

# Blended Learning Models in Engineering Colleges

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**ABSTRACT**—Indian engineering colleges—along with many institutions worldwide—experimented with a range of blended learning (BL) models that combined face-to-face classroom instruction with digital resources, learning management systems (LMS), video lectures, and problem-based online activities. This manuscript explores the conceptual foundations, historical drivers, and practical manifestations of those early blended initiatives. A descriptive survey of 100 participants (70 undergraduate students, 20 faculty, and 10 academic administrators) from five engineering colleges provides empirical insights into perceived effectiveness, challenges, and readiness levels. Results indicate that while students valued flexibility, repetition-on-demand, and collaborative forums, faculty cited design time, assessment alignment, and limited institutional support as major barriers.

study finds that pre-2016 BL implementations were predominantly supplemental and replacement models rather than full-scale redesigns, and that success depended on instructional design support, stable infrastructure, and teacher digital competence. The paper concludes with a nuanced discussion of scope—curriculum integration, faculty development, and policy frameworks—and limitations related to sample size, self-reporting bias, and temporal specificity. Recommendations emphasize iterative instructional design, analytics-informed feedback loops, and inclusive access strategies.

## KEYWORDS

blended learning, engineering education, flipped classroom, LMS, pre-2016 innovations, survey research, digital pedagogy, instructional design, India, higher education

## INTRODUCTION

Engineering education has traditionally relied on lecture-heavy, content-driven teaching, with limited opportunities for active learning. By the early 2010s, however, rapid improvements in broadband connectivity, the proliferation of affordable laptops and smartphones, open courseware (e.g., NPTEL, MIT OCW), and the rise of LMS platforms (such as Moodle and Blackboard) created fertile ground for blended learning models. In the Indian context, the National Mission on Education through ICT (NMEICT), the Technology Enabled Learning initiative, and state-level virtual university projects encouraged colleges to integrate digital modalities. Globally, research in this period highlighted the potential of

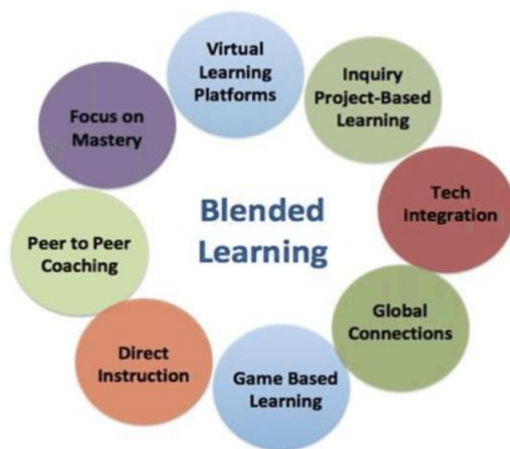


Fig.1 Blended Learning, [Source\(\[1\]\)](#)

Administrators focused on cost-benefit balance, accreditation pressures, and bandwidth constraints. The

the flipped classroom, problem-based online modules, and hybrid labs as viable strategies to improve conceptual understanding and engagement.

This paper focuses on “pre-2016” implementations to capture the formative phase, when institutions were experimenting without the later acceleration triggered by massive open online courses (MOOCs) maturity, cloud-based analytics, and post-2016 policy pushes. By examining early models, we can better understand foundational challenges, design heuristics, and stakeholder perceptions that continue to inform contemporary blended strategies.

### Purpose of the Study

1. To map the dominant blended learning models adopted in engineering colleges before 2016.
2. To analyze stakeholder perceptions (students, faculty, administrators) regarding effectiveness, challenges, and support systems.
3. To suggest design, policy, and infrastructural recommendations for sustainable blended learning integration in engineering curricula.

### Research Questions

- What blended learning configurations were most prevalent in engineering colleges prior to 2016?
- How did students, faculty, and administrators perceive the effectiveness and challenges of these models?
- What factors enabled or hindered the success of early blended initiatives?
- What lessons from the pre-2016 landscape can inform future blended learning policy and practice?

## LITERATURE REVIEW

### 2.1 Conceptualizing Blended Learning

Blended learning is typically defined as the intentional integration of face-to-face and online learning experiences.

Scholars such as Graham (mid-2000s) emphasized the continuum from fully face-to-face to fully online, with various hybrid points in between. In engineering education, BL often includes simulation tools, virtual labs, collaborative coding environments, and discussion forums aligned with project-based learning.

### 2.2 Drivers of Blended Learning in Engineering

Key drivers included: (a) the need to enhance problem-solving and design thinking through active pedagogies; (b) constraints of overcrowded classrooms; (c) the availability of open educational resources (like NPTEL lectures); and (d) pressure from accrediting bodies (NBA, ABET) to demonstrate outcome-based education.

### 2.3 Early Models (Pre-2016)

Common models included:

- **Supplemental Model:** Traditional lectures remained central, but instructors uploaded slides, readings, and quizzes to an LMS for pre/post-class engagement.
- **Replacement Model:** Portions of lecture time were replaced by online modules, freeing in-class time for discussions, problem-solving, or labs.
- **Flipped Classroom:** Core content delivered via recorded lectures or curated videos before class; face-to-face time used for application exercises.
- **Emporium/Studio Models:** Particularly in mathematics and programming fundamentals, students worked in computer labs at their own pace, with faculty as facilitators.

