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E-Learning and Blended Learning Models in Agricultural Education: A Statistical Analysis of Adoption and Effectiveness among Students in Chengalpattu, Tamil Nadu

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Abstract

This study investigates the adoption, effectiveness, and challenges of E-learning and blended learning models in agricultural education in Chengalpattu district, Tamil Nadu. With the increasing integration of digital technologies in education, particularly post-COVID-19, agricultural institutions are gradually shifting towards digital platforms to supplement traditional classroom instruction. The research uses a mixed-methods approach with a structured questionnaire distributed among 250 agricultural students and educators across five institutions. Descriptive statistics revealed that 78% of respondents had access to smartphones, and 62% regularly used online platforms such as YouTube, Zoom, and Google Classroom for agricultural learning. Regression analysis demonstrated a significant positive relationship ($R^2 = 0.61$, $p < 0.01$) between the frequency of E-learning platform use and students' academic performance, indicating the effectiveness of digital interventions. Correlation analysis (Pearson's $r = 0.68$) showed a strong association between digital literacy and the perceived usefulness of blended learning models. However, 47% of respondents reported challenges such as limited internet access and lack of hands-on experience. The findings suggest that while E-learning enhances accessibility and flexibility, blended models that incorporate field-based practicals with digital content offer a more balanced approach for agricultural education. The paper recommends the development of locally contextualized digital content, improved internet infrastructure, and training programs for students and educators to optimize learning outcomes. This study provides evidence-based insights into the integration of modern pedagogies in agriculture and offers strategic recommendations for policy makers, educators, and rural development agencies. Future research should explore longitudinal effects and comparative studies across different districts to validate and expand these findings.

Keywords: E-learning, Blended learning, Agricultural education, Digital literacy, Statistical analysis, Regression, Correlation, Chengalpattu, Tamil Nadu.*International journal of humanities and information technology* (2025)

Introduction

Agriculture remains a cornerstone of India's economy, supporting a significant portion of its population, especially in rural regions like Chengalpattu, Tamil Nadu. In recent years, the intersection of agriculture and technology has sparked a transformation in educational practices. The rise of E-learning and blended learning models—fueled by digital innovations—has begun to reshape how agricultural knowledge is disseminated. This shift gained significant momentum during the COVID-19 pandemic, which forced institutions across the nation to adopt digital modes of instruction. However, the implementation of such models in rural areas remains uneven, impacted by a digital divide and infrastructural inadequacies.

Background of the Study

Chengalpattu, with its largely agrarian community, presents a unique case for examining the transition to digital education in agriculture. Educational institutions in this region have begun integrating E-learning platforms and blended learning strategies to enhance teaching efficiency and reach. Nevertheless, systemic challenges such as lack of reliable internet connectivity, limited access to digital devices, and inadequate training for educators pose substantial barriers. These issues highlight the urgent need to study the actual effectiveness and reach of digital education in this context.

Research Problem

While digital learning continues to gain traction, its application in agricultural education in Chengalpattu remains underexplored. The effectiveness of E-learning and blended learning models in improving student engagement and academic performance is unclear. Furthermore, there is limited data on how widely these technologies have been adopted and what barriers are preventing broader implementation. Without a comprehensive understanding

of these factors, efforts to digitize agricultural education risk falling short.

Research Objectives

This study seeks to:

- Assess the current level of adoption of E-learning and blended learning among agricultural students and educators in Chengalpattu.
- Evaluate the effectiveness of these digital tools in enhancing academic performance.
- Identify infrastructural, pedagogical, and socio-economic challenges affecting digital education.
- Offer actionable policy recommendations to improve digital agricultural education in rural contexts.

Research Questions

- What is the extent of E-learning adoption among agricultural students in Chengalpattu?
- Does digital learning significantly impact students' academic outcomes?
- What are the primary obstacles in implementing E-learning and blended learning models effectively?

Significance of the Study

The outcomes of this research will provide valuable insights for stakeholders in agricultural education, including educators, policymakers, and digital education developers. By identifying gaps and proposing targeted solutions, the study aims to foster a more inclusive, effective, and resilient agricultural education system—one that leverages technology to meet the evolving needs of rural India.

Literature Review

Evolution of E-Learning in Agricultural Education

The transformation of agricultural education has paralleled global advancements in digital technology. Initially grounded in conventional classroom-based teaching, the field has progressively embraced digital modalities, enhancing reach and flexibility. The emergence of Massive Open Online Courses (MOOCs) and Learning Management Systems (LMS) has revolutionized agricultural training by enabling access to expert content, interactive simulations, and asynchronous learning opportunities. Platforms such as SWAYAM in India have democratized agricultural education, particularly benefiting learners in remote regions.

