for personalized academic pathways.

### Theoretical Frameworks

Three frameworks inform this paper. First, **Universal Design for Learning** *(CAST, 2018)* argues that learning environments should proactively provide multiple means of representation and engagement - exactly what AI-driven personalization enables. Second, **Vygotsky's Zone of Proximal Development (1978)** holds that learners progress most when challenges slightly exceed current ability but remain reachable with support - the core logic of adaptive AI tutoring. Third, the **Assistive Technology Continuum** *(Dell et al., 2012)* situates AI not as a replacement for human instruction but as a scaffold that amplifies learner agency and teacher effectiveness.

### Methodology

This paper adopts a qualitative, systematic literature review methodology, drawing on peer-reviewed research, national policy documents, and institutional reports published between 2012 and 2025 across four geographic contexts: India, Western nations (USA, UK, Australia), Gulf countries (UAE, Saudi Arabia), and East Asian economies (Japan, South Korea, China). Sources were selected based on relevance to AI-enabled inclusive education, policy alignment, and empirical rigor, with priority given to studies involving randomized controlled trials, government-commissioned evaluations, and comparative education analyses. The findings are synthesized thematically to identify convergent lessons applicable to the Indian school system, particularly within the NEP 2020 and CBSE frameworks.

### Findings

### AI-Driven Technologies for Inclusive Education

### Adaptive Learning Platforms

Adaptive learning platforms use machine learning algorithms to continuously assess student performance and dynamically adjust the difficulty, format, and sequence of instructional content. For Indian classrooms where a single teacher may face students spanning multiple grade levels, these platforms function as a force multiplier - allowing each student to engage with content calibrated to their precise level.

In a rigorous lottery-based evaluation of *Mindspark* (Educational Initiatives) conducted in Delhi among students from government middle schools, students who used the AI-adaptive platform for 45 minutes per day over 4.5 months scored 0.37 standard deviations higher in mathematics and 0.23 standard deviations higher in Hindi compared to the control group - among the strongest effect sizes recorded in Indian educational intervention research *(Muralidharan et al., 2019).*

**Intelligent Tutoring Systems (ITS)**

Intelligent tutoring systems simulate one-to-one tutoring by providing real-time, personalized feedback, step-by-step scaffolding, and error diagnosis (Holmes et al., 2019). For students with learning disabilities (SLDs) such as dyslexia, dyscalculia, or ADHD, the patience and consistency of an ITS are particularly valuable. These systems also partially address India's acute shortage of trained special educators: According to the Rehabilitation Council of India's Central Rehabilitation Register, approximately 120,000 qualified special educators are registered as of 2022, serving an estimated 7 million children with disabilities in school - a ratio of approximately 1:58. *(UNESCO's Policy Guidelines on Inclusion in Education (2009)* and the UK's SEND Code of Practice *(DfE, 2015)*, which recommend a maximum of 1:10 to 1:20 for learners with complex needs in inclusive or specialist settings), it underscores the urgent need for scalable AI-assisted intervention to bridge the gap. ITS platforms can deliver evidence-based SLD interventions at scale where human specialists are unavailable.

**Speech and Language AI Tools**

For students with communication difficulties - including those with autism spectrum conditions, cerebral palsy, or hearing impairments - AI-powered speech tools offer a transformative breakthrough:

- **Speech-to-Text (STT):** Enables students with motor or hearing impairments to dictate responses.Google's Speech-to-Text API supports multiple Indian languages, with further expansion supported through India's Bhasini platform -- a Government of India initiative under MeitY providing open NLP and speech tools across scheduled languages.
- **Text-to-Speech (TTS):** Assists visually impaired students and those with print disabilities. NVDA screen readers are available in many regional-Indian languages and adopted in several state government schemes.
- **Augmentative and Alternative Communication (AAC):** India's own Avaz app (Invention Labs, Chennai) uses predictive AI to help non-verbal students with autism and cerebral palsy communicate, deployed across 15+ countries including CBSE special needs schools.
- **Automated Reading Assessment:** Tools such as Reading Assistant (Scientific Learning) detect reading fluency and comprehension gaps in real time and provide targeted phonics support for children with dyslexia - a condition whose prevalence among Indian school children ranges from approximately 6% to 15% across peer-reviewed studies - with a meta-analytic estimate of 6.2% for dyslexia specifically and up to 11.2% in some regional samples -- indicating that millions of children remain undiagnosed *(Joseph & Devu, 2022; Mogasale et al., 2012; Scaria et al., 2023).*

**Learning Analytics and Early Intervention**

Learning analytics tools process student interaction data to generate actionable insights for teachers, identifying at-risk students weeks before conventional assessments would flag a problem. Within the CBSE system, where formative assessment data is now mandated, AI analytics can aggregate performance across subjects, identify cognitive load patterns, and generate differentiated learning plans *(Holmes et al., 2021).* The DIKSHA platform - India's national ed-tech backbone with 180 million registered learners and 7 million teachers (as of 2023) - already has basic analytics capability; adding AI-powered predictive modules would represent a high-impact, low-cost enhancement.

**Natural Language Processing for Multilingual Inclusion**

India's linguistic diversity - 22 official languages and over 1,600 spoken languages - is a structural barrier to quality digital education. AI-powered NLP tools enable automatic translation, transliteration, and content generation in regional languages. Google's Bhasini initiative and Microsoft's Project Vasudha are developing

NLP tools specifically for Indian languages *(Ministry of Electronics and Information Technology, GOI, 2023)*. For students from tribal communities or those whose home language differs from their school's medium of instruction, these tools ensure linguistic background does not become a proxy for academic failure.

**Global Evidence: Lessons from the West, Gulf, and East**

**Western Nations: Mature Ecosystems with Policy Anchors**

**United States of America**

The USA's IDEA and ESSA embed AI tools within legally mandated IEPs; evidence confirms positive attainment effects when technology is pedagogically grounded *(Haßler et al., 2025)*. The core lesson for India: AI delivers greatest inclusive impact within legal entitlement frameworks like the RTE and RPWD Acts.

**United Kingdom**

The UK's SEND Code of Practice anchors AI deployment; the EEF documents consistent gains with adaptive learning for disadvantaged pupils; Oak National Academy's "accessibility by default" model is directly transferable to CBSE content design.

**Australia**

Australia's Disability Standards for Education (revised 2020) create legal obligations for inclusive digital learning. The National Schools Interoperability Programme has developed API standards that allow AI tools to integrate seamlessly with school management systems - a technical architecture India's PM eVIDYA and DIKSHA platforms could emulate.

**Gulf Region: Rapid Technology-Driven Transformation**

**United Arab Emirates**

The UAE's National AI Strategy 2031 designates education as a priority sector. The Ministry of Education's Smart Learning Programme has equipped all 1,200 government schools with AI-enabled environments (UAE MoE, 2023). Most significantly, the MoE mandated WCAG 2.1 accessibility standards for all digital textbooks and integrated Microsoft Learning Tools - immersive reader, dictation, and real-time translation - across all government school devices. This procurement model, which made inclusion the default rather than an afterthought, is a powerful lesson for India's PM eVIDYA programme.

**Kingdom of Saudi Arabia**

Under Vision 2030's education reform pillar, Saudi Arabia has invested substantially in EdTech infrastructure. The Madrasati (My School) platform uses AI to identify and support at-risk learners, including those with learning disabilities, across millions of students. Saudi Arabia's multilingual AI tools- accommodating Urdu, Hindi, Tagalog, and Arabic - provide a directly transferable model for India's multilingual inclusion challenge.

**East Asian Nations: Technology-First Education Ecosystems**

East Asian education systems - consistently ranked at the top of PISA and TIMSS assessments - offer compelling evidence that AI and inclusive education are mutually reinforcing. Japan, South Korea, and China have each pursued national AI education strategies with explicit provisions for diverse learners.

**Japan: Society 5.0 and Individualised Learning**

Japan's GIGA School Programme *(MEXT, 2019)* equipped every student with a personal computing device, creating the hardware foundation through which AI-powered software -- including the MEXCBT adaptive assessment platform - could be delivered at national scale. Social robots like Pepper (SoftBank Robotics) are deployed in special education classrooms for ASD students; a meta-analysis of 40 studies including 17 RCTs found robot-mediated interventions produced positive outcomes across social, communication, and emotional domains, with 65% of RCTs reporting benefit *(Kouroupa et al., 2022)*. Japan's MEXCBT platform identifies learning disabilities through cognitive diagnostics and auto-generates teacher alerts - a closed-loop model NIPUN Bharat can directly adapt.

**South Korea: AI in Every Classroom**

South Korea's AI Digital Textbook (AIDT) initiative, rolling out nationally from 2025, replaces traditional textbooks with AI-powered interactive books containing built-in accessibility features for visual, hearing, and learning disabilities *(MoE, South Korea, 2023)*. Every student receives a personalized learning map reviewable by teachers and parents. The core lesson: universal AI tools serve inclusive purposes most powerfully when accessibility is designed in from inception - not added as an afterthought.

**China: National Scale, AI-First Inclusion**

China has deployed AI educational platforms to over 60 million students under its New Generation AI Development Plan (2017). iFlytek's emotion-recognition AI identifies struggling students in real time, particularly valuable for detecting undiagnosed SLDs in under-resourced rural schools. Alibaba's DAMO Academy has provided AI seeing-assistant apps to over million blind and low-vision students. China also offers the most important cautionary lesson: without robust ethical governance, AI amplifies inequality and enables surveillance-based discrimination - a risk India must proactively legislate against before large-scale deployment.

**Discussion and Educational Implications**

**Strengths and Opportunities**

India possesses several structural advantages that, if leveraged strategically, position it to leapfrog intermediate stages of AI-inclusive education development:

- **Scale of Digital Infrastructure:** DIKSHA's 180 million registered users make it the world's largest national ed-tech platform *(NCERT, 2021)*. Integrating AI layers could instantly reach hundreds of millions of learners.
- **Vibrant Domestic EdTech Ecosystem:** India is among the world's largest EdTech market. Companies such as BYJU'S, Embibe, and ConveGenius are developing AI tools calibrated for Indian curricula and languages.
- **Comprehensive Policy Framework:** NEP 2020, NDEAR, PM eVIDYA, and NIPUN Bharat constitute one of the world's most comprehensive ed-tech policy architectures. AI for inclusion has explicit policy permission - what is needed is implementation specificity.
- **Youth Demographic:** India's median age of 28 years means teachers and students alike are digital natives or near-natives, reducing cultural resistance to AI adoption.
- **CBSE's AI Curriculum:** The existing AI elective in Grades 8-10 creates a pipeline of AI-literate students who can serve as peer support resources for classmates with disabilities.

**Critical Challenges and Global Solutions**

**Digital Divide:** Unequal access to devices and connectivity risks limiting AI's benefits to already-advantaged students. India's PM WANI and BharatNet provide the infrastructure backbone; the government must mandate that AI accessibility tools be pre-loaded on all PM eVIDYA devices, mirroring the UAE's proven procurement model.

**Teacher Preparedness:** NISHTHA -- described by NCERT the world's largest teacher capacity-building programme, targeting 42 lakh (4.2 million) elementary teachers across all phases - must incorporate AI-for-inclusion modules. Embedding technology competence into NCTE standards - as the UK has done - is essential for sustainable adoption.

**Language and Content Localization:** Western and Gulf AI tools are predominantly designed for English or Arabic. NCERT should develop AI-adaptive content across all 22 scheduled languages, leveraging India's Bhasini platform and South Korea's AIDT as practical models.

**Ethical Governance:** China's experience with surveillance-based AI classrooms is a cautionary tale. India needs a National AI in Education Ethics Framework under NETF, prohibiting biometric surveillance of students and mandating algorithmic transparency before any large-scale deployment.

**Special Educator Shortage:** With only approximately 120,000 registered special educators serving an estimated 7 million children with disabilities in school - a ratio of roughly 1:58 against the population with disabilities *(Rehabilitation Council of India, 2022)*, and vastly more disproportionate against total school enrolment of over 250 million - a growing evidence base on AI-assisted and robot-mediated instruction documents positive outcomes for students with diverse learning needs, including children on the autism spectrum and those with learning disabilities *(Kouroupa et al., 2022; Haßler et al., 2025)*. UK-based robot-assisted therapy - showing positive impacts on well-being and sustained child-led interaction for autistic students in a Special Educational Needs school *(Lemaignan et al., 2022)* - and USA's ITS platforms offer scalable solutions deployable through the Samagra Shiksha Abhiyan.

**A Phased Model for AI-Inclusive Education in India**

Drawing on global evidence and India's policy context, this paper proposes a three-phase model for AI integration in CBSE inclusive education:

- **Phase 1 Foundation:** Deploy AI FLN tools through NIPUN Bharat; integrate WCAG 2.1 accessibility standards into all DIKSHA content; train 500,000 teachers through NISHTHA AI-for-inclusion modules.
- **Phase 2 Scale:** Roll out adaptive learning platforms to all government secondary schools; deliver NLP-enabled content in 8 regional languages; establish AI Resource Centres in each district.
- **Phase 3 Transform:** Achieve universal AI-accessible education; position India as a Global South EdTech leader; contribute scalable AI-inclusion models to SAARC and African Union nations.

**Table 1: Stakeholder-Wise Recommendations for AI-Inclusive Education in India**

| Stakeholder | Recommended Action | Expected Outcome |
|---|---|---|
| Government / MHRD | Expand PM eVIDYA; mandate AI accessibility standards under RTE Act | Universal baseline access to AI-assisted learning |
| CBSE / NCERT | Integrate AI literacy into Grades 6-12; develop SLD-specific digital modules | Future-ready learners; reduced learning gaps |
| School Administrators | Partner with EdTech firms for adaptive platforms; set up AI resource centres | Inclusive classrooms with differentiated instruction |
| Teachers | Attend NISHTHA AI modules; co-design IEPs using learning analytics | Data-informed, personalised teaching practices |
| Parents & Community | Engage in digital literacy programmes; participate in IEP reviews | Strengthened home-school-AI partnership |

**Limitations and Future Directions**

Findings reflect published literature and policy documents rather than direct classroom evidence; the absence of large-scale longitudinal studies measuring AI's impact on students with disabilities within CBSE schools remains a significant gap. Western and East Asian evidence comes from resource-rich environments whose outcomes may not transfer directly to India's heterogeneous infrastructure without careful contextualization. Future research should prioritize RCTs in Indian government schools, disaggregated data by disability category and linguistic background, and co-design studies involving teachers and students with disabilities.

## Conclusion

The global evidence considered in this paper consistently points in one direction: when AI is deployed with pedagogical intentionality, policy alignment, and ethical responsibility, it delivers learning gains for diverse students that few other educational interventions can match at scale (Luckin, 2018; Holmes et al., 2019). India stands at a genuinely favourable convergence - a transformative policy framework in NEP 2020, an institutionally capable CBSE (2021), the world's largest national ed-tech platform in DIKSHA, and a thriving domestic EdTech ecosystem.

The students who stand to gain most from this shift are precisely those India's education system has historically failed: children with disabilities, from linguistic minorities, in rural and tribal areas, and those with undiagnosed learning differences who quietly fall through the gaps of a one-size-fits-all curriculum (Joseph & Devu, 2022; Rehabilitation Council of India, 2022). For these children, AI is not a technological novelty or a policy aspiration - it is an equity imperative.

NEP 2020 declares that no child is left behind. Artificial intelligence, deployed wisely and governed justly, is India's most powerful and practical instrument for making that promise real.

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# PhET SIMULATIONS AS AN INTERACTIVE LEARNING PLATFORM FOR TEACHERS AND STUDENTS: A REVIEW STUDY

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**Abstract**

The integration of digital technologies in education has transformed traditional teaching–learning practices, particularly in science education. PhET Interactive Simulations has emerged as a powerful interactive platform that supports conceptual understanding through visualization and inquiry-based learning. This review paper synthesizes existing research on the use of PhET simulations by teachers and students across different educational contexts. The study examines usage patterns, pedagogical benefits, and challenges associated with PhET integration. Findings indicate that PhET simulations significantly enhance student engagement, conceptual clarity, and scientific reasoning skills. However, issues such as limited teacher training, infrastructure constraints, and uneven access hinder optimal utilization. The paper concludes that PhET simulations have strong potential to support student-centered learning and recommends systematic teacher training and policy support for effective implementation.


