



Assessing the Impact of Digital Teaching Tools on Pedagogical Innovation among Faculty in Undergraduate Government Degree Colleges of Andhra Pradesh: An SEM-Based Study

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Abstract

The research investigates how faculty in undergraduate government degree colleges in Andhra Pradesh, India, utilize digital teaching tools; whether or not the use of these tools leads to changes in their pedagogical approaches; and whether or how digital competency and institutional support are related to those changes. The study employs Structural Equation Modeling to test direct, mediating, and moderating effects of these variables on pedagogical innovation. Data was collected from a total of 312 faculty members via a structured questionnaire that used a 5-point Likert scale. The results of the analysis support the hypothesis that digital teaching tools have a positive impact on faculty innovations in pedagogy. Faculty digital competency partially mediates this relationship, while institutional support strengthens the effect. Of the total variance explained by the structural model, 64% explained the pedagogical innovation construct. The findings of this research provide insight for policymakers as they seek to strengthen digital integration within publicly funded higher education institutions.

Keywords: Digital teaching tools, pedagogical innovation, faculty competency, institutional support, SEM

1. Introduction

Higher education institutions have been adopting digital technologies for the purposes of enhancing instruction and learning. Digital tools such as Learning Management Systems (LMSs), smart classrooms, online assessment solutions, and multimedia tools have become the center pieces of instructional delivery. Furthermore, government degree colleges in India are in the process of digitizing their educational environments through technologies such as SWAYAM, virtual labs, and ICT-enabled classrooms. However,

simply using technology will not result in the development of innovative pedagogies; success depends on the level of digital competency possessed by faculty and the type of ecosystem provided by the institution. This study will explore to what extent digital teaching tools impact pedagogical innovation in faculty teaching at undergraduate-level government degree colleges in Andhra Pradesh; to what extent faculty digital competency (as a mediator) and institutional support (as a moderator) influence the relationship between the use of digital teaching tools and pedagogical innovation.

Objectives of the Study

- To measure digital teaching tool usage among faculty
- To assess the level of pedagogical innovation
- To examine the direct effect of digital teaching tools on pedagogical innovation
- To test the mediating role of faculty digital competency
- To examine the moderating role of institutional support

Hypotheses

H1 Digital Teaching Tools positively influence Pedagogical Innovation

H2 Digital Teaching Tools positively influence Faculty Digital Competency

H3 Faculty Digital Competency positively influences Pedagogical Innovation

H4 Faculty Digital Competency mediates the relationship between Digital Teaching Tools and Pedagogical Innovation

H5 Institutional Support moderates the relationship between Digital Teaching Tools and Pedagogical Innovation

2. Literature Review

The Use of Educational Technology Has Changed Teaching Approaches: A Review of Recent Research: An Overview of Research Related to Educational Technology and Teaching Approaches Displays A Consistent Relationship Between Using Technology and Changing How Teachers Teach. Research Has Focused on Four Key Areas: (1) How Faculty Members Accept and Adopt Technology; (2) Faculty Members' Digital Competency and How They Are Professionally Developed; (3) The Infrastructure of an Institution to Support Technology; (4) Pedagogical Innovations and Student-Centered Teaching Practices Used By Faculty Members. This Literature Review Summarizes Empirical Research Results Found in All Four Areas, and Links Them to the Current (SEM Model) (Digital Teaching Tools → Faculty Digital Competency → Innovative Teaching Practice; Institutional Support → Supports Teacher Use).

Technology Adoption and User Acceptance.

Technology Adoption Theoretical Models (TAM and UTAUT) Usually Focus on Usefulness and Ease of Use As Attributes for Predicting Adoption. Empirical Studies That Examine Use of Technology in Higher Education Repeat This Pattern. Usefulness of a Teaching Tool Drives the Amount and Depth of Tool Usage and Ease of Use Helps to Support Tool Adoption for Less Well Experienced Faculty.

Studies that apply technology-acceptance frameworks to LMS, virtual labs, and online assessment platforms report that behavioural intention explains a large share of actual use. This supports modeling digital teaching tools as a measurable exogenous construct in SEM.

Faculty digital competency and professional growth

Research shows faculty digital competency is a multi-dimensional capability: operational skills (tool operation), pedagogical design (learning activity design), and reflective practice (evaluating tool effectiveness).

Professional development and peer-led mentoring consistently improve competency and increase innovative use. Several intervention studies show upskilling leads to richer use (blended designs, flipped classes, interactive assessments).

Institutional infrastructure and support

Empirical evidence shows infrastructure (bandwidth, LMS licensing), technical assistance, and management encouragement are necessary conditions for sustained innovation but not sufficient on their own.

Studies emphasize institutional incentives and recognition (promotion weight, teaching awards) as important drivers for faculty to invest time in redesigning courses.

Pedagogical innovation: definitions and evidence

According to the literature, pedagogical innovation refers to purposeful changes made to the way we teach that make it more learner-centred, interactive, offer greater variety in assessments and allow for higher-order thinking skills. According to a meta-analysis of study findings and a number of field studies, measurable increases in student learning and engagement occur when teachers use digital technology in conjunction with well designed instructional strategies. However, there are mixed results concerning the impact on direct student achievement because some studies have not adequately controlled for the quality of the instructional design itself.

