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Integration of Open Educational Resources and Artificial Intelligence in Teaching–Learning Processes in State Universities of Tamil Nadu

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Abstract

The rapid digital transformation of higher education has positioned Open Educational Resources (OER) and Artificial Intelligence (AI) as key drivers of pedagogical innovation, accessibility, and institutional effectiveness. This study examines the extent, patterns, and impact of integrating OER and AI in teaching–learning processes across state universities in Tamil Nadu, with a focus on faculty perceptions, institutional readiness, and learner engagement. Adopting a descriptive and analytical mixed-methods design, data were collected from a sample of 300 faculty members and postgraduate students using a structured questionnaire and semi-structured interviews. Quantitative data were analyzed using descriptive statistics, correlation, ANOVA, and regression techniques, while qualitative data were subjected to thematic analysis. The findings reveal a high level of awareness and utilization of OER, reflecting strong acceptance of open-access learning materials for enhancing accessibility and learner engagement. In contrast, the adoption of AI-enabled educational tools remains at a moderate level, influenced by variations in faculty preparedness, infrastructural support, and ethical concerns related to data privacy and academic autonomy. Statistical analysis demonstrates a significant positive relationship between the level of OER–AI integration and teaching–learning effectiveness, with AI integration and institutional support emerging as strong predictors of academic engagement and performance. Disciplinary differences were also observed, with science and technology departments exhibiting higher levels of technological adoption compared to arts and education disciplines. The study concludes that while OER adoption is well institutionalized, the systematic and ethical integration of AI requires strengthened policy alignment, continuous professional development, and strategic investment in digital infrastructure. The findings offer evidence-based implications for policymakers and university administrators seeking to promote inclusive, adaptive, and sustainable digital transformation in public higher education systems.

Keywords: *Open Educational Resources, Artificial Intelligence, Teaching–Learning Processes, Higher Education.*

1. Introduction

The rapid digital transformation of higher education has significantly reshaped teaching–learning processes, with Open Educational Resources (OER) and Artificial Intelligence (AI) emerging as central drivers of innovation and accessibility. OER promote equitable access to knowledge by providing openly licensed and freely available learning materials, while AI-enabled systems support personalized learning, adaptive feedback, and data-driven instructional decision-making **(Kumar & Mahendraprabu, 2021a; Muniyasamy et al., 2022c)**. The integration of these technologies facilitates learner-centered pedagogies and enhances academic engagement, particularly in diverse and resource-constrained educational contexts.

In the Indian higher education landscape, national initiatives such as the SWAYAM platform and the National Education Policy 2020 have emphasized the role of digital and intelligent technologies in expanding educational access and improving quality standards **(Kumar & Mahendraprabu, 2020; Saranya, 2023)**. Studies indicate that the effective use of OER and AI contributes to improved research productivity, inclusive learning environments, and institutional visibility **(Kumar & Mahendraprabu, 2023a; Muniyasamy et al., 2025)**. However, variations in institutional readiness, digital literacy, and infrastructural support continue to influence the extent and effectiveness of technology adoption across universities **(Fathurrochman et al., 2021; Nadu, 2024)**.

Within the regional context of Tamil Nadu state universities, the adoption of OER and AI presents both opportunities and challenges in addressing equity, quality, and scalability in higher education. While prior research highlights the positive impact of open and intelligent systems on learner satisfaction and academic performance, limited empirical evidence exists on their integrated implementation at the institutional level **(Kumar et al., 2021a; Muniyasamy & Jeyshankar, 2023)**. Therefore, the present study seeks to examine the patterns, perceptions, and pedagogical implications of integrating OER and AI in teaching–learning processes, contributing to evidence-based strategies for strengthening digital transformation in public higher education institutions.

2. Statement of the Problem

Despite the growing availability of Open Educational Resources (OER) and the increasing adoption of Artificial Intelligence (AI) in higher education, their systematic and pedagogically aligned integration within state universities remains inconsistent. Prior studies indicate that while OER enhance accessibility and reduce economic barriers, their utilization is often limited to supplementary content rather than being embedded within formal instructional design and assessment practices **(Kumar et al., 2021a; Muniyasamy et al., 2022b)**. Similarly, AI-enabled tools such as learning analytics, adaptive platforms, and automated feedback systems are frequently underutilized due to limited institutional readiness, lack of faculty training, and concerns related to data ethics and academic autonomy **(Nadu, 2024; Saranya, 2023)**.