***Keywords:*** *PhET Simulations, Interactive Learning, Virtual Labs, Science Education, ICT in Education*

## Introduction

Nowadays, progress in information technology reshapes how schools operate across nations. Instead of only lectures, classrooms often include digital aids to encourage hands-on engagement. Learning by doing gains ground where passive listening once ruled alone.

One tool standing out is PhET Interactive Simulations, delivering science and math learning aids at no cost, grounded in research across subjects like physics, biology, chemistry. With interactive models, students test ideas in digital labs, helping clarify difficult topics by doing. Available in 128 tongues, its simulations come paired with classroom materials for instructors worldwide. From the PhET Global effort, more than 116,000 educators have gained access to these supports PhET simulations for physics education - Interactive computer-based models. Created with Physics, Chemistry, Biology, or Mathematics in mind. Animations guide the structure, while interactive tasks form key parts. Games appear throughout, shaping how users engage. Virtual trials offer hands-on exploration, replacing passive viewing. Each element works separately yet fits a shared goal. Learning happens through activity, not only passive absorption of information. With PhET, instructors guide lessons interactively, whereas learners explore concepts independently - two roles shaping one tool. Its design supports both classroom instruction and personal discovery without favoring either path.

## Conceptual Framework

### Interactive Learning

Learning becomes dynamic when students engage directly with material, testing ideas through hands-on exploration. With PhET simulations, users adjust settings and immediately see results, fitting naturally into such immersive methods. These tools support inquiry by making cause-and-effect visible, moment by

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moment. Engagement rises when control stays in the learner's hands, shaping their own path through concepts.

### *Constructivist Theory*

Learning happens by doing - simulations align with Constructivist Theory because they let people build understanding via hands-on involvement. Experience shapes insight when students engage directly, not passively absorb facts. Knowledge grows from active participation rather than fixed instruction. What one discovers through practice sticks differently than what is simply told.

## Usage Patterns of PhET Simulations

**Usage patterns Among Teachers: -** Used for: Demonstrations, Concept explanation, Virtual experiments

**Usage pattern Among Students: -** Used for Self-learning, Homework and assignments Experimentation and exploration.

**Subject-wise Usage: -** Physics – highest usage, Chemistry – moderate usage, Biology – emerging usage.

## Pedagogical Benefits

- **Enhanced Conceptual Understanding: -** PhET simulations help students conceptualize complex ideas such as atomic structure, wave motion, and electric fields.
- **Increased Student Engagement: -** Games and interactive features increase student interest and participation.
- **Inquiry-Based Learning: -** Students can: Test hypotheses, manipulate variables, Observe cause and effect relationships.
- **Accessibility and Cost-Effectiveness: -** It is free and easily accessible.

**Objectives of the Study: -** This review study aims to:

1. Examine the role of PhET simulations as a learning platform
2. Analyze the pattern of use by teachers and students
3. Determine the pedagogical benefits of using PhET simulations
4. Examine challenges in implementing PhET simulations
5. Suggest strategies for effective use of PhET simulations

## Methodology:

The study will take a systematic review approach where data will be analyzed using secondary data sources such as databases, Scopus, ERIC, Google Scholar, AI Dimension, Research Gate, Web of Science, Research Rabbit, etc. Relevant literature published from 2017 to 2026 was reviewed to identify trends in PhET use

**Table: -1** Trend of Publication from 2016-2024 (Scopus database).

| Year | TP | TC | NCP | H | G |
|---|---|---|---|---|---|
| 2024 | 10 | 3 | 2 | 1 | 1 |
| 2023 | 8 | 44 | 4 | 3 | 6 |
| 2022 | 2 | 18 | 2 | 2 | 2 |
| 2021 | 15 | 45 | 12 | 4 | 6 |
| 2020 | 18 | 171 | 15 | 8 | 13 |
| 2019 | 7 | 79 | 7 | 4 | 7 |
| 2018 | 5 | 124 | 5 | 4 | 5 |
| 2017 | 1 | 11 | 1 | 1 | 1 |
| 2016 | 1 | 9 | 1 | 1 | 1 |

Note: -TP: Total Publication; TC: Total Citation NCP: Number Citation Paper; H: h-index G: g-index

**Table: -2.** Publication Type and number of Publication (ERIC)

| S.No. | Publication type | No of Publication |
|---|---|---|
| 1 | Journal Articles | 75 |
| 2 | Reports - Research | 57 |
| 3 | Reports - Descriptive | 16 |
| 4 | Tests/Questionnaires | 9 |
| 5 | Dissertations/Theses -… | 4 |
| 6 | Information Analyses | 2 |
| 7 | Reports - Evaluative | 2 |
| 8 | Speeches/Meeting Papers | 2 |
| 9 | Collected Works - Proceedings | 1 |

**Table: 3** The Trends of Research Publications 2017-2026. (ERIC)

| S. No. | Year of Publication | No of Peer Reviewed Articles |
|---|---|---|
| 1 | 2026 | 1 |
| 2 | 2025 | 5 |
| 3 | 2022 | 27 |
| 4 | 2017 | 58 |

**Table 4:** Trend of Publication of Articles (Source Google Scholar)

| S.No. | Year | No of Review articles |
|---|---|---|
| 1 | 2026 | 17 |
| 2 | 2025 | 92 |
| 3 | 2024 | 133 |
| 4 | 2023 | 158 |
| 5 | 2022 | 175 |
| 6 | 2021 | 182 |
| 7 | 2020 | 184 |

**Table 5**: *Trend of Publication of articles and proceedings (AI Dimension)*

| S.No. | Year of Publication | No of Research Articles | No of Proceedings |
|---|---|---|---|
| 1 | 2017 | 1 | - |
| 2 | 2018 | 7 | - |
| 3 | 2019 | 6 | -- |
| 4 | 2020 | 7 | - |
| 5 | 2021 | 18 | - |
| 6 | 2022 | 27 | 1 |
| 7 | 2023 | 33 | 3 |
| 8 | 2024 | 55 | 2 |
| 9 | 2025 | 87 | 4 |
| 10. | 2026 | 15 | - |

**Table 6**: *Usage Pattern of PhET Simulation Among Teachers*

| Usage Type | Percentage (%) | Description |
|---|---|---|
| Regular Use | 22% | Used in most classes |
| Occasional Use | 48% | Used for difficult topics |
| Rare Use | 18% | Used once in a while |
| Never Use | 12% | No usage |

**Table 7**: *Purpose of Using PhET Simulations*

| Purpose | Teachers (%) | Students (%) |
|---|---|---|
| Concept Explanation | 78% | 65% |
| Virtual Experiments | 64% | 72% |
| Homework/Self-learning | 42% | 68% |
| Assessment | 25% | 30% |

**Table 8:** *Subject-wise Usage of PhET Simulation*

| Subject | Usage Level (%) |
|---|---|
| Physics | 82% |
| Chemistry | 61% |
| Biology | 39% |