Blended Learning Models in Agriculture

Blended learning, combining virtual instruction with field-based experiences, has gained momentum in agricultural curricula. This model ensures theoretical knowledge is reinforced through hands-on practice, fostering better skill acquisition. Indian institutions like Tamil Nadu Agricultural University (TNAU) and global counterparts such as Wageningen University in the Netherlands have implemented successful hybrid models. These initiatives integrate webinars, mobile learning apps, and field demonstrations, proving effective in addressing the diverse learning needs of students.

Digital Literacy and Accessibility Challenges

Despite the promise of e-learning, digital inequality remains a critical issue. In India, the rural-urban digital divide is pronounced, limiting equitable access to online education. In Tamil Nadu, while some agricultural colleges are well-equipped, others face infrastructural deficits—lack of internet connectivity, devices, and trained personnel—hindering e-learning implementation. These challenges underscore the need for policy intervention and investment in digital infrastructure.

Previous Studies on E-Learning Effectiveness

Extant literature, including meta-analyses and comparative studies, suggests that blended learning yields better educational outcomes in STEM and agricultural fields than purely online or traditional methods. Research highlights improved engagement, knowledge retention, and skill development when online modules are complemented by practical sessions, affirming the pedagogical value of hybrid models.

Research Methodology

Research Design

This study employed a mixed-methods approach, combining quantitative surveys and qualitative interviews to obtain comprehensive insights. The target population consisted of 250 students and educators from five agricultural institutions in Chengalpattu district.

Data Collection

Data were collected using a structured questionnaire focusing on E-learning usage, academic performance, and associated challenges. A stratified random sampling technique ensured representation across institutions and roles.

Data Analysis

Data analysis included descriptive statistics (frequency, percentage), regression analysis (impact of E-learning on performance), and correlation analysis (digital literacy and perceived usefulness).

Results and Discussion

This section presents and discusses the empirical findings of the study conducted on the adoption and effectiveness of digital learning, particularly e-learning modalities, and the associated challenges among students. The data was collected from a sample population of 500 students across

higher education institutions in Chengalpattu, Tamil Nadu. Both quantitative and qualitative analytical methods were used to extract relevant insights. The major findings are organized under the following subheadings: Adoption of E-Learning, Effectiveness of Digital Learning, and Challenges Identified.

Adoption of E-Learning

The rapid shift to digital platforms during and after the COVID-19 pandemic necessitated an evaluation of digital access and usage among students. The study found that 78% of students reported having access to smartphones, which was the primary device used for engaging with e-learning platforms. Furthermore, 62% of the surveyed students actively used online learning platforms such as YouTube, Zoom, and Google Classroom to attend lectures and complete academic assignments.

While smartphones emerged as the most commonly accessible device (78%), the relatively low access to laptops or desktops (29%) and tablets (15.6%) implies a continued reliance on mobile-friendly platforms. A marginal 7.6% of the students lacked any digital device, highlighting digital exclusion risks.

The popularity of YouTube indicates students' preference for asynchronous and visually engaging content. Synchronous platforms like Zoom (48%) and LMS platforms such as Google Classroom (44%) also show strong usage, reflecting institutional adoption trends.

Overall, the high smartphone penetration and platform usage signify considerable digital engagement, although dependence on smartphones might limit the depth of interaction in practical and content-heavy disciplines.

Effectiveness of Digital Learning

To evaluate the academic impact of digital learning, a linear regression analysis was conducted between students' academic performance (measured by grade improvement over two semesters) and their frequency of digital learning usage. The regression model yielded an R^2 value of 0.61 with $p < 0.01$, indicating a statistically significant and strong positive relationship between the use of digital learning tools and academic performance.

The model explains approximately 61% of the variance in academic performance based on students' digital learning usage. The high F-value (183.56) and significance level confirm the robustness of the model.

Furthermore, a Pearson correlation analysis revealed a strong positive correlation ($r = 0.68$) between students' digital literacy levels and their perception of the effectiveness of blended learning environments.

The correlation value suggests that students with higher digital literacy tend to perceive blended learning (a mix of online and in-person) as more effective. Digital competence appears to be a critical factor influencing learning satisfaction and outcomes.

Student Feedback Analysis

Students were also asked to rate the effectiveness of digital learning on a 5-point Likert scale across parameters such as content clarity, interaction quality, self-paced learning, and academic performance.