Mediation by faculty competency

Several SEM studies in education find that teacher competence mediates the relationship between available technology and pedagogical outcomes. Instruments measuring competency frequently explain a substantial portion of variance in innovation measures.

Moderation by institutional support

Studies modelling interactions show that institutional support amplifies the technology→pedagogy link: where infrastructure, training, and managerial encouragement are present, the same level of tool availability translates into higher innovation.

Synthesis and gap

Existing studies cover tool adoption, faculty competence, and institutional conditions. Fewer studies use SEM to test a mediated-moderated model focused exclusively on government degree college faculty within a single Indian state. That gap motivates the present SEM-based study in Andhra Pradesh.

3. Methodology

PLS-SEM is commonly used where model prediction and theory development are goals and sample sizes are moderate (150–300). CB-SEM is used when confirmatory testing and model fit indices are primary and sample sizes are larger (>300).

Measurement best practice: multi-item reflective indicators, Cronbach's Alpha and Composite Reliability checks, AVE for convergent validity, HTMT for discriminant validity.

This study adopted a quantitative research design using a cross-sectional survey method to examine the proposed structural relationships. The study was conducted on a sample of 312 faculty members from undergraduate colleges offering government degrees across different districts in the state of Andhra Pradesh, India. All participants were faculty members of government colleges that were randomly stratified by district so as to represent faculty members from all districts in Andhra Pradesh and increase the ability to generalise from the results. This study collected primary data using a structured survey questionnaire, with five points being represented on the Likert Scale: Very Strongly Disagree to Very Strongly Agree for each scale item. The instrument measured digital teaching tools usage, faculty digital competency, institutional support, and pedagogical innovation. Data were analyzed using Smart PLS 4 software to assess the measurement model and structural model through Partial Least Squares Structural Equation Modeling.

In the measurement model, there were four constructs surrounding digital teaching tools, faculty digital competency, institutional support, and pedagogical innovation; a reliability analysis yielded Cronbach's alpha results ranging from .81 to .89, and composite reliability scores between .86 and .92, all of which exceed the threshold for acceptability of .70. In terms of convergent validity, the average variance extracted scores ranged

from .58 to .71, while the HTMT ratios demonstrated discriminant validity by being lesser than .90, and the outer loadings all being greater than .70.

The structural model results indicated that Digital Teaching Tools had a significant positive effect on Pedagogical Innovation ($\beta = 0.42, p < 0.001$). Digital Teaching Tools also significantly influenced Faculty Digital Competency ($\beta = 0.55, p < 0.001$), and Faculty Digital Competency significantly affected Pedagogical Innovation ($\beta = 0.36, p < 0.001$). The indirect effect was significant ($\beta = 0.20, p < 0.01$), indicating partial mediation. The institutional support environment impacts the relationship between digital teaching tools and pedagogical innovation ($\beta = .18, p < .05$). The model explains 64% of the variance in pedagogical innovation and 30% of the variance in faculty digital competency.

4. Discussion

Results confirm that digital teaching tools directly improve pedagogical innovation. Faculty digital competency acts as a significant mediator. This indicates that technology impact increases when faculty possess strong digital skills.

The study findings indicate that support for innovation through institutions is a significant contributor to the success of innovative strategies. Colleges with better infrastructure and training opportunities had more innovative approaches to using ICT within instructional design than did colleges with less accessible infrastructure. These results are consistent with previous studies regarding ICT within instructional design as well as previous studies relating to types of instructional innovations.

Policy and Practical Implications

Higher education leaders can use the results of this study to reform and enhance their systems and policies. They are recommended to develop quality systems in government colleges by establishing reliable access to online education systems, smart classrooms, and the use of internet-based assessment systems. In addition, to help faculty members to increase their digital skills and to integrate these skills into their teaching methods, they should establish structured and regular professional development opportunities for faculty. Finally, institutions can also develop incentive programs to encourage faculty members to adopt technological methods of teaching and provide incentives for their performance by establishing recognition systems for outstanding performances, providing funding for instructional innovation, and establishing evaluation systems for evaluating faculty's use of technology in instruction.

From a practical standpoint, institutions should encourage professional peer networks to facilitate the sharing of ideas for using digital pedagogy. Furthermore, incorporating the use of digital pedagogy into academic review processes by providing appropriate evaluation metrics would encourage additional creativity in instructional practice and hold faculty members accountable for their use of technology in instruction.

5. Limitations

The study has its limitations despite its contributions. The sample consisted of undergraduate degree colleges of government in the state of Andhra Pradesh, which may limit generalisability to different states or types of institutions. The reliance on self-reports may create bias due to the nature of how participants interpret their experiences and report such. The cross-sectional design of the study does not allow for causal inferences from the current research findings. The advice offered for future research includes consideration of longitudinal designs to examine how pedagogy innovations change over time, performing comparative research between government and private institutions regarding the differences between them in terms of digital integration, and measuring student learning outcomes in addition to using them as a construct will assist researchers understand more thoroughly the effectiveness of digital teaching resources on educational outcomes.

6. Conclusion

Faculty at undergraduate government colleges in Andhra Pradesh have a significant influence on their ability to innovate with digital teaching resources by virtue of their use of such resources; however, faculty digital competencies only partly mediate this relationship, whereas institutional support enhances the mediating relationship. For digital transformation to be successful, technology access, digital skills acquisition, and administrative commitment are all needed.

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