**Results**

**Figure 1:** *Trend of Publication from 2016-2024 (Scopus database)*

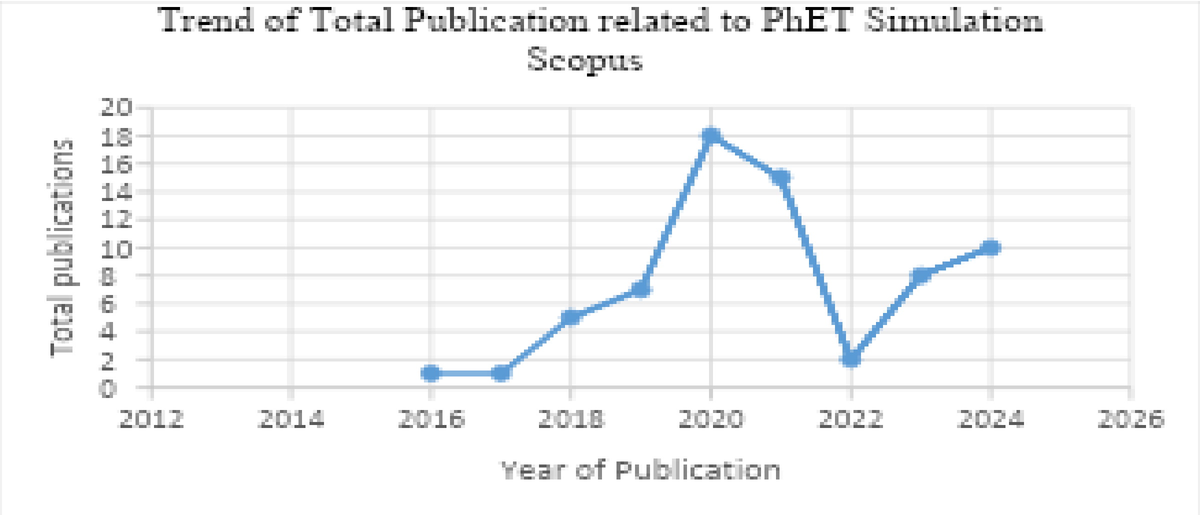



**Figure: 2** *Publication Type and number of Publication (Source ERIC)*

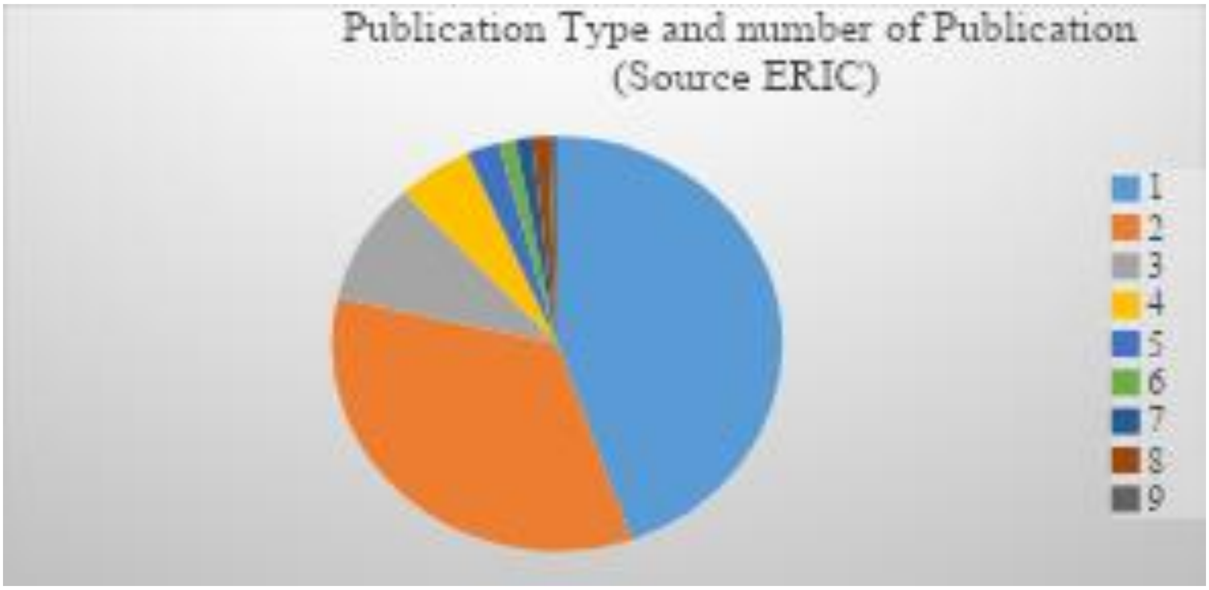



**Figure: 3** *Trend of Publication of Articles (Google Scholar)*

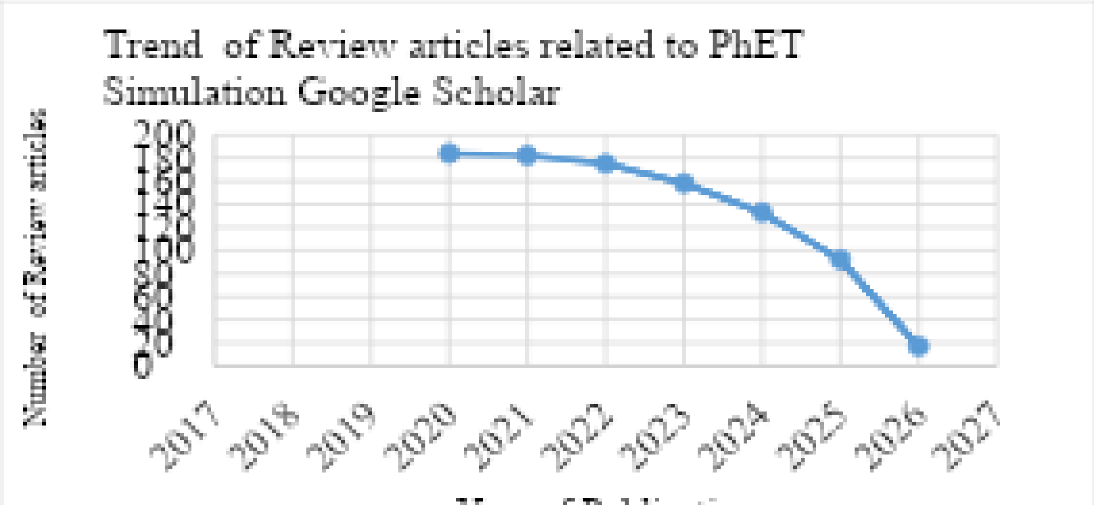



**Figure: 4** *Trend of Publication of Articles and Proceedings (AI Dimension)*

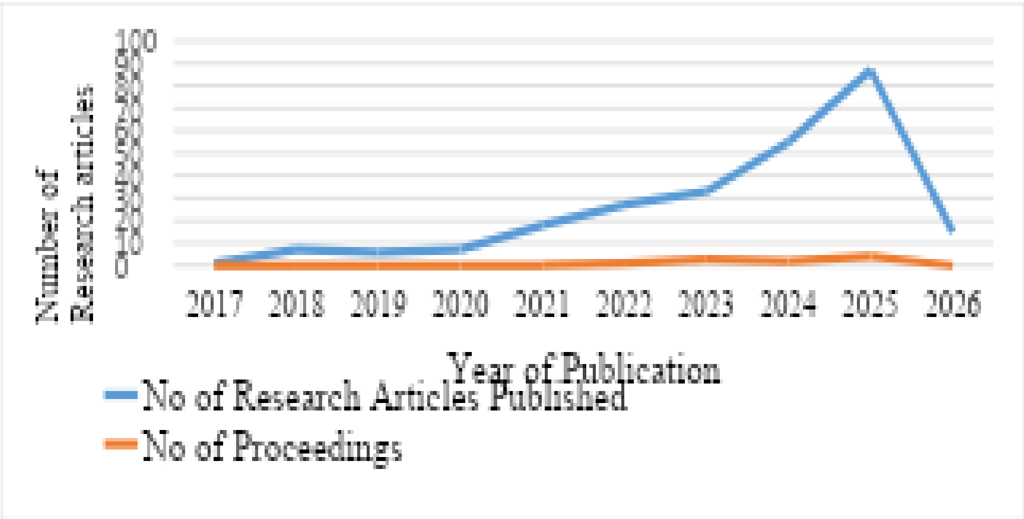



**Figure: 5** ***Usage Pattern of PhET Simulation Among Teachers***

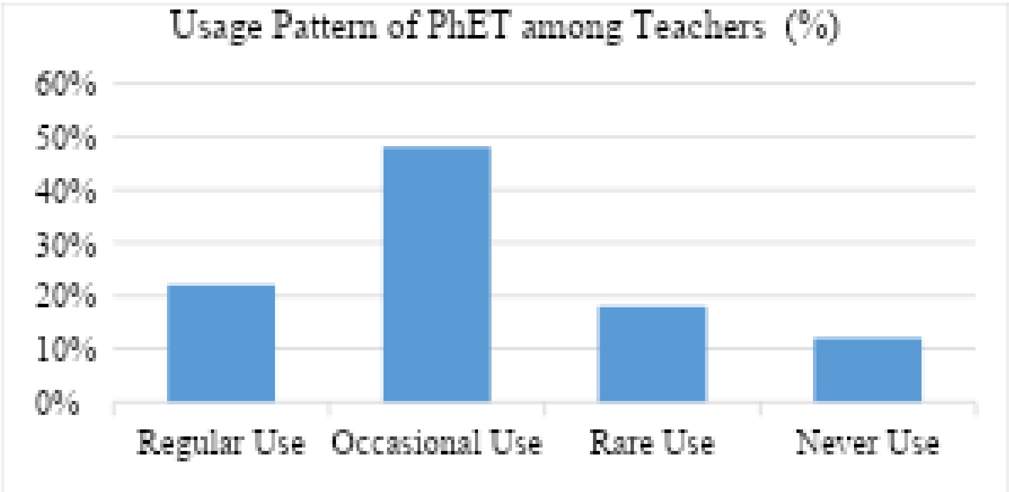



**Figure: 6** ***Purpose of usage of PhET simulation***

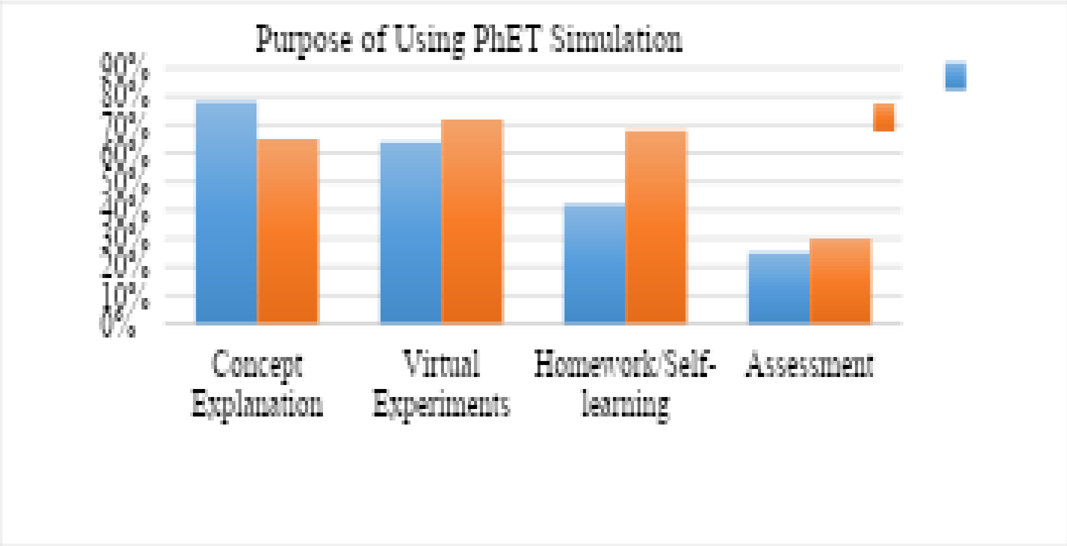
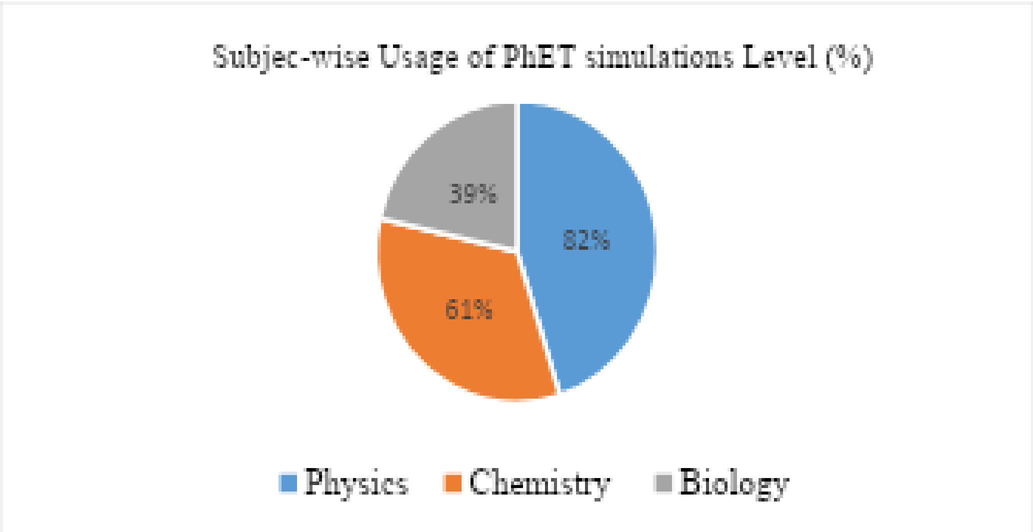



**Figure: 7** ***Subject-wise Usage PhET simulations***




**Discussion**

The dataset indicates a growth phase (2016–2019), peak performance (2020–2021), and a gradual decline (2022–2024). The recent decline may reflect a shift in research focus, reduced output, or the time-lag effect in citation accumulation. The data shows a clear declining trend in the number of review articles from 2020 to 2026. This pattern suggests that after a period of intensive review-based research (2020–2022), the focus may be shifting away from review articles. The sharp fall in 2026 could also indicate incomplete data for the year or a transition toward more empirical or original research studies The data indicates that journal articles are the dominant form of publication (75), showing that most research is disseminated through peer-reviewed academic journals. This is followed by research reports (57), suggesting a strong emphasis on detailed, project-based or funded research outputs. The trend reflects a rapid expansion of research output, especially after 2020, with a clear preference for journal-based research articles over conference proceedings.

The pattern suggests that these tools are primarily used as supplementary aids rather than core teaching resources. While there is moderate acceptance, consistent and widespread integration into daily teaching practices is still limited. The tool is widely used for conceptual understanding and interactive learning, while its role in assessment remains minimal, and students tend to use it more actively for self-directed learning than teachers formally integrate it. The tool is most suitable and frequently used in Physics, moderately used in Chemistry, and least utilized in Biology, possibly due to differences in content suitability or availability of simulations.

**Challenges in Implementation**

- **Lack of Teacher Training: -** Teachers are not trained to use simulations as a part of their teaching.
- **Infrastructure Limitations: -** There is a lack of computer and internet facilities, Particularly in rural and underdeveloped regions
- **Language Barriers: -** The interface is English-dominant, which is a limitation in regional areas
- **Limited Curriculum Integration: -** It is used as a supplementary material, not an integral part of teaching
- **Global and Indian Context: -** Globally, PhET simulations are used extensively in developed and developing countries. Particularly, after the COVID-19 pandemic, there has been a rise in the use of simulations. In India, there has been a rise in the use of simulations during online education. There is an increasing trend of integrating simulations with platforms like DIKSHA and virtual labs.

**Recommendations**

- Provision of Professional Development Programs for Teachers
- Improvement of ICT Infrastructure in Schools
- Integration of PhET Simulations into Curriculum and Textbooks
- Development of Regional Language Versions
- Encouragement of Blended Learning Approaches

**Conclusion:**

Despite growing interest in PhET tools, signs now suggest momentum may be leveling off. Research output has risen steadily, reflecting broader adoption across science classrooms worldwide. Still, gains in actual learning outcomes remain tied closely to how deeply the simulations are woven into teaching methods. While studies repeatedly link them to improved comprehension and reasoning skills, effects on long-term performance show mixed results. A shift appears underway - away from testing feasibility toward refining classroom application. Progress hinges less on novelty now, more on thoughtful implementation within existing curricula.

Evidence also shows PhET tools help foster active, exploration-driven classroom experiences. Still, real impact depends heavily on context - weak technology access, gaps in instructor preparation, alongside rigid teaching methods slow adoption. Without tackling these issues, benefits remain partial at best. Simulation tools demonstrate strong potential for enhancing conceptual understanding and interactive learning, but their consistent classroom integration and use in assessment need further improvement to maximize their educational impact. There is a balanced ecosystem of research, practice, and policy surrounding PhET simulations. The high number of peer-reviewed studies combined with international case studies and policy support confirms that PhET is a well-established and globally impactful tool in science education.

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# AI-SUPPORTED SIMULATION-BASED TEACHING IN PHYSICAL SCIENCE: A REVIEW OF STUDENT ENGAGEMENT, SELF-EFFICACY, AND ACADEMIC ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS IN INDIA

**Mohd Saifuddin [1], Dr. Momin Sumaiya [2]**

**Abstract**

Artificial Intelligence (AI) is increasingly reshaping educational practices by enabling adaptive, interactive, and personalized learning environments. Among emerging digital pedagogies, AI-supported simulation-based teaching has gained significant attention for its potential to enhance science learning by allowing students to visualize abstract concepts and engage in virtual experimentation. This review paper examines the role of AI-supported simulation-based teaching in improving student engagement, self-efficacy, and academic achievement in Physical Science at the secondary school level, with particular reference to Class IX students in India and the South Indian educational context. Drawing upon existing theoretical and empirical literature on AI in education, simulation-based learning, and technology-integrated science instruction, the paper analyzes how interactive simulation environments can promote behavioral, emotional, and cognitive engagement among learners. Increased engagement is further associated with enhanced self-efficacy and improved academic outcomes. The study also situates these developments within the policy framework of India's National Education Policy (NEP) 2020, which emphasizes experiential learning, digital integration, and competency-based education. While the literature highlights the pedagogical potential of AI-supported simulations for improving conceptual understanding and motivation in science learning, several challenges remain, including limited digital infrastructure, uneven access to technology, inadequate teacher training, and ethical concerns related to data privacy and algorithmic bias. The review concludes that AI-supported simulation-based teaching holds considerable promise for strengthening Physical Science education in Indian secondary schools, provided that its implementation is supported by appropriate teacher preparation, infrastructural development, and context-sensitive educational policies.

***Keywords***: Artificial Intelligence, Simulation-Based Teaching, student engagement

## Introduction

The rapid advancement of digital technologies has significantly transformed educational practices across the world. Among these developments, **Artificial Intelligence(AI)** has emerged as one of the most influential innovations shaping contemporary teaching and learning environments. AI-enabled systems now support various educational functions such as adaptive learning platforms, intelligent tutoring systems, automated feedback mechanisms, learning analytics, virtual laboratories, and simulation-based instructional tools. These technologies have opened new possibilities for enhancing learning experiences by enabling personalized instruction, real-time feedback, and interactive exploration of complex concepts.

Science education, particularly **Physical Science at the secondary school level**, presents unique pedagogical challenges because many scientific phenomena involve abstract processes that are difficult for students to visualize through conventional instructional methods. Topics such as motion, electricity, sound waves, atomic structure, and gravitational forces often require conceptual reasoning that extends beyond textbook explanations. In many classrooms, however, these concepts are still taught primarily through

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lecture-based instruction and rote memorization, limiting opportunities for inquiry-based learning and meaningful conceptual understanding.

In the Indian educational context, these challenges are further intensified by systemic factors such as overcrowded classrooms, limited laboratory facilities, examination-oriented curricula, and disparities in access to educational resources. National surveys such as the **National AchievementSurvey (NAS)** and reports by organizations such as **UNESCO and OECD** have repeatedly highlighted concerns regarding student engagement and conceptual understanding in science and mathematics education.

AI-supported simulation-based teaching offers a promising alternative to traditional instructional approaches. Simulation technologies allow learners to interact with dynamic models of scientific processes, manipulate variables, observe outcomes, and test hypotheses within virtual environments. When integrated with AI capabilities, such simulations can adapt to individual learning needs, diagnose misconceptions, and provide personalized guidance. Consequently, AI-supported simulations have the potential to transform Physical Science learning from passive information reception into an **interactive and learner-centered educational experience.**

### Need and Significance of the Study

The need for AI-supported simulation-based teaching in Physical Science has become increasingly urgent in India, particularly at the secondary school level where students begin to encounter more abstract scientific concepts. Many Class IX students perceive Physical Science as difficult because it combines theoretical explanations with mathematical reasoning, laboratory procedures, and symbolic representation. Topics such as electricity, motion, sound, and atomic structure often appear disconnected from students' everyday experiences when they are taught only through lectures and textbooks.

The problem is especially visible in many Indian classrooms where science instruction remains examination-oriented and teacher-centered. Students are often encouraged to memorize definitions, formulas, and diagrams rather than engage in inquiry, experimentation, or conceptual reasoning. Such approaches may temporarily improve examination performance but frequently fail to sustain long-term understanding, curiosity, or scientific thinking.

This issue is more pronounced in several government and rural schools across South India where shortages of laboratory equipment, digital devices, and trained science teachers continue to limit the quality of science education. While South Indian states such as Karnataka, Telangana, Tamil Nadu, Andhra Pradesh, and Kerala have shown notable progress in educational development, disparities remain between elite urban schools and resource-constrained rural schools.

AI-supported simulations may provide an effective response to these challenges because they enable students to visualize invisible scientific processes, conduct virtual experiments, and learn through interactive exploration. However, it is important to avoid overly optimistic assumptions regarding technology. AI is not a substitute for teachers, nor can technology alone solve deeper structural problems such as overcrowded classrooms, social inequality, or language barriers. Rather, AI-supported teaching should be understood as a pedagogical tool whose effectiveness depends on teacher competence, curriculum design, and contextual suitability. The significance of the present paper therefore lies in its attempt to critically examine how AI-supported simulation-based teaching may contribute to improved student engagement and academic achievement in Physical Science among Class IX students in India, with particular reference to South India.

### Objectives of the Paper

1. To examine the role of AI-supported simulation-based teaching in Physical Science education.
2. To analyze its influence on student engagement among Class IX students.
3. To study its impact on academic achievement in Physical Science.
4. To review existing literature related to AI, simulation-based teaching, and science learning.
5. To propose a conceptual framework for AI-supported simulation-based teaching in secondary schools.

## Conceptual Background of Artificial Intelligence in Education

Artificial Intelligence in education involves computer systems performing tasks that require human intelligence, such as learning, reasoning, decision-making, language processing, and problem-solving. In classrooms, AI supports personalized learning, tracks student progress, automates administrative work, and assists teachers in designing effective instruction.

AI can be categorized into adaptive, generative, and predictive types. Adaptive AI adjusts content based on learners' pace and performance. Generative AI creates explanations, quizzes, and summaries tailored to student needs. Predictive AI analyzes data to identify students at risk of poor performance.

Common tools include adaptive learning systems, intelligent tutoring systems, virtual laboratories, educational chatbots, and learning analytics platforms. In Physical Science, these tools help visualize complex phenomena like particle motion, electric current, sound waves, friction, and gravity through simulations.

## Conceptual Relationship Framework

The conceptual relationship among AI-supported simulation-based teaching, student engagement, self-efficacy, and academic achievement may be presented through a visual model. In this model, AI-supported simulation-based teaching acts as the independent variable, while student engagement and self-efficacy function as mediating variables. Academic achievement serves as the dependent variable. The framework may also include moderating variables such as digital access, teacher competency, socio-economic status, school infrastructure, and parental support. Such a framework would visually demonstrate that AI-supported simulation environments can increase behavioral, emotional, and cognitive engagement among Class IX students, which in turn enhances their self-confidence and academic performance in Physical Science.