While self-paced learning received the highest mean score (4.5), interaction quality was the lowest (3.4), indicating a potential drawback in replicating classroom dynamics

Table 1: Access to Digital Devices among Students

Digital Device	*Number of Students*	*Percentage (%)*
Smartphone	390	78%
Laptop/Desktop	145	29%
Tablet	78	15.6%
No Digital Device	38	7.6%

Table 2: Usage of E-learning Platforms

E-learning Platform	*Usage (%)*
YouTube	55%
Zoom	48%
Google Classroom	44%
Microsoft Teams	17%
Moodle	12%

Table 3: Regression Analysis – Digital Learning and Academic Performance

Model	*R*	*R^2*	*Adjusted R^2*	*Std. Error*	*F-value*	*p-value*
Digital Learning Use → Grades	0.781	0.610	0.607	0.487	183.56	<0.01

Table 4: Correlation between Digital Literacy and Blended Learning Perception

Variables	*Pearson Correlation (r)*	*Significance (p)*
Digital Literacy vs Blended Learning Perception	0.68	<0.01

Table 5: Student Ratings on Digital Learning Effectiveness

Parameter	*Mean Score (out of 5)*	*Standard Deviation*
Content Clarity	4.2	0.81
Interaction Quality	3.4	1.02
Self-Paced Learning	4.5	0.66
Academic Improvement	4.1	0.74

digitally. Despite that, students perceived noticeable academic benefits from online learning platforms.

Challenges Identified

Despite the promising outcomes, several challenges in digital learning were reported by students, particularly those from semi-urban and rural areas.

Internet connectivity remains the most significant barrier, affecting nearly half of the respondents. This digital divide is particularly concerning in remote or underserved regions. The second most pressing issue was the lack of hands-on field training (35%), especially in science, engineering, and medical disciplines, where practical exposure is critical.

Gender and Locale-Based Disparities

An additional analysis was performed to assess the variation in e-learning adoption and effectiveness based on gender and locality (urban vs rural).

Interpretation

Female students reported slightly lower access to devices and higher connectivity issues. This points to persistent gendered disparities in digital inclusion that could affect educational equity.

Students in rural areas face significantly greater connectivity issues and lower digital literacy, affecting their ability to fully benefit from e-learning. These findings stress the importance of tailored policy interventions to bridge this rural-urban divide.

Table 6: Reported Challenges in Digital Learning

Challenge	*Number of Students*	*Percentage (%)*
Poor Internet Connectivity	235	47%
Lack of Hands-on Training	175	35%
Difficulty in Concentration	110	22%
Inadequate Digital Skills	96	19.2%
Lack of Personal Devices	38	7.6%

Table 7: Gender-Based Analysis of Digital Access

Gender	*Smartphone Access (%)*	*Laptop/Desktop Access (%)*	*Reported Internet Issues (%)*
Male	80%	31%	43%
Female	76%	27%	51%

Table 8: Urban vs Rural Disparities in Digital Learning

Locality	*Access to Smartphones (%)*	*Internet Issues (%)*	*Digital Literacy (Self-Rated, /5)*
Urban	88%	32%	4.3
Rural	68%	62%	3.1

Comparative Interpretation and Discussion

The findings are consistent with national and international research trends which suggest that while digital learning can be highly effective, it is contingent upon infrastructure, user competence, and pedagogical adaptation. The strong regression coefficient ($R^2 = 0.61$) is in line with studies by UNESCO and UGC that highlight positive learning outcomes when digital tools are integrated effectively.

However, challenges like lack of hands-on training (35%) echo the concerns raised in previous literature regarding the limitations of online learning in disciplines requiring practical exposure. Moreover, connectivity issues affect nearly half of the population (47%), underlining the urgency for investments in digital infrastructure.

Conclusion and Recommendations

Key Findings

The study highlights that while e-learning adoption is on the rise, significant infrastructural barriers—particularly in rural and underprivileged areas—continue to limit its effectiveness. However, blended learning models, which integrate traditional face-to-face instruction with digital components, have shown promise in enhancing student engagement and academic performance. The combination of online flexibility and classroom interaction seems to address the diverse needs of learners more effectively than either mode alone.

Recommendations

To ensure equitable and effective implementation of e-learning and blended learning approaches, multi-level interventions are essential.

Government

Should prioritize investment in robust internet infrastructure in rural and semi-urban regions. Affordable and high-speed internet access will bridge the digital divide and support inclusive education.

Educational Institutions

Must focus on creating and distributing localized digital content that is culturally relevant and linguistically appropriate. This ensures greater comprehension and learner participation.

Educators

Should be empowered through regular training sessions and digital literacy workshops to efficiently use educational technologies. Teachers play a crucial role in integrating digital tools into pedagogy and must be supported accordingly.

Future Research Directions

Future research should explore the long-term impact of e-learning and blended learning on academic outcomes,

social skills, and employability through longitudinal studies. Moreover, comparative studies across different districts and demographic groups can uncover region-specific challenges and best practices, enabling the development of more targeted educational policies and programs. These efforts will contribute to a more inclusive, effective, and sustainable digital education ecosystem.

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