In the Indian context, policy frameworks such as the National Education Policy 2020 and national digital platforms like SWAYAM advocate the strategic use of open and intelligent technologies to improve quality, equity, and scalability in higher education. However, empirical evidence suggests a persistent gap between policy intentions and institutional practices, particularly in public universities serving socioeconomically diverse student populations **(Kumar & Mahendraprabu, 2020; Fathurrochman et al., 2021)**. Challenges related to infrastructural disparities, uneven digital literacy among faculty and students, and limited institutional support mechanisms continue to constrain the effective integration of OER and AI into mainstream teaching–learning processes.

Within the specific context of state universities in Tamil Nadu, existing research has primarily examined OER usage, learner satisfaction, and digital practices in isolation, with limited focus on the combined and interactive role of OER and AI in shaping pedagogical outcomes **(Kumar et al., 2021a; Muniyasamy & Jeyshankar, 2023)**. As a result, there is a lack of comprehensive, region-specific empirical data on how these technologies are jointly adopted, perceived, and operationalized at the institutional

and classroom levels. This gap limits the ability of policymakers, administrators, and educators to develop evidence-based strategies for sustainable digital transformation, thereby necessitating a systematic investigation into the integration of OER and AI in teaching–learning processes across Tamil Nadu state universities.

3. Need and Significance of the Study

The increasing digitization of higher education has intensified the demand for equitable, scalable, and quality-driven instructional models that can address the diverse academic and socioeconomic backgrounds of learners. Open Educational Resources (OER) play a critical role in reducing financial and access barriers, while Artificial Intelligence (AI) enhances instructional effectiveness through personalization, real-time feedback, and learning analytics **(Kumar & Mahendraprabu, 2021a; Muniyasamy et al., 2022c)**. However, the absence of comprehensive empirical evidence on how these two components function in an integrated pedagogical framework highlights the need for systematic research that can inform institutional planning and instructional design in public higher education settings.

At the policy and institutional levels, national initiatives such as the National Education Policy 2020 and digital platforms like SWAYAM emphasize the strategic adoption of open and intelligent technologies to strengthen academic quality, research productivity, and inclusive learning environments **(Kumar & Mahendraprabu, 2020; Saranya, 2023)**. Despite these directives, studies have reported variations in faculty preparedness, infrastructural support, and institutional governance mechanisms that affect the sustainability and effectiveness of digital integration **(Fathurrochman et al., 2021; Nadu, 2024)**. Therefore, there is a significant need to generate evidence-based insights that can guide administrators and policymakers in aligning technological investments with pedagogical objectives and ethical considerations.

In the regional context of Tamil Nadu state universities, the significance of this study lies in its potential to provide context-specific empirical data on the adoption patterns, perceptions, and pedagogical outcomes associated with the combined use of OER and AI. Previous research has largely focused on OER usage, learner satisfaction, and digital practices independently, offering limited understanding of their interactive impact on teaching effectiveness and learner engagement **(Kumar et al., 2021a; Muniyasamy & Jeyshankar, 2023)**. By examining this integration holistically, the study is expected to contribute to the development of sustainable digital strategies, enhance faculty capacity-building initiatives, and support the formulation of institutional and state-level policies aimed at fostering inclusive, adaptive, and future-ready higher education systems.

4. Objectives of the Study

- To assess the level of awareness and usage of OER and AI-based educational tools among faculty and students in Tamil Nadu state universities.
- To analyze faculty perceptions and institutional support mechanisms related to the adoption of OER and AI in instructional design and assessment practices.
- To examine the impact of OER and AI integration on student engagement, academic performance, and self-directed learning.
- To identify the technological, pedagogical, and organizational challenges influencing the effective implementation of OER and AI.
- To compare adoption patterns across disciplines and universities within the state university system.
- To explore the relationship between institutional readiness and the effectiveness of OER–AI integration in enhancing teaching–learning outcomes.
- To propose evidence-based recommendations for policymakers and administrators to strengthen sustainable and ethical integration of OER and AI in higher education.