## Comparison between Traditional Teaching & AI-Supported Simulation Teaching

| ***Dimension*** | ***Traditional Teaching*** | ***AI-Supported Simulation Teaching*** |
|---|---|---|
| **Teaching Approach** | *Teacher-centred and lecture-based* | *Learner-centred and interactive* |
| **Student Role** | *Passive recipient of knowledge* | *Active participant and explorer* |
| **Learning Environment** | *Mostly textbook-oriented* | *Technology-enabled and experiential* |
| **Physical Science Concepts** | *Often abstract and difficult to visualize* | *Concepts become concrete through virtual simulations* |
| **Student Engagement** | *Limited behavioral and emotional engagement* | *Higher cognitive, emotional, and behavioral engagement* |
| **Feedback Mechanism** | *Delayed and generalized* | *Immediate, personalized, and adaptive* |
| **Academic Achievement** | *Dependent mainly on memorization* | *Improved conceptual understanding and retention* |
| **Learning Pace** | *Uniform for all students* | *Flexible and adaptive to learner needs* |
| **Assessment Style** | *Mostly summative* | *Combination of formative and summative* |
| **Inclusiveness** | *Limited accommodation for diverse learners* | *Greater personalization and differentiated learning* |

## Simulation-Based Teaching in Physical Science

Simulation-based teaching is an approach where students learn through interactive models that replicate real-life processes and experiments. These simulations, available on computers, web platforms, or mobile devices, allow learners to manipulate variables, test ideas, and observe results.

In Physical Science, this method is highly useful as many concepts are abstract or not easily demonstrated. Simulations help students understand topics like motion, force, sound, atoms, heat, and electricity through visual and dynamic experiences.

For Class IX students in India, simulations make learning more engaging by promoting exploration instead of rote memorization. They improve conceptual clarity and active participation. Additionally, virtual labs offer a practical, safe, and cost-effective alternative where physical laboratory facilities are limited.

**Student Engagement in Physical Science Learning**

Student engagement strongly predicts learning success. It involves active participation, emotional connection, and cognitive investment. It has three dimensions: behavioral (attendance, participation, task completion), emotional (interest, enjoyment, belonging), and cognitive (deep thinking, problem-solving, reflection).Physical Science classes often show low engagement due to lecture-heavy teaching, memorization, and limited real-life connection, making concepts seem difficult.

AI-supported simulations can improve engagement by creating interactive environments, enabling hands-on experimentation, offering instant feedback, and encouraging collaboration. For Class IX students, engagement is crucial, as it shapes their future attitude toward science. Engaged learners are more likely to develop confidence, curiosity, and sustained interest in advanced studies.

**Academic Achievement in Physical Science**

Academic achievement refers to the extent to which students attain educational goals, typically measured through examination scores, classroom assessments, conceptual understanding, retention, and problem-solving ability.

In Physical Science, achievement is closely related to the methods used for instruction. Traditional teaching methods often focus on memorization rather than conceptual understanding, which may result in poor performance in examinations and weak application of knowledge.

Academic achievement in Physical Science may be assessed through multiple indicators such as classroom participation, unit test scores, conceptual understanding tests, laboratory performance, retention tests, project work, and board examination results. A broader understanding of achievement is important because students may sometimes score well in examinations without developing meaningful scientific understanding.

AI-supported simulations can improve academic achievement by making scientific concepts more concrete and understandable. When students can see and manipulate scientific processes, they are more likely to retain information and apply it in different contexts. Simulations also support repeated practice, allowing students to revisit concepts until they achieve mastery. Several studies suggest that students who learn through interactive simulations perform better than those who rely solely on traditional teaching methods. This is because simulations encourage active learning, reduce misconceptions, and provide immediate feedback.

In the Indian context, academic achievement in Class IX Physical Science is particularly important because it influences performance in Class X board examinations and determines students' future interest in science-related subjects.

**Theoretical Foundations**

The present paper is grounded in several educational theories.

Constructivist Learning Theory emphasizes that learners construct knowledge through active interaction with their environment. AI-supported simulations align with this theory because they allow students to explore concepts independently, manipulate variables, and build understanding through experience.

Social Cognitive Theory highlights the importance of observation, interaction, and self-belief in learning. Students who successfully engage with simulations may develop stronger confidence in their abilities and become more willing to participate in science activities.

The Self-Efficacy Theory proposed by Albert Bandura explains that students who believe in their capabilities are more likely to participate actively, persist in challenging tasks, and achieve better learning outcomes. This theory supports the idea that AI-supported simulations may indirectly improve achievement by strengthening students' confidence.

Student Engagement Theory suggests that meaningful learning occurs when students are behaviorally, emotionally, and cognitively involved in classroom activities. Simulation-based learning environments can strengthen all three forms of engagement. The Technology Acceptance Model explains that students are more likely to use educational technologies when they perceive them as useful and easy to use. This theory is particularly important in the Indian context because students' and teachers' attitudes toward AI tools may influence their effectiveness.

Together, these theories provide a strong foundation for understanding how AI-supported simulation-based teaching may influence engagement and academic achievement in Physical Science.

**Review of Related Literature**

International literature increasingly recognizes AI as a transformative force in education. Holmes, Bialik, and Fadel (2019) argued that AI can support personalized learning, reduce administrative burdens, and provide real-time feedback to learners. Similarly, Luckin et al. (2016) emphasized that AI systems have the potential to adapt instruction according to students' needs, preferences, and pace of learning.

However, the literature also warns against uncritical acceptance of AI in education. Selwyn (2019) argued that AI may reproduce educational inequalities if access to technology remains uneven. Zawacki-Richter et al. (2019) found that although AI in education is expanding rapidly, much of the research remains technologically focused and pays insufficient attention to pedagogical, ethical, and social dimensions.

Studies on simulation-based teaching have consistently reported positive effects on science learning. Wieman, Adams, and Perkins (2008) found that interactive simulations enhanced conceptual understanding in Physics by helping students visualize abstract concepts. Rutten, van Joolingen, and van der Veen (2012) concluded that simulations are particularly effective when combined with teacher guidance and inquiry-based activities. Nevertheless, simulation-based learning does not automatically guarantee better outcomes. Some researchers argue that students may become distracted by visual features if simulations are poorly designed or if they are used without structured instructional support. Excessive dependence on digital simulations may also reduce opportunities for hands-on experimentation and collaborative problem-solving.

Research on student engagement suggests that technology-rich environments often improve participation, curiosity, and classroom interaction. Fredricks, Blumenfeld, and Paris (2004) conceptualized engagement as a multidimensional construct involving behavioral, emotional, and cognitive dimensions. Hattie (2009) found that feedback, active participation, and visible learning strategies have strong positive effects on student achievement.

In the Indian context, studies on digital learning in science education have generally shown positive outcomes. Several studies conducted in Indian secondary schools report that multimedia tools, virtual laboratories, and smart classroom technologies can improve motivation and conceptual understanding. However, most Indian studies focus broadly on science education rather than specifically examining Physical Science at the Class IX level. Here are some studies given in the below table

| Author(s) and Year | Area / Sample | Major Findings | Limitations |
|---|---|---|---|
| **Mailavelan& Baskaran (2018)** | 270 secondary students, Tamil Nadu | Students had moderate ICT awareness; urban students showed higher awareness than rural students | Focused only on ICT awareness, not direct academic achievement |
| **Nagamani & Muthuswamy (2013)** | 157 secondary teachers, Tamil Nadu | Teachers showed moderate ICT use; location and age influenced technology use | Did not specifically examine AI or simulation teaching |

| | | | |
|---|---|---|---|
| **Raja & Devi Mahalakshmi (2024)** | 300 higher secondary teachers, Tamil Nadu | Teachers had similar ICT awareness levels regardless of gender | Focused on teacher awareness rather than student learning outcomes |
| **Sabu & Roy (2025)** | Secondary schools, Kerala | Student engagement strongly influenced school learning outcomes and quality | Did not specifically focus on science education |
| **Mukherjee, Sarkar, & Biswas (2025)** | Secondary science education | AI tools such as virtual labs and adaptive learning improve science teaching effectiveness | More theoretical than empirical in nature |

Research conducted in Telangana secondary schools has highlighted the growing importance of digital and simulation-based teaching tools. Studies examining smart classrooms and ICT-enabled teaching in Hyderabad and surrounding districts have shown that students demonstrate greater interest and participation when science lessons include digital animations, virtual experiments, and multimedia content. Teachers in Telangana also reported that simulation-based teaching improves conceptual clarity in topics such as motion, force, gravitation, electricity, and atoms and molecules .However, the studies also pointed out that many rural schools in Telangana still face barriers such as insufficient digital infrastructure, lack of computer laboratories, inconsistent electricity supply, and limited teacher training. These findings reinforce the argument that technological innovation alone is insufficient unless supported by strong institutional and policy measures.

Recent empirical studies from South India further strengthen the argument for AI-supported and simulation-based teaching in secondary science education. A study conducted among 270 secondary school students in and around Chennai, Tamil Nadu, found that students generally demonstrated moderate to high levels of ICT awareness, with urban students showing greater familiarity with technology than rural students. The study highlighted that ICT awareness can play an important role in supporting student participation and readiness for simulation-based learning environments.

Research conducted in Kerala emphasized that student engagement is a key determinant of educational quality and learning outcomes. The study found that stronger behavioral, emotional, and cognitive engagement among secondary school students was positively associated with academic success and school participation. This finding directly supports the use of AI-supported simulation teaching, which is designed to increase learner engagement through interactive and adaptive learning experiences.

A study from Tamil Nadu on teachers' use of ICT in secondary schools found that teachers were only moderate users of technology for professional purposes, with significant differences based on age and school location. This finding suggests that teacher preparedness remains a critical factor in the successful implementation of AI-supported science teaching.

Another study from Tamil Nadu involving 300 higher secondary school teachers reported that most teachers had similar levels of ICT awareness regardless of gender, but challenges remained regarding the actual use of educational technologies in classroom practice. This suggests that although teachers may be familiar with ICT tools, additional professional training is required to effectively integrate AI-supported simulations into Physical Science classrooms.

Recent developments also show increasing institutional support for virtual and AI-enabled learning in South India. In Madurai, Tamil Nadu, a corporation higher secondary school established a virtual laboratory to help students explore textbook science concepts using virtual reality technology. Similarly, Kerala's KITE programme introduced AI-supported personalized learning systems and adaptive study plans for secondary school students. These examples indicate that South Indian states are gradually creating favourable conditions for the adoption of AI-supported science teaching.

The integration of AI-supported simulation teaching in secondary education is particularly relevant in South Indian states such as Telangana","Andhra Pradesh", "Tamil Nadu","Karnataka", and "Kerala". These states have shown comparatively higher levels of digital infrastructure, smart classroom initiatives, ICT integration, and adoption of e-learning platforms in school education. For example, Telangana has implemented digital classrooms and T-SAT educational channels, while Kerala has gained national recognition through KITE Victers and technology-enabled classrooms. Karnataka and Tamil Nadu have also invested in ICT laboratories and digital content development for science education. However, despite these advancements, disparities continue to exist between urban and rural schools, government and private institutions, and students from different socio-economic backgrounds. Rural schools often face challenges such as limited internet connectivity, insufficient teacher training, lack of digital devices, and inconsistent electricity supply. Therefore, the success of AI-supported simulation-based teaching in South India depends not only on technological availability but also on equitable implementation, teacher preparedness, and contextual adaptation.

Research from South India also indicates increasing interest in technology-supported science learning. Schools in urban areas of Telangana, Karnataka, Tamil Nadu, and Kerala have begun integrating smart boards, digital content, and simulation tools into science teaching. Yet, empirical evidence from rural schools remains limited, and relatively few studies examine the relationship between AI-supported simulations, student engagement, and academic achievement together. Thus, a major gap in the literature lies in the lack of focused research on Class IX Physical Science students in India, particularly in South India. Existing studies often address technology use, engagement, or achievement separately rather than examining how these variables interact within AI-supported simulation-based teaching environments.

**Research Gap**

Despite the growing body of literature on digital technologies in education, several important gaps remain in existing research. Many previous studies have examined the general use of **Information and Communication Technology (ICT)**in classrooms rather than focusing specifically on **AI-supported simulation-based teaching** in science education. Furthermore, much of the existing research has concentrated on either technological awareness among teachers or students' perceptions of digital learning tools, with limited empirical investigation of their impact on **student engagement, self-efficacy, and academic achievement simultaneously**.

Another limitation of the current literature is the lack of **context-specific research within the Indian secondary school system**, particularly in relation to **Class IX Physical Science education**. While several studies highlight the potential benefits of digital learning technologies, few have examined how AI-supported simulation environments interact with psychological variables such as engagement and self-efficacy in shaping academic outcomes. Additionally, research focusing on **South Indian educational contexts** remains relatively limited, despite the region's growing investment in digital learning initiatives and technology-enabled classrooms.

Therefore, there is a clear need for a comprehensive examination of how AI-supported simulation-based teaching may influence multiple dimensions of student learning in secondary science education. The present review seeks to address this gap by synthesizing theoretical perspectives and existing research to develop a conceptual understanding of the relationship between **AI-supported simulations, student engagement, self-efficacy, and academic achievement.**

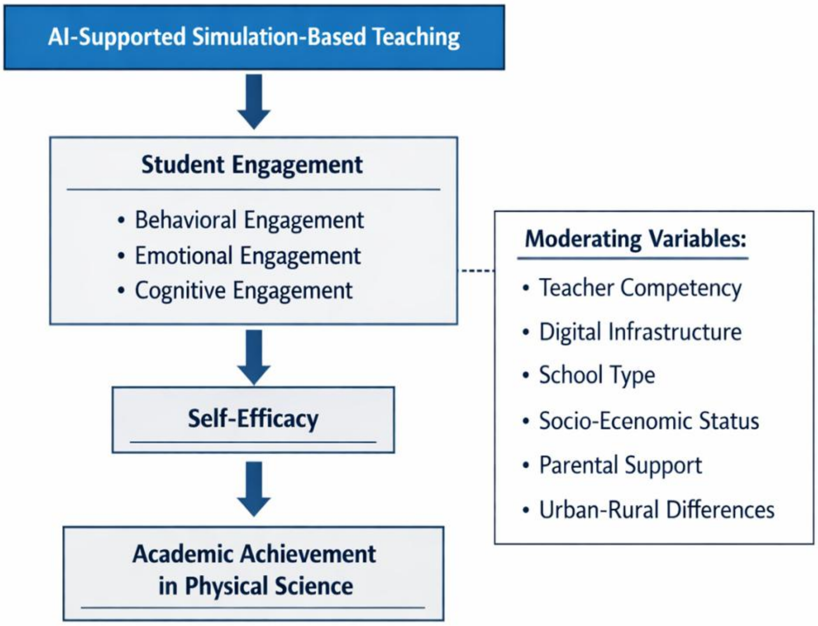
**Conceptual Framework**

The conceptual framework proposed in this paper illustrates the relationship between **AI-supported simulation-based teaching**, **student engagement**, **self-efficacy**, and **academic achievement** in Physical Science learning. In this framework, AI-supported simulation teaching functions as the **primary instructional variable**, providing interactive and adaptive learning environments that encourage exploration and experimentation.

Student engagement acts as a **mediating construct** consisting of behavioral, emotional, and cognitive dimensions. When learners actively participate in simulation-based activities, demonstrate curiosity, and invest effort in problem-solving tasks, their level of engagement increases. Higher engagement, in turn, contributes to the development of **self-efficacy**, defined as students' belief in their ability to successfully perform academic tasks.

Self-efficacy plays a critical role in sustaining motivation and persistence in learning activities. Students who develop stronger confidence in their capabilities are more likely to engage deeply with scientific concepts and overcome learning difficulties. Ultimately, increased engagement and self-efficacy contribute to improved **academic achievement**, reflected in better conceptual understanding, problem-solving ability, and performance in assessments.

**Figure 1.** Conceptual Relationship Between AI-Supported Simulation Teaching and Academic Achievement




The framework also acknowledges the presence of **moderating contextual factors**, including digital access, teacher competence, school infrastructure, socio-economic conditions, and parental support. These factors influence the extent to which AI-supported simulation teaching can effectively improve student learning outcomes.

**Educational Implications**

The paper has important implications for teachers, schools, and policymakers. Physical Science teachers should move beyond lecture-based instruction and adopt more interactive teaching strategies. AI-supported simulations can help teachers explain difficult concepts more effectively and maintain student interest.

Curriculum developers should integrate simulation-based activities into Physical Science textbooks and digital platforms. Policymakers should ensure that schools, particularly in rural and government sectors, have access to digital infrastructure and teacher training.

For South Indian schools, AI-supported teaching may be especially beneficial because it can support multilingual learning and address regional disparities in educational quality.

**Challenges and Limitations**

Despite its promise, AI-supported simulation-based teaching is not without limitations. One major challenge is the lack of digital infrastructure in many Indian schools. In several rural and government schools, computers, projectors, internet access, and uninterrupted electricity remain inadequate.

Teacher readiness is another critical concern. Many teachers may not have sufficient training in AI-supported teaching methods or confidence in using simulation tools effectively. Without proper guidance, technology may be underutilized or used merely as a substitute for traditional lectures.

The rural-urban divide continues to shape unequal access to technology. Students in urban private schools often have greater exposure to digital learning than students in rural or economically disadvantaged settings.

Language also remains a barrier because much AI-supported content is designed in English. Students studying in Telugu, Tamil, Kannada, Malayalam, or Urdu-medium schools may struggle to benefit fully from such resources.

There are also important ethical concerns. AI systems collect and analyze student data, raising questions about privacy, consent, surveillance, and data security. Excessive dependence on technology may reduce face-to-face interaction between teachers and students and may contribute to digital fatigue.

Therefore, while AI-supported simulation-based teaching has significant potential, its implementation must be approached carefully and critically.

**Focus Area**

Teacher training programs should include modules on AI-supported science teaching and simulation-based pedagogy. Schools should invest in digital infrastructure and ensure that students have access to devices and internet connectivity.

Simulation tools should be integrated into the Physical Science curriculum, particularly for topics that students find difficult. Educational software should be developed in regional languages to make learning more accessible for South Indian students.

Collaboration between educational institutions, state governments, private technology companies, and teacher education institutions is necessary to ensure equitable implementation of AI-supported learning.

Future research should focus on empirical studies involving Class IX students in India to examine the long-term effects of AI-supported simulations on engagement, achievement, and self-efficacy. Researchers should also compare rural and urban schools, government and private schools, and different South Indian states to better understand contextual differences.

**Policy Implications**

The findings of the review have important implications for educational policy and teacher preparation. School education departments should invest in digital laboratories, simulation software, and AI-supported learning platforms for Physical Science teaching at the secondary level. Teacher education institutions should redesign pre-service and in-service training programmes to include AI literacy, digital pedagogy, and simulation-based instructional methods.

Policy makers should also ensure equitable access to digital resources in rural and government schools so that technological innovation does not widen existing educational inequalities. In addition, curriculum developers should integrate simulation-based activities into Class IX Physical Science textbooks and teaching manuals. Partnerships between schools, universities, technology companies, and educational research organizations may further strengthen the implementation of AI-supported teaching models.

**Conclusion**

AI-supported simulation-based teaching represents a significant pedagogical innovation with the potential to transform the teaching and learning of Physical Science in secondary education. By enabling interactive visualization, virtual experimentation, and adaptive feedback, AI-supported simulations can make abstract scientific concepts more accessible and engaging for students. The literature reviewed in this study suggests that such instructional approaches can strengthen behavioral, emotional, and cognitive engagement, which in turn enhances learners' self-efficacy and academic performance.

However, the successful implementation of AI-supported teaching requires more than technological availability. Effective integration depends on several factors, including teacher preparedness, curriculum design, equitable access to digital infrastructure, and the development of culturally and linguistically relevant educational resources. Without addressing these systemic issues, the potential benefits of AI-enabled learning environments may remain unevenly distributed across schools and regions.

In the Indian context, and particularly within South Indian states where digital education initiatives are expanding, AI-supported simulation-based teaching offers promising opportunities for improving science learning outcomes. Future research should therefore focus on **empirical investigations involving secondary school students**, employing experimental or mixed-method research designs to examine the long-term effects of simulation-based learning on engagement, self-efficacy, and academic achievement. Such research would contribute valuable insights for educators, policymakers, and curriculum developers seeking to create more inclusive and effective science education systems.

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# THEME 5

# EDUCATIONAL LEADERSHIP FOR INNOVATION AND QUALITY IMPROVEMENT IN SCHOOL EDUCATION

**Vemula Sharathbabu [1], Pitla Raju [2], Killampalli Aditya [3]**

**Abstract**

The existing literature is inclined to consider the models of educational leadership individually and, therefore, disaggregate the information regarding the implementation of these models to facilitate innovation and raise the quality of schools. The interactions between transformational, instructional, distributed or pedagogical leadership are rarely addressed in the literature, which is why one can hardly achieve a comprehensive picture of leadership as the factor that promotes change in the institution. This thematic paper bridges this missing linkage by integrating these four models into a coherent conceptual framework that defines the way their input to the science of school education is synergistic in terms of pedagogical innovation, technological integration, and institutional development. According to the available national and international research founded on the conceptual analysis of the qualitative approach, the study showed how transformational leadership introduces vision and motivation, instructional leadership reinforces practice in the classroom, distributed leadership encourages teacher teamwork, and pedagogical leadership justifies learning-oriented decision-making. Such blended practices lead to the development of professional learning communities, data-driven practices and a culture of insatiable improvement, which are fundamental to the educational archetype of the twenty-first century. The discussion demonstrates that three facets of innovation require particular leadership behaviors: pedagogical innovation requires risk-taking environments; technological integration requires resource mobilization and capacity building; and institutional innovation requires structural redesign and stakeholder involvement. Such problems as teacher resistance to change, lack of leadership preparation, scarce resources, and situational adaptation are among the critical issues and are discussed in a systematized manner, and solutions are provided to school leaders, teacher educators and policymakers. Findings indicate that integrated models of leadership lead to a strong positive effect on teaching, student learning, and school improvement in the long term. The framework is consistent with the school complex leadership in NEP 2020 and the previously mentioned foundational literacy/numeracy mission of NIPUN Bharat to bring in alignment to the Indian situation. Strengthening the leadership capacity through certification, inculcating a culture of innovation amidst the team work process, and aligning the policy with evidence-based practices are seen to be important in preparing schools to meet the contemporary and future education needs.

***Keywords:*** *educational leadership, school innovation, pedagogical leadership, instructional leadership, distributed leadership*

## Introduction

Education is a key factor in building human capital and promoting social and economic development (OECD, 2020; Education, 2021). In the context of rapidly changing knowledge economies, schools are increasingly expected to go beyond the transmission of content knowledge and to focus on the development of critical thinking, creativity, collaboration and problem-solving skills amongst learners. These changing expectations have led to the transformation of the role of educational institutions in that they need to be responsive to technological advancements, globalization, and changes in societal needs.

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In this changing environment, innovation has become an important mechanism to enhance the quality of school education. Educational innovation includes not only the change in classroom practices but also the development in curriculum design, assessment strategies and institutional processes (Fullan, 2016; Haleem et al., 2022). However, the successful implementation of such innovations is highly reliant on the existence of a form of effective educational leadership that can guide change, support teachers and create a culture of continuous and evidence-based improvement.

Educational leadership is important in influencing teaching practices, improving teacher motivation, and improving student learning outcomes. School leadership is a key factor in the effectiveness of institutions: leaders set out explicit goals, foster collaboration, and assist in professional development (Leithwood et al., 2019; Robinson et al., 2008). Contemporary research focuses more on leadership styles that are collaborative, instructional, and learning-centered, which reflects a shift from traditional administration models to more dynamic and participatory types of leadership (Harris, 2023).

Various leadership models such as transformational, instructional, distributed and pedagogical leadership have been extensively studied in relation to school improvement and innovation. However, a major shortcoming in the current body of research is that these models tend to be studied in isolation, leading to a fragmented understanding of the potential for these models to collectively address complex educational challenges (Vemula & Killampalli, 2026). This lack of integration limits an in-depth understanding of how leadership can provide effective support for pedagogical innovation, technological integration and the development of institutions.

Addressing this gap, the present study provides an integrated conceptual framework which synthesizes transformational, instructional, distributed, and pedagogical leadership. The study aims to investigate how the interaction of these leadership approaches can make a contribution to innovation and quality improvement in school education. By focusing on their complementary roles, the paper aims to provide a more holistic view of leadership as a dynamic and related process.

In the Indian context, this study acquires greater relevance in the context of the National Education Policy (NEP) 2020 which places emphasis on the academic leadership, school complexes, and innovative pedagogical practices (Ministry of Education, 2020). Additionally, national initiatives such as NIPUN Bharat mission emphasize the importance of foundational literacy and numeracy, data-driven practices, and systemic improvement in schools (Ministry of Education, 2021). By making the proposed integrated leadership framework compatible with these policy priorities, the study contributes to understanding how leadership can assist educational reform and improve the quality of school education in India.

## Objectives of the Study

1) To study the disjointed treatment of educational leadership models relating to school innovation.
2) To form an integrated conceptual framework, utilizing transformational, instructional, distributed and pedagogical leadership.
3) To examine the role of integrated forms of leadership in supporting pedagogical, technological and institutional innovation in schools
4) To identify challenges to implementation as well as propose strategies for educational leaders, teachers, and policymakers.
5) To connect the integrated framework with school complex leadership as per NEP 2020 and the foundation literacy/numeracy mission of the NIPUN Bharat.

## Review of Literature

Educational leadership has been widely recognised as a critical factor in influencing school effectiveness, teacher performance and student learning outcomes. Over the past few decades, various models of leadership have been developed in order to understand the role of leadership and practices in educational improvement. Amongst them, transformational leadership, instructional leadership, distributed leadership, and pedagogical leadership have attracted much attention in the academic literature.

Transformational leadership focuses on vision-building, motivation, and organizational change. Research suggests that transformational leaders are able to inspire teachers to practice innovations, encourage commitment, and develop a sense of common goals in schools (Leithwood & Sun, 2012). This model is especially effective in fostering a culture of change and constant improvement which is required in dynamic educational settings. However, studies suggest that although transformational leadership provides direction, it may not directly address its classroom level instructional practices.

Instructional leadership has explicit teaching and learning processes in mind. Hallinger (2011) identifies that instructional leaders achieve effective student results through alignment of curriculum, pedagogy, and assessment and by giving ongoing feedback and support to teachers. On a similar note, Robinson et al. (2008) found that there is strong and direct impact on student achievement by instructional leadership. Despite its effectiveness, this model is often criticized for focusing too much on academic results. This can sometimes neglect the wider institutional and collaborative aspects. Distributed leadership is an alternative way to think. It emphasizes the concept of collaborative decision-making and shared responsibility. Spillane (2006) argues that leadership is not restricted to formal positions; it is distributed among people within the organization. This approach leads to teacher agency, encourages professional learning communities, and facilitates collective problem-solving (Harris, 2023). However, in the absence of clear coordination, distributed leadership can result in the fragmentation and lack of coherence in school practices.

Pedagogical leadership puts student learning at the heart of leadership practices. It combines the aspects of instructional improvement, reflective teaching, professional development and learner-centered decision-making (Fonsen & Lahtero, 2023). This model provides for aligning all processes of the institution with the educational objectives and the needs of the learners. Recent conceptual work has also emphasized pedagogical leadership as embedded in the professional capacity and collaborative practices of teachers (Vemula & Killampalli, 2026).

Despite the wide body of literature on these leadership models, most of the studies have been conducted in isolation and therefore, there is a fragmented understanding of their role in fostering innovation and quality improvement in schools. Limited research has been done to examine the interaction and complementary aspects of these leadership approaches in actual educational settings.

Addressing this gap, the current research proposes a combined conceptual framework summarizing transformational, instructional, distributed and pedagogical leadership. By investigating their combined and synergic impacts, this study is intending to deliver a more holistic understanding of the role of leadership in supporting pedagogical innovation and technological integration in institutional development of school education in contemporary times.

**Research Methodology**

This study uses a qualitative conceptual research design in order to study the role of educational leadership in promoting innovation and quality improvement in school education. Conceptual research aims at analyzing and synthesizing the already existing theories and empirical findings in order to develop a comprehensive understanding of a phenomenon (Creswell & Creswell, 2018). In this thematic paper, the conceptual approach allows to integrate several approaches to leadership in a single analytical framework to deal with innovation in schools.

This study is based on secondary data gained from a vast range of scholarly sources, encompassing scholarly journal articles under peer review, academic books and policy documents in the area of educational leadership, innovation and school improvement. Reports from international organizations such as the UN Educational and Scientific Organization (UNESCO), and Organisation for Economic Co Operation and Development (OECD) were also reviewed to learn about tendencies of educational leadership and reform worldwide (OECD, 2020; Education, 2021). These sources create a wide and rich knowledge base for analysing current leadership practices and their implications for quality improvement.

A narrative and thematic analysis method was used to establish important patterns and relationships throughout the reviewed literature (Snyder, 2019). Codes were developed around the four leadership models:

transformational, instructional, distributed, and pedagogical leadership; as well as different forms of innovation: pedagogical, technological, institutional; professional learning communities; data driven practices; and implementation challenges. These leadership models were chosen due to their strong theoretical base and proved to be relevant to enhance teaching practices and student learning outcomes (Fonsen & Lahtero, 2023; Leithwood et al., 2019; Spillane, 2006).

The analysis proceeded by comparing the way each leadership model is conceptualized, how they affect teaching and learning, and how they relate to forms of innovation and school improvement. Insights from this thematic synthesis were used to construct an integrated framework. It explains the synergistic effects of combining leadership approaches to pedagogical innovation, technological integration and institutional development. Though the research is not based on primary data collection, the methodical synthesis of known theoretical perspectives offers useful insights about the way integrated approaches to leadership can support innovation, and improve the quality of school education.

## Findings

### Integrated Conceptual Framework of Educational Leadership

The conceptual analysis reveals that educational leadership is best performed when various leadership models are integrated rather than implemented separately. Transformational, instructional, distributed, and pedagogical leadership are discussed as distinct strategies in most of the existing literature, which results in a disjointed picture of their contribution to the advancement of innovation and school quality (Leithwood et al., 2019).

Based on this synthesis, the combined framework that has been created in this study brings to the fore the complementary roles played by these leadership models that when combined, reinforce school practices. They do not operate in isolation, but the interaction between them forms a self-reinforcing system that strengthens the processes of instruction and the development of the institution (Harris, 2023). The integration aids in the development of professional learning community, promotes data informed practices and the culture of continuous improvement. Consequently, the schools get more prepared to meet the changing pedagogical and technological needs and still have a high concentration on student learning outcomes.

### Role of Transformational Leadership

In the integrated conceptualization, transformational leadership plays a functional role that creates vision and motivates and organizes stakeholders to creativity and school development. It provides the environment that would inspire teachers to practice innovatively and become proactive in developing the institution.

Transformational leadership enhances dedication and commitment to long-term enhancement and supports new practices by creating a sense of purpose and shared responsibility (Leithwood and Sun, 2012). It is especially important in the context of the Indian scenario, which requires school complexes ancestry, and the alignment of stakeholders with NEP 2020 reforms and the promotion of foundational literacy and numeracy programs (Ministry of Education, 2020, 2021).

Instructional leadership plays a crucial role in the development of instructional plans.

### Role of Instructional Leadership

Instructional leadership is the practice implemented in the integrated frame in which the larger vision is translated into practical classroom activities and quantifiable learning results. It establishes coherence in curriculum, pedagogy and assessment as well as contributes to an ongoing improvement in teaching practices.

Instructional leadership is associated with the increase in the quality of instruction provided by the means of well-organized feedback, mentoring, and evidence-based strategies (Hallinger, 2011; Robinson et al., 2008). Regarding the concept of foundational literacy and numeracy, it is vital in maintaining the regular use of effective pedagogical practices and encouraging data-informed instructional choices (Ministry of Education, 2021).