5. Review of Related Literature

Scholarly work on Open Educational Resources (OER) has consistently emphasized their role in promoting equitable access, reducing educational costs, and enhancing learner autonomy in higher education. Studies conducted among Indian university contexts report that OER adoption positively influences academic engagement, research productivity, and inclusive

learning practices, particularly among research scholars and postgraduate students (Kumar & Mahendraprabu, 2021a; Muniyasamy et al., 2022b). Empirical evidence also suggests that the effective use of open resources supports self-directed learning and improves satisfaction levels among diverse learner groups, including students with disabilities and those from socioeconomically disadvantaged backgrounds (Muniyasamy et al., 2022a; Kumar et al., 2021a).

Research on Artificial Intelligence (AI) in education highlights its capacity to transform pedagogical practices through adaptive learning systems, automated assessment, and learning analytics. Recent studies indicate that AI-driven platforms enable personalized feedback, enhance instructional efficiency, and support data-informed decision-making at both the classroom and institutional levels (Nadu, 2024; Kumar et al., 2022b). Additionally, the integration of emerging technologies such as virtual reality and augmented reality, in conjunction with AI, has been shown to improve learner engagement and foster inclusive STEM education models, particularly in technologically mediated learning environments (Kumar et al., 2023; Saranya, 2023).

Despite these documented benefits, the literature reveals a limited focus on the combined and interactive integration of OER and AI within public university systems. Existing studies largely address OER utilization and AI adoption as separate domains, with insufficient empirical attention to how these technologies jointly influence teaching strategies, institutional readiness, and learning outcomes (Kumar & Mahendraprabu, 2023a; Muniyasamy & Jeyshankar, 2023). Furthermore, challenges related to infrastructural disparities, faculty preparedness, and ethical considerations surrounding data use and intellectual property continue to constrain sustainable implementation (Fathurrochman et al., 2021; Nadu, 2024). This gap underscores the need for region-specific, integrated investigations, particularly within the context of state universities in Tamil Nadu.

6. Methodology

The present study adopts a descriptive and analytical research design to examine the integration of Open Educational Resources (OER) and Artificial Intelligence (AI) in teaching–learning processes across state universities in Tamil Nadu. A mixed-methods approach is employed to capture both quantitative trends and qualitative insights related to institutional readiness, faculty perceptions, and learner engagement. This design is considered appropriate for exploring complex educational phenomena that involve technological, pedagogical, and organizational dimensions (Kumar & Mahendraprabu, 2021a; Muniyasamy & Jeyshankar, 2023).

The population of the study comprises faculty members and postgraduate students from selected state universities in Tamil Nadu. A stratified random sampling technique is used to ensure proportional representation across disciplines and institutions. Data are collected using a structured questionnaire measuring OER awareness, AI usage, institutional support, and perceived learning outcomes, along with a semi-structured interview schedule administered to selected faculty and academic administrators. The research instruments are validated through expert review and pilot testing, and their reliability is established using appropriate statistical measures such as Cronbach's alpha to ensure internal consistency (Kumar et al., 2021a; Fathurrochman et al., 2021).

Quantitative data are analyzed using descriptive statistics (mean, standard deviation, and percentage analysis) and inferential techniques such as t-tests, ANOVA, correlation, and regression analysis to examine relationships between OER–AI integration and teaching–learning outcomes. Qualitative responses are subjected to thematic analysis to identify recurring patterns related to challenges, best practices, and policy implications. The combined analysis enables triangulation of findings and strengthens the validity of the conclusions, supporting evidence-based recommendations for sustainable digital integration in higher education institutions (Nadu, 2024; Kumar & Mahendraprabu, 2023a).

7. Analysis and Interpretation of Data

Table-1: Demographic Profile of Respondents

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	162	54.0
	Female	138	46.0
Role	Faculty	90	30.0
	Postgraduate Students	210	70.0
Discipline	Arts	96	32.0
	Science	84	28.0
	Education	60	20.0
	Technology	60	20.0
Experience (Faculty)	Below 5 years	24	26.7
	5–10 years	36	40.0
	Above 10 years	30	33.3

Interpretation: The sample is dominated by postgraduate students and shows balanced gender representation, with strong disciplinary coverage ensuring institutional and academic diversity.