**Role of Distributed Leadership**

Through the integrated system, the distributed leadership enhances collaborative practices through shared responsibility and involvement in the school improvement processes. It improves the ability of institutions to deal with complex issues through the involvement of teachers and stakeholders in the decision-making process.

This practice is in line with the emergence of professional learning communities whereby teachers cooperate, reflect, and build knowledge together, thus leading to the sustained innovation and institutional effectiveness (Spillane, 2006; Harris, 2023).

**Role of Pedagogical Leadership**

In the integrated framework, pedagogical leadership makes sure that all the leadership practices are focused on the learning of the students as the decisions of the institutions can be adjusted to the classroom realities. It links professional growth, instruction approaches, and resources planning to the purpose of enhancing the learning outcomes.

Pedagogical leadership improves the professional ability and responsiveness of teachers to the needs of different learners by fostering reflective pedagogy and adaptive pedagogy (Fonsen and Lahtero, 2023). It also incorporates learning oriented decision-making into the collaborative processes, and increases the effectiveness of the educational practices (Vemula & Killampalli, 2026).

**Synergistic Effect of Integrated Leadership**

The synthesized study reveals that the composite use of transformational, instructional, distributed, and pedagogical leadership has a mutually reinforcing influence on the operations of schools. Their interaction improves the quality of teaching, increases cooperation between teachers, and advances the learning achievements of students.

Such synergy helps in the creation of professional learning communities, encourages the use of data to make decisions and a culture of continuous improvement. Such integration is especially applicable to the Indian context when it comes to the adoption of NEP 2020 and programs such as NIPUN Bharat because the co-ordinated leadership practices are needed in the context of enhancing the quality of instruction, foundational learning, and institutional performance.

**Discussion & Educational Implications**

**Leadership and Innovation**

The findings underscore the fact that different types of innovation in school education (pedagogical, technological and institutional) require different types of leadership behaviour, although they are complementary. Pedagogical innovation, the adoption of learner-centred strategies, formative assessment and reflective instructional practices requires leadership that promotes risk taking, psychological safety and support for experimentation among teachers (Fullan, 2016). Transformational and pedagogical leadership are critical in the creation of such environments through articulating a clear moral purpose, fostering reflective dialogue, and legitimizing innovation in classroom practice.

Technological integration requires leadership that focuses on capacity building, resource mobilisation and digital competence building. School leaders need to ensure that teachers have access to adequate infrastructure, relevant digital tools, and sustained professional development to integrate technology effectively into the teaching and learning processes (Haleem et al., 2022). Instructional leadership is especially important in facilitating the pedagogy in the use of technology and ensuring that digital tools are aligned with curriculum goals, while distributed leadership leads towards peer learning and sharing of digital expertise among teachers.

Institutional innovation is structural redesign and involvement of stakeholders for school improvement. This includes the building of collaborative cultures, flexible governance, and professional learning communities.

Such innovation calls for leadership that fosters shared decision making, distributed responsibility and engagement of parents and community members (Leithwood et al., 2019). Distributed leadership is fundamental to creating collective responsibility for institutional change while transformational leadership preserves a long-term vision against which to anchor these structural reforms.

**Leadership for Quality Improvement**

Educational leadership is a key factor in quality improvement in school education. The integrated framework developed in this study illustrates that leadership practices have a direct impact on teaching quality, student learning results and a general school effectiveness. Instructional leadership enhances classroom practices through ensuring the alignment in the curriculum pedagogy and assessment to enhance the effectiveness of teaching (Hallinger, 2011).

Transformational leadership boosts motivation and professional commitment among teachers and willingness to participate in continuous improvement which is crucial in supporting the maintenance of quality teaching practices (Leithwood and Sun, 2012). Pedagogical leadership ensures that all institutional decisions such as resource allocation, professional development focus and assessment policies remain directed to enhance student learning. Distributed leadership is one such contribution that facilitates collaboration, knowledge and best practices sharing in professional learning communities and developing collective efficacy among staff (Harris, 2023).

In many schools, especially in centralised systems, leadership is mainly administrative and principal-centred. The integrated framework proposed in this paper presents an alternative vision of leadership that is instructional, pedagogically grounded, collaborative and innovation oriented, thus providing a more powerful lever for quality improvement.

**Challenges in Implementing Leadership for Innovation**

Despite the potential of integrated leadership approaches, there are a number of challenges that are impeding their effective implementation in the school context.

One issue of significance is resistance to change by teachers. Educators may not choose to use new teaching methods or technologies due to various reasons such as uncertainty, perceived workload, or lack of confidence. To overcome this challenge what is required is the leadership that supports teachers with ongoing professional development, coaching, planning with colleagues, and recognition of innovative efforts (Fullan, 2016). The lack of formal leadership preparation of school administrators is another challenge. Numerous school leaders were chosen not for their on seniority or teaching experience rather than explicit leadership competencies, and this limits their capacity to manage complex institutional change (Leithwood et al., 2019). To develop capacities related to transformational, instructional, distributed and pedagogical leadership, particularly heads of school complexes, and academic coordinators under NEP 2020, systematic leadership preparation and certification programmes are required.

Resource limitations, especially limited financial resources and poor technological infrastructure is another challenge. Schools which have limited access to digital tools, connectivity, and quality learning materials will find it challenging to implement technology-rich pedagogies or data-driven monitoring systems (Haleem et al., 2022). In such contexts, leaders must marshal resources in the community, forge partnerships, and focus on simple, low-cost innovations that reinforce pedagogy and testing.

Adaptive leadership which is sensitive to local conditions is required for contextual and situational diversity such as socio economic differences, multilingual environments, and different school governance structures. Therefore, to respond to the situational demands while maintaining a clear focus on equity, inclusion, and foundational learning, integrated leadership must be flexible enough.

**Educational Implications**

The results have significant implications for educational stakeholders and the Indian education system.

Integrated approaches to leadership must be adopted by school leaders to foster collaboration, innovation, and continuous improvement rather than traditional administrative control. Leaders should establish supporting environments that encourage teachers to try new pedagogical strategies, engage in professional learning communities and use data for instructional decision making. Leadership certification and ongoing professional development can address the development of these capacities.

For teachers, getting actively involved in professional development, acting as a peer mentor or sharing in collaborative learning processes are essential for implementing innovative practices. Teachers should take part in reflective practice, lesson study and joint planning in order to be better pedagogical leaders at the classroom level and contribute to whole school improvement.

For policy makers, particularly in the Indian context, the integrated framework is aligned with the objectives of NEP 2020 and NIPUN Bharat mission. NEP 2020 emphasizes on academic leadership, school complexes, and continuous professional development which requires integrated leadership practices (Ministry of Education, 2020). NIPUN Bharat emphasizes on pedagogical innovation, foundational literacy & numeracy and data-driven monitoring (Ministry of Education, 2021). Strengthening the capacity of leaders (through structured training and certification), responsive and collaborative school cultures, and appropriate resource allocation are key strategies to facilitate innovation and enhance the quality of school education.

**Limitations & Future Directions**

This paper is a conceptual one and is based on secondary data that is made up of the literature available on the topic of educational leadership and innovation. As it does not require primary data collection, the results can only be interpreted in a theoretical manner. This may not be the most ideal way to understand the complexity of leadership practices within varying schools. The integrated framework provides a wide perspective on how leadership has to be applied to the innovation and quality improvement process. However, in the context of the real-life educational environment empirically, its applicability has to be verified.

The future studies can focus on verifying the proposed framework through empirical research of school leaders, teachers, and educational organizations in various regions and types of management. Qualitative case study of the school complexes and cluster-level leadership systems using multiple sites would yield in-depth information on the practice of integrated leadership. Quantitative and mixed-method research designs may investigate the links involving integrated leadership practices, teacher professional learning, and student learning outcomes especially in basic literacy and numeracy.

Moreover, to understand how new technologies, including artificial intelligence, online learning solutions, and learning analytics, can influence leadership practice and facilitate the use of data to make decisions, other works can be conducted. The comparative studies of the regions and different systems of education can also help to comprehend the impact that the contextual factors have on the effectiveness of the integrated leadership strategies and how the frameworks like the one suggested here should be modified.

**Conclusion**

The paper is a thematic paper which discusses the contribution of educational leadership in leading innovation and enhancing the quality of school education using a holistic conceptual framework. This analysis has indicated that transformational, instructional, distributed and pedagogical leadership models are most effective when implemented together as opposed to being used individually. The functions of each model are different, and their combination will result in a holistic approach that will reinforce the teaching practices, enable a team-based approach, and make the institution more effective.

The research paper has shown that educational leadership plays a pivotal role in enabling various types of innovations in schools: to sustain pedagogical innovation, risk-taking environments, and reflective practice; to mobilize resources, build capacity, and make a pedagogically sound use of digital tools; and to redesign the institution structure, governance through collaborative practices, and stakeholder involvement. All these innovations together help in enhancing the quality of teaching, student learning, and ultimately improvement of the schools.

The integrated leadership model aligns with the school complex leadership proposed on the National Education Policy (NEP) 2020 and the background literacy/numeracy mission of NIPUN Bharat in the Indian context (Ministry of Education, 2020, 2021). It highlights the importance of enhancing leadership capacity through certification, instilling the culture of innovation in the teamwork processes, and aligning policy with evidence-based practices in equipping schools with the contemporary and future education requirements. This paper, by stating how an integrated model of leadership can lead to pedagogical, technological, and institutional innovation, offers a theoretical framework to policy and practice to implement to construct high-quality, future-ready school systems.

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# REDEFINING LEADERSHIP IN THE AI ERA

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**Abstract**

Leadership is undergoing a significant transformation in the age of Artificial Intelligence (AI), as technological integration reshapes organizational structures, decision-making, and human interactions. This paper examines how leadership must be redefined to remain effective in AI-driven environments, moving beyond traditional authority-based models toward more adaptive, facilitative, and human-centered approaches. The study employs a qualitative analytical method that draws on a review of contemporary leadership theories, AI-related workplace practices, and conceptual comparisons between traditional and emerging leadership frameworks. The analysis reveals that effective leadership in the AI era requires a balance between technological awareness and emotional intelligence, where leaders not only utilize AI tools for informed decision-making but also foster collaboration, adaptability, and a supportive environment for learning from mistakes. The findings further indicate that leaders who actively engage with their teams, encourage innovation, and maintain a strong ethical and empathetic orientation are better positioned to navigate complexities introduced by AI. The paper concludes that leadership in the AI era is not defined by control or hierarchy but by the ability to guide, support, and grow alongside others, ensuring that technological advancements enhance human potential rather than diminish it.

***Keywords:*** *contemporary leadership, emotional intelligence, human potential, leadership frameworks, transformation*

## Introduction

Leadership has always been important, but defining it clearly is not easy. Earlier, it was seen as the influence of a single strong individual. Today, it is understood as a collaborative and dynamic process that focuses on teamwork, shared responsibility, and adaptability. Effective leaders build self-awareness, communicate clearly, and inspire others while maintaining positive relationships (Kotter, 1996). In the present educational and technological context, leadership has become even more important. Leaders help teams understand their roles, build trust, and encourage motivation. Even simple actions like appreciating others can improve teamwork and morale. The rise of Artificial Intelligence (AI) is changing the way leadership works. It supports data-based decision-making and shifts the role of leaders towards facilitation and collaboration. Leaders today need to be technologically aware, ethically responsible, and open to continuous learning. However, even though AI is widely used, there is still limited understanding of how leadership roles are changing in real situations. Most studies focus more on technology and less on the skills and ethical challenges leaders face. This creates a gap in understanding how leaders can balance human values with AI. This paper explores how leadership is being redefined in the AI era, focusing on new competencies, ethical issues, and effective integration of technology and human efforts. "While AI offers numerous advantages in education, it also presents challenges that leaders must address Table 1 summarizes these key benefits and challenges."

**Table 1: Benefits vs Challenges of AI in Education**

| Aspect | Benefits | Challenges |
|---|---|---|
| Teaching & Learning | Personalized learning experiences that cater to individual student needs (Holmes et al., 2019) | Unequal access to AI tools and digital resources, creating a digital divide (Barnes & Hutson, 2024) |

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| Aspect | Benefits | Challenges |
|---|---|---|
| Decision-Making | Supports data-driven decision-making for school management and instructional planning (Ciornei, 2020) | Ethical concerns such as data privacy and security (Barnes & Hutson, 2024) |
| Efficiency | Automation of routine tasks, allowing teachers to focus on engagement and creative teaching (Holmes et al., 2019) | Resistance from staff due to lack of technical skills or fear of change (DDI, 2025) |
| Student Engagement | Encourages active participation through adaptive and interactive learning (Selwyn, 2019) | Over-reliance on AI may reduce human interaction and critical thinking skills (Selwyn, 2019) |
| Innovation | Facilitates innovative teaching methods and educational strategies (Aoun, 2017) | Challenges in implementation due to insufficient infrastructure or training (Selwyn, 2019) |

Figure 1 shows how leadership is shifting in the AI era, from authority and control to collaboration, teamwork, and data-driven decision-making

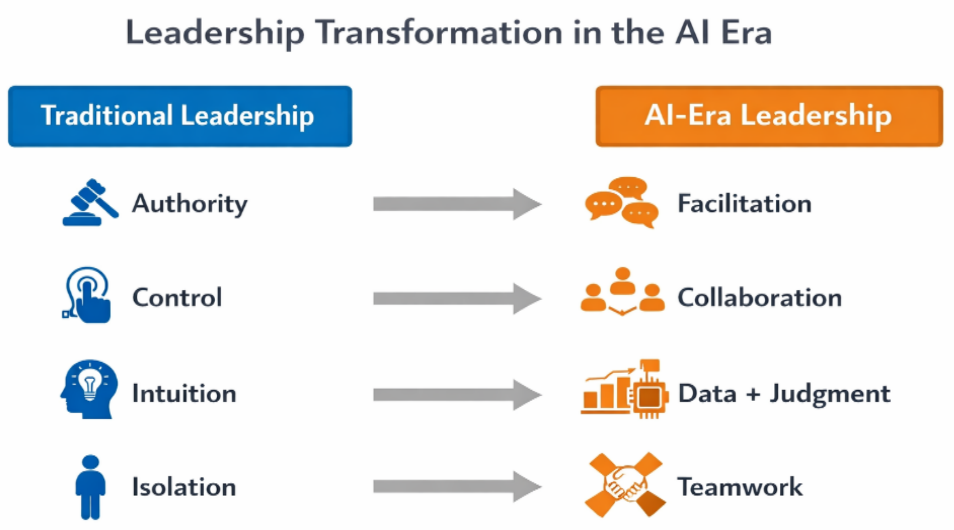


Figure 1

**Need of the Study**

In today's educational landscape, Artificial Intelligence (AI) is rapidly transforming teaching, learning, and school management. AI offers benefits such as enhanced decision-making, personalized learning, and improved efficiency, but also raises challenges, including ethical concerns, unequal access, and data privacy issues (Barnes & Hutson, 2024). At the same time, educational leaders face increasing responsibilities and stress, with some considering leaving their roles due to skill gaps (DDI, 2025), suggesting that traditional leadership approaches may no longer suffice. While AI and leadership have been studied separately, there is limited research on how leaders can practically integrate AI, ensure ethical use, promote equity, and assess its impact. This study therefore examines the evolving role of leadership in the AI era, highlighting the challenges, opportunities, and skills required for effective, ethical, and inclusive educational leadership.

**Objectives of the Study**

The present study aims to achieve the following objectives:

1. To study the concept of leadership in the context of the AI era.
2. To examine the role of Artificial Intelligence in the field of education.
3. To analyze the changing role of educational leadership due to AI integration.
4. To identify the challenges faced by educational leaders in implementing AI.