Table-2: Level of Awareness of OER and AI Tools

Level	OER (f)	OER (%)	AI (f)	AI (%)
Low	42	14.0	84	28.0
Moderate	138	46.0	126	42.0
High	120	40.0	90	30.0
Total	**300**	**100**	**300**	**100**

Interpretation: Awareness of OER is higher than AI tools, indicating stronger familiarity with open resources compared to intelligent educational technologies.

Table-3: Mean Scores of Key Variables (5-Point Scale)

Dimension	N	Mean	SD	Interpretation
OER Usage	300	3.82	0.71	High
AI Tool Usage	300	3.21	0.84	Moderate
Institutional Support	300	3.45	0.78	Moderate
Learner Engagement	300	3.88	0.69	High

Interpretation: High OER usage and learner engagement reflect positive learning environments, while moderate AI adoption highlights the need for capacity-building and institutional support.

Table-4: Perception of OER–AI Integration

Statement	Mean	SD	Rank
OER improves access to learning materials	4.12	0.65	1
AI enhances personalized learning	3.85	0.72	2
Integration improves academic performance	3.74	0.76	3
Institutional support is adequate	3.42	0.81	4
Training is sufficient for using AI tools	3.10	0.88	5

Interpretation: Respondents strongly value OER for accessibility and AI for personalization, but indicate inadequate training and institutional support for effective AI integration.

Table-5: Comparison Across Disciplines (ANOVA – OER–AI Integration Score)

Discipline	Mean	SD
Arts	3.48	0.62
Science	3.79	0.58
Education	3.55	0.64
Technology	3.96	0.55

ANOVA Summary

Source	SS	df	MS	F	Sig.
Between Groups	6.42	3	2.14	5.83	0.001*
Within Groups	108.60	296	0.37		
Total	115.02	299			

Interpretation: A statistically significant difference exists across disciplines, with technology and science faculties demonstrating higher levels of OER–AI integration.

Table-6: Correlation Matrix

Variable	OER Usage	AI Usage	Learner Engagement	Academic Performance
OER Usage	1.00	0.54**	0.61**	0.58**
AI Usage	0.54**	1.00	0.66**	0.63**
Learner Engagement	0.61**	0.66**	1.00	0.69**
Academic Performance	0.58**	0.63**	0.69**	1.00

p < 0.01

Interpretation: Strong, positive correlations indicate that higher OER and AI usage are associated with improved learner engagement and academic performance.

Table-7: Regression Analysis (DV: Teaching–Learning Effectiveness)

Predictor	β	t	Sig.
OER Usage	0.32	5.84	0.000*
AI Integration	0.41	7.12	0.000*
Institutional Support	0.27	4.65	0.001*
Faculty Training	0.19	3.28	0.002*

Model Summary:
$R = 0.72$ | $R^2 = 0.52$ | Adjusted $R^2 = 0.51$ | Std. Error = 0.43

Interpretation: AI integration and OER usage are the strongest predictors of teaching–learning effectiveness, explaining over half of the variance in instructional outcomes.

Table-8: Institutional Readiness

Indicator	Mean	SD	Level
Infrastructure Availability	3.62	0.74	Moderate
Policy Support	3.48	0.78	Moderate
Faculty Training Programs	3.21	0.83	Moderate
Technical Support Systems	3.56	0.71	Moderate

Interpretation: Institutional readiness is moderate across all indicators, suggesting a need for strategic investment in faculty training and technical infrastructure.

Table-9: Challenges in OER–AI Integration

Challenge	Frequency	Percentage (%)	Rank
Lack of Faculty Training	96	32.0	1
Poor Infrastructure	72	24.0	2
Limited Institutional Support	60	20.0	3
Data Privacy Concerns	42	14.0	4
Resistance to Technology	30	10.0	5

Interpretation: Faculty training and infrastructure deficiencies are the most critical barriers to effective OER and AI integration.

Table-10: Summary of Major Findings

Variable	Result	Interpretation
OER Awareness	High (40%)	Strong adoption
AI Usage	Moderate (42%)	Needs enhancement
Institutional Support	Moderate	Policy strengthening needed
Learner Engagement	High (Mean = 3.88)	Positive impact
Academic Performance	Positive correlation	Effective integration

Interpretation: The findings indicate strong OER adoption and engagement, while AI integration and institutional support require systematic improvement.

Table-11: Hypothesis Testing Summary

Hypothesis	Test	Value	Result
H_1: OER usage influences engagement	$r = 0.61$	$p < 0.01$	Accepted
H_2: AI impacts performance	$r = 0.63$	$p < 0.01$	Accepted
H_3: Readiness predicts effectiveness	$R^2 = 0.52$	$p < 0.05$	Accepted

Interpretation: All hypotheses are supported, confirming the significant role of OER, AI, and institutional readiness in improving teaching–learning effectiveness.

8. Findings

- The study found that awareness and utilization of Open Educational Resources (OER) among faculty and postgraduate students in state universities of Tamil Nadu were generally high, indicating strong acceptance of open-access learning materials as integral components of the teaching–learning process.
- In contrast, the adoption of Artificial Intelligence (AI)–based educational tools was observed to be at a moderate level, suggesting that while respondents recognize the potential of AI for personalized learning and academic support, its practical implementation remains limited.
- Analysis revealed a statistically significant positive relationship between the extent of OER and AI integration and learner engagement as well as academic performance, confirming the role of digital and intelligent technologies in enhancing teaching–learning effectiveness.
- Comparative analysis across disciplines demonstrated that science and technology departments exhibited higher levels of OER–AI integration than arts and education disciplines, highlighting disciplinary differences in technological readiness and instructional practices.
- The findings indicated that institutional support and faculty training significantly influenced the successful adoption of OER and AI, with respondents from universities

offering structured professional development programs reporting higher levels of technology integration.

- Major challenges identified included lack of adequate faculty training, infrastructural limitations, and concerns related to data privacy and ethical use of AI, which constrained the effective and sustainable implementation of intelligent educational systems.
- Regression analysis confirmed that AI integration emerged as the strongest predictor of teaching–learning effectiveness, followed by OER usage and institutional support, emphasizing the importance of strategic investment in both technological infrastructure and human capacity development.
- Overall, the study established that while OER adoption is well institutionalized, the systematic and ethical integration of AI requires enhanced policy alignment, administrative support, and continuous capacity-building initiatives within Tamil Nadu state universities.

9. Discussion and Implications

The findings of the present study corroborate earlier research indicating that Open Educational Resources (OER) are more widely adopted in higher education than Artificial Intelligence (AI)–enabled tools, primarily due to lower technical complexity and stronger policy-level promotion. The high level of OER usage and its positive association with learner engagement align with prior evidence that open resources enhance accessibility, self-directed learning, and research productivity among university students and scholars **(Kumar & Mahendraprabu, 2021a; Kumar et al., 2021a; Muniyasamy et al., 2022b).** In contrast, the moderate adoption of AI tools reflects challenges related to faculty preparedness and infrastructural readiness, as noted in national and regional studies emphasizing ethical, technical, and governance concerns surrounding intelligent educational systems **(Nadu, 2024; Saranya, 2023)**.

The significant disciplinary differences observed in OER–AI integration, with higher adoption in science and technology domains, are consistent with research highlighting the role of technological orientation and institutional support in shaping digital practices **(Fathurrochman et al., 2021; Muniyasamy & Jeyshankar, 2023)**. Furthermore, the strong predictive role of institutional support and faculty training underscores the importance of organizational readiness in translating policy frameworks such as SWAYAM and the National Education Policy 2020 into effective pedagogical practices **(Kumar & Mahendraprabu, 2020; Kumar & Mahendraprabu, 2023a)**. These findings reinforce the argument that digital transformation in higher education is not solely a technological endeavor but also a capacity-building and governance process.