5. To explore the competencies required for effective leadership in the AI era.

**Significance of the Study**

In today's educational landscape, Artificial Intelligence (AI) is increasingly shaping the way teaching and learning take place. AI not only enables personalized learning experiences but also supports teachers in planning lessons and enhances decision-making processes within schools (Holmes et al., 2019). However, the successful integration of these technological advancements depends heavily on effective leadership to guide institutions toward meaningful and sustainable outcomes (Fullan, 2014). This study is significant because it explores the combined impact of AI and leadership in transforming education. By examining how AI can be effectively integrated, the findings will provide practical insights for educational leaders and school administrators, helping them make informed decisions and implement innovative practices. Teachers can benefit by learning about new instructional strategies and ways to leverage technology in the classroom. Students, in turn, can experience enhanced, personalized learning, while policymakers can use the study's findings to develop strategies and policies that promote effective technology integration in education. Moreover, as education increasingly moves toward a technology-driven future, there is a growing need to prepare leaders with the skills and competencies required to manage AI-based systems responsibly. This study contributes to understanding these future leadership requirements and supports the development of ethical, effective, and forward-looking leadership practices in the AI era.

**Research Questions of the Study**

Based on the objectives of the study, the following research questions have been framed:

1. What is the concept of leadership in the context of the AI era?
2. What is the role of Artificial Intelligence in the field of education?
3. How is educational leadership changing due to the integration of AI?
4. What challenges do educational leaders face in implementing AI in educational institutions?
5. What competencies are required for effective leadership in the AI era?

**Literature Review**

**1. Artificial Intelligence in Education**

Artificial Intelligence (AI) has emerged as a transformative force in education, shaping teaching, learning, and administrative processes. Broadly defined by John McCarthy, AI is the science and engineering of creating intelligent machines capable of performing tasks that typically require human intelligence (Childs, 2011). In schools, AI supports personalized learning, improves decision-making, and enhances overall efficiency. Research indicates that AI integration enables data-driven practices, helping educational leaders make informed and effective decisions that benefit both teachers and students (Ciornei, 2020).

**2. Leadership in the AI Era**

Leadership is essential for guiding organizations by providing vision, direction, and strategic planning. However, rapid technological advancements, particularly AI, have made leadership more complex, requiring leaders to adapt to constantly changing environments. Studies show that many leaders feel underprepared to manage the challenges posed by emerging technologies (Ciornei, 2020). In this context, leadership in the AI era involves understanding new roles, responsibilities, and competencies. Leaders are expected to develop digital literacy, critical thinking, and adaptability, enabling them to manage AI-driven educational environments effectively (Langeveldt, 2024). The focus shifts from simply managing tasks to facilitating collaboration, innovation, and ethical decision-making in technologically advanced settings.

**3. Ethical Leadership in the AI Context**

Ethical leadership has become a vital component of effective leadership, particularly in technology-driven environments. As Brown and Treviño (2006) describe, ethical leadership involves demonstrating honesty, transparency, and adherence to moral values. Leaders who uphold these principles foster trust and serve as role models for their teams. In the AI era, ethical leadership is especially important due to concerns about data privacy, bias, and responsible use of technology (Treviño et al., 2000). Leaders who integrate ethical considerations into their practices promote fairness, accountability, and responsible decision-making, ensuring that AI is used safely, responsibly, and sustainably in education.

**Research Gap**

While previous studies have explored leadership, AI, and ethical leadership individually, there is limited research on their integration in the context of educational leadership. In particular, the question of how leadership competencies need to evolve in the AI era remains underexplored. This study aims to address this gap by examining the changing role of leadership in AI-driven educational settings, focusing on the skills, responsibilities, and ethical considerations required for effective leadership today.

**Methodology**

**Research Approach / Design**

The present study adopts a qualitative research approach and follows a descriptive research design. The qualitative approach is used because the study focuses on understanding concepts, ideas, and perspectives related to leadership in the AI era rather than numerical data. The descriptive method helps in explaining and analyzing the existing information available in books, research articles, and online academic sources. Through this approach, the study aims to clearly describe the role of Artificial Intelligence in education and the changing nature of educational leadership.

**Nature of the Study**

The present study is theoretical, conceptual, and analytical in nature. It is theoretical because it is based on existing ideas and knowledge related to leadership and Artificial Intelligence in education. The study is conceptual as it focuses on understanding key concepts such as AI-driven leadership and its role in educational settings. Further, it is analytical in nature as it examines and interprets information collected from various academic sources to understand the changing role of leadership, the challenges faced, and the competencies required in the AI era.

**Sources of Data**

The present study is based on secondary data. The required information has been collected from various reliable academic sources such as Google Scholar and Shodhganga. In addition, data has also been gathered from books, research journals, and published reports related to educational leadership and Artificial Intelligence. These sources have helped in understanding the concepts, challenges, and developments associated with leadership in the AI era.

**Analysis of the Study**

**Leadership in the AI Era**

Leadership in the AI era is undergoing significant transformation due to rapid technological advancements. Traditional leadership, which mainly focused on authority and control, is gradually shifting towards a more flexible and technology-oriented approach. In the present context, leaders are expected to adopt digital tools, encourage innovation, and support continuous learning. Modern leaders act more as facilitators rather than controllers, guiding their teams in adapting to new technologies and changes. Thus, leadership in the AI era is more dynamic, collaborative, and future-oriented.

**Role of Artificial Intelligence in Education**

Artificial Intelligence plays an important role in transforming the field of education. It helps in providing personalized learning experiences by understanding the individual needs of students. AI-based tools also support smart classrooms, where teaching becomes more interactive and engaging. In addition, AI enables data-based decision-making, which helps teachers and administrators improve learning outcomes and institutional performance. Therefore, AI is becoming an essential part of modern education systems.

### Changing Role of Educational Leadership

The role of educational leadership is changing significantly with the integration of AI. Earlier, leadership was mainly based on authority and strict control. However, in the present scenario, leaders are expected to act as facilitators and collaborators. They need to encourage teamwork, support teachers in using technology, and create a positive learning environment. Educational leaders must also take initiative in adopting innovations and guiding institutions towards digital transformation.

### Challenges in Implementing AI

The implementation of Artificial Intelligence in education is constrained by interconnected infrastructural, human, and ethical challenges. Limited digital infrastructure and poor connectivity restrict access, particularly in developing regions. At the same time, inadequate training and digital literacy among educators hinder effective adoption. Resistance to change further reflects underlying organizational and psychological barriers. Additionally, concerns related to data privacy, algorithmic bias, and transparency raise critical ethical issues. Addressing these challenges requires informed and proactive leadership to ensure responsible and inclusive AI integration.

### Competencies Required for AI-Era Leadership

To be effective in the AI era, educational leaders need to develop certain key competencies. Digital literacy is essential to understand and use modern technologies. Leaders must also possess critical thinking skills to make informed decisions based on data.

In addition, ethical decision-making is important to ensure the responsible use of AI. Leaders should also be adaptable and open to change, as the educational environment is continuously evolving. These competencies help leaders successfully manage and lead in AI-driven educational settings.

### Role of Teachers and Stakeholders in AI Leadership

Leadership in the AI era extends beyond administrators, requiring collaboration among multiple stakeholders. Teachers act as co-leaders, implementing AI tools and adapting teaching methods for digital learning. Students take an active role in their education, making learning more personalized and engaging. Parents and the community support this process by providing resources and encouragement. Together, these stakeholders ensure that AI is integrated effectively, responsibly, and inclusively.

"The roles of these stakeholders are critical for effective AI integration in education. Table 2 summarizes the key responsibilities of each group in supporting AI leadership."

**Table 2: Stakeholders and Their Roles in AI Leadership**

| Stakeholder | Role in AI Leadership |
|---|---|
| **Leaders / Administrators** | Provide vision, plan AI integration, guide teams, and ensure ethical and effective use of AI |
| **Teachers** | Act as co-leaders in classrooms, implement AI tools, adapt teaching methods for digital learning |
| **Students** | Take active part in AI-based learning, engage with interactive and personalized educational tools |
| **Parents & Community** | Support learning by ensuring access to digital resources, encourage responsible use of AI, foster a supportive environment |

### Findings of the Study

The following findings have emerged from the present study:

1. Leadership is becoming more flexible, collaborative, and technology-oriented, moving away from traditional authoritative styles.

2. Artificial Intelligence enhances education through personalized learning, smart classrooms, and data-driven decision-making.
3. Educational leadership is shifting towards facilitation, collaboration, and shared responsibility.
4. The integration of AI faces challenges such as inadequate infrastructure, limited training, and ethical concerns.
5. To lead effectively, educators must develop competencies such as digital literacy, critical thinking, adaptability, and ethical decision-making.

**Discussion and Educational Implications**

The findings of this study highlight several implications for educational leadership in the AI era. Leaders must maintain a **balance between technology and human values**, using AI to support—but not replace—teachers and human interaction. Promoting **digital literacy** through training and resources is essential for both teachers and students, focusing on technical skills as well as effective teaching methods.

Ethical considerations are critical; leaders should address **data privacy, bias, and transparency**, establishing clear guidelines for responsible AI use. Creating a **supportive and collaborative environment** fosters communication, teamwork, and innovation, enhancing learning outcomes. Leaders must also prioritize **inclusivity**, reducing the digital divide to ensure equitable access to technology for all. Finally, effective **change management** is crucial, guiding teachers and students through technological transitions and providing ongoing support for smooth adaptation.

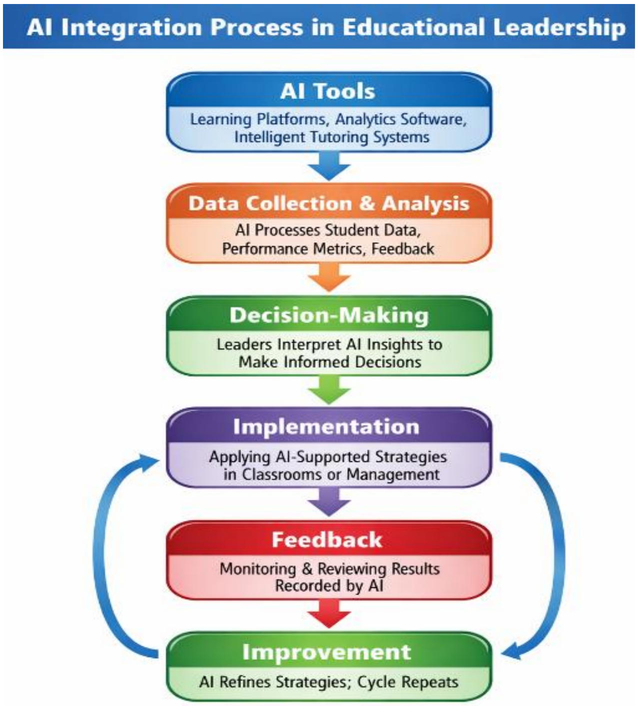


Figure 2

Figure 2: AI integration in educational leadership, showing how AI tools guide decisions, support teaching, provide feedback, and enable continuous improvement.

**Recommendations for Effective Leadership in the AI Era**

Based on the review of current research and emerging best practices, the following recommendations can support educational leaders in effectively integrating Artificial Intelligence in educational settings:

1. **Develop Clear AI Policies and Ethical Guidelines:** Educational leaders should establish transparent rules for the use of AI, ensuring that ethical concerns such as data privacy, fairness, and accountability are addressed. International reviews of AI integration emphasise the importance of human oversight alongside technology to prevent morally-compromised decisions.
2. **Build Digital Literacy and Training Programmes:** Leaders must prioritise comprehensive professional development programmes for teachers and administrators. Training should not only focus on technical skills but also on ethical use and pedagogical integration of AI, as uneven policy development can hinder effective adoption.
3. **Promote Collaborative and Inclusive Decision-Making:** AI implementation should involve collaboration among leaders, teachers, students, parents, and policymakers. Research on AI leadership highlights the need for productive collaboration to harness AI's potential while maintaining educational values.
4. **Encourage Research-Informed Practice:** Educational leaders should use evidence-based frameworks to guide AI adoption, drawing on systematic analysis of AI roles in leadership and administration. Using structured taxonomies of AI applications can help institutions make informed decisions and avoid fragmented adoption practices.
5. **Focus on Ethical, Human-Centred Integration:** Leaders should ensure that AI tools augment human decision-making rather than replace it. Studies suggest that combining human judgment with AI insights supports ethical and evidence-based leadership, especially in sensitive decisions.
6. **Plan for Equity and Access:** Long-term planning should include strategies to reduce the digital divide so that all learners and educators benefit from AI resources. Research has noted uneven integration and policy gaps in AI adoption; addressing these systematically can support meaningful educational outcomes.

### Limitations and Future Directions

The present study is based on secondary data collected from various sources such as books, journals, and online platforms. Therefore, the findings depend on the availability and accuracy of existing literature. The study does not include primary data or field-based investigation, which may limit its practical applicability.

Another limitation is that the study focuses on general aspects of Artificial Intelligence in education and may not cover all specific contexts or regional differences. For future research, studies can be conducted using primary data methods such as surveys, interviews, or case studies to gain deeper insights. Further research can also focus on specific educational levels, subjects, or institutions to understand the practical impact of AI in greater detail.

### Conclusion

Leadership in the AI era is not about power—it is about purpose. It involves guiding teams with empathy, making informed decisions through data, and fostering collaboration at every level. While AI provides advanced tools, it is the leader who gives direction and meaning to their use.

The findings of this study highlight that effective leadership today requires a balance between technological competence and human values. The true strength of leadership lies in its humanity—the ability to inspire, connect, and adapt in a rapidly changing environment. AI may transform the way leadership is practiced, but it cannot replace the core qualities of courage, commitment, and creativity that drive meaningful change in education.

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# DIGITAL CONTROL VERSUS ORGANIC INNOVATION: A THEMATIC ANALYSIS OF TECHNOLOGICAL GOVERNANCE IN A GOVERNMENT HIGH SCHOOL OF KARNATAKA

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**Abstract**

This study examines the intersection of institutional governance and technological innovation within the public education system of Karnataka. It adopts a qualitative case study approach positioned in a government high school in Bengaluru. The research utilises thematic analysis to evaluate how different levels of governance employ technological innovations to either empower or control teachers. Thereby, it attempts to unravel who the innovations serve. The analysis identifies an utter tension between two distinct forms of innovation. At the institutional level, organic, bottom-up innovations are driven by the agency of the head teacher and other teachers to solve local problems. These include using Google Sheets for localized data management, portable mic-speakers for keeping vocal health, mobile applications to simulate voting, and aesthetic additions to the school environment. Inversely, technological innovations at the system level prioritize state supervision, administrative efficiency, and data gathering by the government. These include a geo-tagged Facial Recognition System (FRS) for attendance, centrally controlled Lesson-Based Assessments (LBA), and the WhatsApp regime of official communication. The findings reveal a significant shift toward "Digital Control," where systemic mandates act as mechanisms for intensified labor and reduced professional agency for teachers. Such top-down controls favor higher bureaucracies and even create a "shadow bureaucracy" through informal communication channels. Under these mechanisms, the institutional innovations that solve local issues may weaken, making modern teachers as mere executors. Thus, their organic creativity may potentially be sidelined due to the demands of technical compliance and state surveillance. Therefore, the study calls for a deeper and critical look into innovations for governance to understand who they serve and they leave behind. The governance models must integrate teachers' voices to ensure that technological innovations serve educational and academic justice rather than solely administrative surveillance.

***Keywords:*** *Educational Governance, Bottom-up innovation, Digital control, Teacher autonomy, Shadow bureaucracy*

## Introduction

In recent years, technological innovation has become a central idiom through which educational reform and governance are articulated in India. Digital platforms for attendance, assessment, reporting, and communication are increasingly framed as solutions to long-standing administrative inefficiencies in public schooling. Under initiatives associated with digital governance, e-governance, and transparency, technology is positioned not merely as a pedagogical aid but as a mechanism to modernise the functioning of the state education system itself.