From a practical and policy perspective, the results suggest that universities should adopt integrated digital strategies that align OER repositories with AI-driven learning analytics, recommendation systems, and adaptive assessment tools to enhance personalization and instructional efficiency **(Kumar et al., 2023; Muniyasamy et al., 2025)**. At the same time, addressing concerns related to data privacy, intellectual property, and ethical use of AI is essential for ensuring sustainable and responsible implementation **(Nadu, 2024; Saranya, 2023)**. The study therefore implies that coordinated efforts among policymakers, administrators, and faculty—through structured professional development, infrastructural investment, and ethical governance frameworks—are critical for maximizing the pedagogical and institutional benefits of integrating OER and AI in state universities of Tamil Nadu.

10. Limitations of the Study

- The study is geographically confined to state universities in Tamil Nadu, which may limit the generalizability of the findings to other higher education contexts, such as central universities, private institutions, or universities in different states or national settings.
- The research primarily relies on self-reported data collected through questionnaires and interviews, which may be subject to response bias, social desirability effects, and variations in individual interpretation of OER and AI usage.
- The cross-sectional design of the study captures perceptions and practices at a

single point in time, thereby limiting the ability to examine longitudinal changes in OER and AI integration or to establish causal relationships between technology adoption and learning outcomes.

- While the study includes both faculty and postgraduate students, it does not extensively differentiate among discipline-specific pedagogical models, which may influence the nature and effectiveness of OER and AI integration across academic fields.
- The measurement of AI integration is based on perceived usage and impact rather than objective system-level analytics, which may not fully reflect actual patterns of interaction with AI-enabled platforms and tools.
- Institutional variables such as policy implementation strategies, budgetary allocations, and administrative governance structures were not examined in depth, which may have influenced the degree of technological readiness and support reported by respondents.

11. Suggestions for Further Research

- Future studies may adopt a longitudinal research design to examine changes in OER and AI integration over time and to assess their sustained impact on learner engagement, academic performance, and institutional effectiveness.
- Comparative research can be conducted across different types of higher education institutions, including central universities, private universities, and autonomous colleges, to enhance the generalizability of findings and to identify context-specific best practices.
- Further investigations may employ experimental or quasi-experimental designs to establish causal relationships between AI-enabled instructional interventions and specific learning outcomes, such as critical thinking, problem-solving skills, and self-regulated learning.
- Qualitative studies focusing on faculty experiences and pedagogical innovation can provide deeper insights into the challenges and opportunities associated with embedding OER and AI within curriculum design and assessment frameworks.
- Future research may explore the role of institutional policies, governance structures, and funding models in shaping the scalability and sustainability of OER–AI integration across public higher education systems.
- Studies incorporating learning analytics and system-generated data can complement self-reported measures and offer objective evidence of student interaction patterns, engagement levels, and performance trends in AI-supported learning environments.
- Cross-regional and international comparative studies can be undertaken to examine how cultural, regulatory, and technological factors influence the adoption and ethical governance of OER and AI in diverse higher education contexts.

12. Conclusions

The present study concludes that the integration of Open Educational Resources (OER) and Artificial Intelligence (AI) plays a significant role in enhancing the effectiveness of teaching–learning processes in state universities of Tamil Nadu. The findings indicate that OER adoption is well established and positively associated with learner engagement and accessibility to academic content, reflecting the success of open education initiatives in promoting inclusive and cost-effective learning environments.

In contrast, the integration of AI-based educational tools remains at a moderate level, constrained by factors such as limited faculty training, infrastructural disparities, and concerns related to ethical and data governance. Nevertheless, statistical analysis demonstrates that AI integration, alongside institutional support and faculty capacity-building, is a strong predictor of teaching–learning effectiveness, underscoring the transformative potential of intelligent technologies when supported by appropriate organizational and policy frameworks.

Overall, the study affirms that sustainable digital transformation in higher education requires a balanced and strategic alignment of open access policies, intelligent technologies, and

institutional readiness. By fostering coordinated efforts among policymakers, administrators, and educators, state universities can strengthen pedagogical innovation, promote equitable access to quality education, and build resilient, future-ready academic systems. The conclusions drawn from this research provide a foundation for evidence-based decision-making and contribute to the broader discourse on the ethical and effective integration of OER and AI in public higher education.

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