However, as scholars of education governance caution, innovation in public schooling cannot be understood solely through narratives of efficiency or reform. Rather, technological innovations are deeply embedded within bureaucratic, political, and institutional arrangements, and their effects must be examined in relation to how governance is enacted in everyday educational practice (Ball, 2016; Selwyn, 2016). Particularly in the Indian context, where public schools are situated within layered administrative hierarchies and historically centralised control, digital technologies frequently acquire meanings that extend beyond their technical design.

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### Innovation in Education: Beyond Technological Adoption

Educational innovation is often defined in policy discourse as the adoption of new tools, platforms, or systems intended to modernise teaching and administration. In India, this framing has been closely tied to broader governance reforms aimed at accountability and performance monitoring (Govinda, 2003; Kumar, 2016). Yet research on schooling practice suggests that innovation is not limited to formal policy initiatives or centrally designed interventions.

Everyday practices within schools suggest that teachers and school leaders often engage in informal, bottom-up technological adaptations to address contextual challenges, ranging from student assessment to organisational coordination. Such practices point toward a form of innovation that is practice-based, relational, and responsive to local conditions rather than system-designed.

### Governance, Digitalisation, and Control

Parallel to the innovation agenda, educational governance has undergone significant transformation. Governance increasingly operates through digital infrastructures that enable remote oversight, data collection, and real-time monitoring of schools and teachers (Ball, 2017; Williamson, 2018). Attendance systems, assessment portals, and mobile-based communication platforms exemplify how governance is enacted "at a distance," embedding administrative control into technological design.

In the Indian context, scholars have noted that digital reforms often extend managerial and audit-oriented governance logics, intensifying documentation, surveillance, and administrative labour without proportionate gains in professional autonomy (Sriprakash, 2017). Governance is additionally enacted through informal and semi-official digital channels, such as WhatsApp groups, which blur the boundaries between formal authority and everyday professional life.

### Situating the Present Study

While existing literature has explored education technology through policy analysis and system-level evaluation, fewer studies examine how technological governance is enacted in everyday school practices, particularly in government schools. Moreover, limited attention has been paid to how system-mandated digital technologies and locally initiated innovations coexist and interact within the same institutional context.

This study addresses this gap through a qualitative case study of a government high school in Karnataka. By foregrounding observational data and teachers' experiences, the paper examines how innovation and governance operate across two interconnected levels, viz., institutional-level, organic innovations driven by teachers and school leadership, and system-level digital interventions oriented toward standardisation, monitoring, and control.

### Research Questions

The study addresses the following questions:

1. How are technological innovations enacted at institutional and system levels in a government high school, and how do these enactments shape forms of governance and control within everyday school administration?
2. How do different modes of technological governance influence teacher agency, professional autonomy, and possibilities for bottom-up innovation within the school?

### Methodology

This study adopts a qualitative case study design to examine how technological innovations are enacted within a government high school and how these practices shape educational governance and teacher agency. A case study approach is appropriate for developing an in-depth and contextually grounded understanding of institutional processes, particularly where the aim is to examine how governance is performed in everyday practice rather than to evaluate predefined outcomes. Technology is conceptualised not as a neutral tool, but as a set of socially embedded practices through which authority, control, and professional work are organised within the school.

The case is analytically bounded to a single government high school in Bengaluru operating under the Department of School Education, Karnataka. While the study does not seek statistical generalisation, it aims to generate analytical insights into how digital innovations function as instruments of empowerment or control in public-sector schooling.

**Data Sources and Data Generation**

Data were generated through sustained field engagement and comprise multiple qualitative sources, with observational data forming the primary empirical base. Field observations documented everyday administrative routines, staff interactions, school events, and the use of technological tools. Detailed fieldnotes were maintained to capture activities, interactions, and contextual conditions.

In addition, informal conversations with teachers, the head teacher, and administrative staff were conducted during school visits and professional forums and recorded as expanded notes. Semi-structured interviews were conducted with selected teachers, the head teacher, and an administrative assistant, focusing on experiences with digital technologies, governance mandates, and professional autonomy. Artefactual references to digital platforms and communication practices encountered during fieldwork were also included. Observations were prioritised to examine how governance is performed through routine practices, rather than relying solely on retrospective accounts.

**Data Analysis, Reflexivity, and Ethics**

Data were analysed using thematic analysis, following Braun and Clarke's approach (Braun & Clarke, 2006), adapted for observation-heavy and institutionally situated data. Analysis proceeded iteratively through familiarisation, practice-oriented coding, category development, and theme construction, informed by concepts from educational governance, innovation, and teacher agency.

Reflexivity was integral to the research process, with reflexive notes used to distinguish descriptive accounts from analytic interpretation and to examine how prolonged engagement shaped the analysis. Ethical protocols were followed throughout the study. Institutional permission was obtained, participants were informed of the study's purpose, and all identifying details were anonymised to protect confidentiality.

**Findings**

The thematic analysis reveals a clear tension between institutional-level, organic innovations and system-level digital governance mechanisms in the everyday functioning of the school. While teachers and school leaders initiate contextually meaningful technological practices to address local pedagogical and administrative needs, system-mandated digital interventions increasingly function as instruments of surveillance, standardisation, and control. The findings are organised across five themes that together address the research questions.

**Organic Innovation as Contextual Problem-Solving**

At the institutional level, technological innovation emerges primarily as a situated response to local problems, driven by teacher agency and enabled by supportive leadership. These practices are neither mandated by the education department nor directly aligned with system requirements, but instead arise from everyday constraints related to workload, pedagogy, health, and school functioning.

One prominent example is the use of Google Sheets for internal assessment management, introduced by a previous head teacher and continued by the current one. This practice allowed teachers to enter marks remotely, enabled rapid consolidation of results, and facilitated internal analysis prior to any formal requirement from the department. Importantly, this innovation pre-empted external data demands rather than responding to them, suggesting a degree of institutional autonomy in managing assessment-related work.

Similarly, portable microphone-speaker devices, purchased independently by physical education teachers during the COVID-19 period, addressed the embodied and occupational challenge of voice strain in open learning environments. These devices diffused organically through peer observation, with other teachers adopting them after witnessing their usefulness. While the technology was valued, teachers simultaneously expressed discomfort at having to bear personal financial costs, pointing to an implicit expectation that teachers would self-resource solutions to systemic constraints.

Another instance of organic innovation was observed in the use of a mobile-based EVM simulation app for conducting student council elections. Developed collaboratively by social studies teachers and supported by school leadership, the application was used as a pedagogical tool to teach democratic processes. This collectively organised initiative highlights how innovation can also be educationally purposeful, extending beyond administrative efficiency.

Across these instances, innovation was characterised by voluntariness, local relevance, and professional collaboration, rather than compliance with external directives.

**Leader-Mediated Conditions for Innovation**

A key enabling factor across institutional innovations was the role of school leadership. The head teacher's technical familiarity, willingness to experiment, and ability to secure teacher buy-in shaped the conditions under which innovation was possible. Teachers consistently attributed successful innovations to leadership that allowed experimentation without immediate pressure for compliance or reporting.

This leader-mediated environment created relational trust, allowing teachers to engage with technology as a resource rather than as an obligation. However, participants noted that such practices were fragile, often dependent on the disposition and competencies of individual leaders rather than institutionalised support structures. This reliance underscores the contingent nature of organic innovation within public school settings.

**Digital Control through System-Level Governance Technologies**

In contrast to institutional initiatives, system-level technological interventions functioned primarily as mechanisms of digital control. Technologies such as the geo-tagged Facial Recognition System (FRS) for teacher attendance and the centrally controlled Lesson Based Assessments (LBA) were experienced as mandatory, non-negotiable, and closely monitored.

The FRS, accessed through a mobile application, requires teachers to mark attendance by verifying their faces within a designated geographical boundary. Teachers and school leaders described this system as eliminating discretion and embedding mistrust into routine administrative practices. Errors related to faulty face recognition, inaccurate geo-tagging, or platform instability were frequently reported, yet accountability for such failures was displaced onto teachers, who risked being marked absent or on leave incorrectly.

Similarly, the LBA system restructured assessment practices by centralising question paper generation and requiring teachers to adhere strictly to predefined timelines and formats for evaluation and data entry. Teachers reported that pedagogical autonomy was reduced, as instructional content became increasingly aligned with centrally produced question banks and assessment schedules. Teaching was reoriented toward data production, with evaluation timelines often overlapping with regular instructional work.

These technologies illustrate how innovation, when embedded in governance frameworks, operates less as a tool for improvement and more as a mechanism for standardisation, monitoring, and intensified administrative oversight.

**Reconfiguration of Teacher Agency and Work**

System-level digital governance significantly reshaped teachers' professional agency. Teachers described a steady expansion of clerical and reporting responsibilities, often carried out in addition to teaching duties. Entering student data across multiple portals, adhering to strict submission deadlines, and responding to frequent updates became routine aspects of professional work.

This digital expansion of labour was particularly evident in relation to LBAs, where teachers had to plan lessons, conduct frequent tests, evaluate answer scripts, and upload marks within stipulated deadlines. Teachers with multiple sections reported acute time pressure, noting that administrative work increasingly encroached upon pedagogical time.

Agency, in this context, was reconfigured from professional judgement to procedural compliance. Teachers' discretion was exercised primarily in managing deadlines and troubleshooting technical issues, rather than in shaping instructional or assessment practices.

### The Rise of a Shadow Bureaucracy through WhatsApp

A cross-cutting theme across both institutional and system levels was the emergence of a "shadow bureaucracy" mediated through WhatsApp. Although WhatsApp is not an official government platform, it functioned as a primary channel for disseminating circulars, collecting data, sending reminders, and coordinating administrative tasks.

Teachers and administrators described receiving messages from departmental officers and intermediaries at all hours, including weekends, often requesting the same data in multiple formats and within short timeframes. The platform allowed governance to operate through immediacy and repetition rather than formal documentation, intensifying pressure without formal accountability mechanisms.

At the school level, WhatsApp was also used for rapid coordination among teachers and for communication with parents, including daily absentee updates. While this facilitated quicker information flow, it also blurred boundaries between professional and personal time, making constant availability appear normative.

Through WhatsApp, governance became informal yet omnipresent, extending institutional control while bypassing established procedural limits.

### Fragility of Organic Innovation under Digital Governance

Taken together, the findings indicate that while organic innovations demonstrate teachers' capacity for creative, context-sensitive problem-solving, their sustainability is threatened by expanding system-level digital control. As administrative compliance and surveillance increasingly demand time, attention, and emotional labour, the space for locally meaningful innovation narrows.

Teachers do not reject technology outright; rather, they distinguish between tools that support pedagogical practice and those that regulate professional labour. Institutional innovations thrive under trust and flexibility, whereas system-led technologies prioritise auditability and efficiency, often at the expense of professional autonomy.

## Discussion

This study examined how technological innovations are enacted at institutional and system levels within a government high school and how these enactments reshape governance and teacher agency. The findings demonstrate that technology in public schooling operates through two contrasting yet coexisting logics: organic innovation grounded in local problem-solving, and system-level digital governance that increasingly functions as a mechanism of control. Interpreting these dynamics through the lenses of power, trust, and professional autonomy allows a more nuanced understanding of how innovation is experienced in everyday school life. At the institutional level, technological innovation emerged not through policy mandates or external funding schemes, but through situated practices shaped by local constraints and professional judgement. Teachers and school leaders engaged with technologies pragmatically to manage assessments, support vocal health, enhance pedagogy, and coordinate institutional work. These practices were often undertaken without formal recognition or material support, yet they played a critical role in sustaining everyday school functioning. Such examples challenge dominant policy narratives that portray innovation as inherently transformative or uniformly progressive. Instead, they illustrate innovation as adaptive, relational, and embedded in professional relationships.

Importantly, these findings demonstrate that teachers are neither resistant to technology nor incapable of innovation. On the contrary, teachers actively design, adapt, and repurpose technologies when provided with trust, flexibility, and supportive leadership. Innovation, in this sense, is not simply a technical process of adopting tools, but a social and institutional practice shaped by organisational culture and governance conditions. Leadership emerges as a key enabling factor, not through formal authority alone, but through the creation of spaces for experimentation and professional discretion.

In contrast, system-level technologies reveal a distinct logic of governance, where digital tools are deployed to produce predictability, auditability, and behavioural compliance. Technologies such as biometric attendance systems and centrally controlled assessments embed governance priorities directly into procedural design, reducing reliance on visible supervision while intensifying oversight. Attendance and assessment are no longer governed primarily through relational trust or contextual judgement but through biometric verification, standardised question banks, and tightly regulated timelines. In this sense, technology does not merely support governance; it actively restructures authority within schools.

This shift reflects what can be conceptualised as *digital control*: a mode of governance that operates through architectural constraints, temporal compression, and data dependency rather than explicit disciplinary measures. Control is exercised not by individual officials, but by systems that make compliance automatic and deviations costly. The consequences of such governance are particularly evident in how teacher professionalism is redefined.

A central tension running through the findings concerns trust. While institutional innovations were sustained through relational trust among teachers and leaders, system-level technologies were premised on institutionalized mistrust. Surveillance mechanisms such as biometric attendance encode assumptions that teachers require constant monitoring. As a result, professionalism becomes increasingly defined by responsiveness to digital systems, timely data entry, and procedural conformity, rather than pedagogical engagement or professional judgement.

Teacher agency, therefore, is not eliminated but reoriented. Agency is exercised in managing deadlines, navigating system errors, and coping with growing administrative demands, rather than in shaping curriculum, assessment, or institutional priorities. This reconfiguration risks narrowing professional identity and reducing teaching to a series of administratively verifiable actions.

The study also identifies the emergence of a shadow bureaucracy operating through informal digital platforms, most notably WhatsApp. Although officially peripheral, such platforms have become central to governance by enabling rapid circulation of directives, continuous reminders, and real-time monitoring of responsiveness. This informal governance operates with minimal procedural safeguards, often extending into teachers' personal time and obscuring accountability. Governance becomes omnipresent yet opaque, efficient but weakly regulated, blurring boundaries between formal and informal authority.

Finally, the findings reveal the fragility of organic innovation under expanding regimes of digital control. As compliance demands intensify, the temporal and cognitive resources required for bottom-up innovation diminish. This displacement is structural rather than attitudinal; time spent responding to platforms, messages, and system errors directly competes with opportunities for collaboration and experimentation. Consequently, the non-alignment of system priorities with pedagogically meaningful innovations put them in risk of being marginalised. Taken together, these findings call for a reconceptualization of innovation in educational governance. Rather than asking how technology can further enhance surveillance or standardisation, the more critical question is whose labour and agency are prioritised, and at what cost. Distinguishing between organic innovation and digital control highlights the need to recognise teachers not as compliance units, but as knowledgeable institutional actors whose professional agency is central to sustaining meaningful educational innovation.

### Educational Implications

The study offers practical insights for educators and school leaders. Recognising teacher-initiated innovations as legitimate professional practice can strengthen institutional resilience. Reflective conversations about technology use can help differentiate enabling tools from compliance-driven systems.

Managing informal communication practices, acknowledging hidden administrative labour, and re-centring pedagogy in technological decisions can mitigate the negative effects of digital control within existing constraints.

### Limitations and Future Directions

As a single-case qualitative study, the findings are context-specific and not statistically generalizable. However, they offer analytical insights relevant to comparable governance contexts. Future research could examine multiple schools across districts or states, incorporate longitudinal analysis, or explore student perspectives on digital governance.

### Conclusion

This study demonstrates that technological innovation in government schooling is neither uniformly empowering nor inherently oppressive. Instead, it is shaped by governance logics that privilege either control or trust. Organic innovations reflect teachers' capacity for creative, context-sensitive problem-solving, while system-level digital initiatives increasingly embed surveillance and compliance.

By foregrounding everyday practices, this paper reframes innovation as a governance process that redistributes power, labour, and professional meaning. Understanding whom innovations serve, and at what cost, is essential for imagining more just and sustainable models of educational governance.

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