### 2.4 Reported Outcomes

Studies from the era reported improved student satisfaction and achievement in properly designed BL courses, but also emphasized the importance of instructional design, faculty training, and access equity. Technical issues, assessment

misalignment, and resistance to change were recurring problems.

### 2.5 Gaps Identified

There was limited systematic documentation of how engineering colleges—especially in developing contexts—actually implemented and perceived these models. Moreover, comparative stakeholder perspectives (students vs. faculty vs. administrators) were rarely included in single studies. This research addresses that gap.

## METHODOLOGY

### 3.1 Research Design

A descriptive survey design was employed to gather quantitative and qualitative data on perceptions of blended learning models. The study triangulated perspectives from three stakeholder groups.

### 3.2 Population and Sample

The population comprised engineering colleges that had initiated some form of blended learning by 2015 or earlier. Five colleges (two government-aided and three private autonomous) were purposively selected for diversity of management type, geographical location, and discipline mix. From these institutions, a sample of 100 stakeholders was drawn:

- 70 undergraduate engineering students (years 2–4)
- 20 faculty members across core departments (Mechanical, ECE, CSE, Civil)
- 10 academic administrators (HoDs, deans, e-learning coordinators)

### 3.3 Instrumentation

A structured questionnaire titled “Blended Learning Perception Scale (BLPS)” was developed. It contained four sections:

1. **Demographics:** Role, department, prior exposure to online tools.

2. **Adoption Characteristics:** Type(s) of blended model experienced/implemented.
3. **Perception Items:** 25 Likert-scale statements (1 = strongly disagree to 5 = strongly agree) covering effectiveness, engagement, flexibility, workload, support, and assessment alignment.
4. **Open-Ended Questions:** Key benefits, major challenges, and recommendations.

The instrument was pilot-tested on 12 participants and refined for clarity. Cronbach’s alpha for the perception scale was 0.86, indicating good internal consistency.

### 3.4 Data Collection Procedure

Data were collected via paper-based surveys (to respect pre-2016 mode) and supplemented by short semi-structured interviews with administrators. Participation was voluntary and anonymous. Data collection occurred over eight weeks.

### 3.5 Data Analysis

Quantitative data were analyzed using descriptive statistics (means, standard deviations, frequencies). Thematic analysis was used for open-ended responses, coding comments into benefit and challenge categories.

## RESULTS

### 4.1 Adoption Patterns

- **Supplemental Model:** Reported by 82% of respondents (primarily students), characterized by lecture notes and quizzes on LMS platforms.
- **Replacement Model:** 46% experienced partial replacement of lecture hours with online modules.
- **Flipped Classroom:** 38% reported courses where pre-class videos or readings were mandatory.
- **Studio/Emporium:** Only 12% engaged in self-paced lab environments.

#### 4.2 Perceived Effectiveness (Mean Scores on 5-Point Scale)

- Flexibility to learn at one's pace: **4.2** (SD = 0.7)
- Better conceptual understanding: **3.8** (SD = 0.9)
- Increased engagement during class: **3.6** (SD = 1.0)
- Assessment fairness in blended courses: **3.2** (SD = 1.1)
- Faculty workload manageability: **2.9** (SD = 0.9)
- Institutional support adequacy: **3.0** (SD = 1.0)

#### 4.3 Stakeholder Themes

**Students:** Valued access to recordings, forums for doubt clearance, and flexibility around internships/exams. Complaints included patchy internet and inconsistent quality of online content.

**Faculty:** Appreciated opportunities to redesign lectures, but cited lack of instructional design help, increased grading load (due to frequent online quizzes), and inadequate recognition in appraisal systems.

**Administrators:** Focused on cost containment, accreditation-aligned outcomes, and scalability. Bandwidth and server maintenance were concerns, especially before robust cloud adoption.

#### 4.4 Challenges Identified

1. **Technological Infrastructure:** Unreliable campus Wi-Fi, limited server capacity.
2. **Pedagogical Alignment:** Difficulty integrating assessments with blended activities.
3. **Faculty Readiness:** Time, training, and incentives.
4. **Student Digital Divide:** Not all students had personal devices or stable home internet.
5. **Policy and Governance:** Absence of clear institutional frameworks for blended course design, evaluation, and IP rights for recorded content.

#### 4.5 Representative Qualitative Excerpts (Paraphrased)

- “Videos help me rewind and re-learn—especially in math-heavy subjects.” – Student respondent
- “Designing online quizzes that truly test understanding is time-consuming.” – Faculty member
- “We had to justify BL costs to management; bandwidth bills were a sticking point.” – Administrator

#### DISCUSSION

The dominance of the supplemental model suggests that early blended learning efforts were conservative: instructors mostly digitized materials rather than redesigning pedagogy. Where replacement or flipped models succeeded, there was usually a champion faculty member and a supportive departmental culture. The relatively modest mean score for assessment fairness (3.2) highlights a misalignment between online activities and summative evaluations—assessments often remained traditional, undermining the incentive to engage in digital components.

Faculty workload scores (2.9) underscore a systemic issue: early blended courses were added atop existing responsibilities without compensatory time or recognition. This resonates with global literature that stresses the need for institutional policies, instructional design units, and workload models to sustain blended approaches.

Students' high rating for flexibility indicates that even limited blended components can address diverse learning paces. Yet, the digital divide remained a barrier. Pre-2016, many campuses did not provide 24/7 high-speed access, and mobile data was expensive for students. This constraint shaped the modest scale of BL implementation and the reliance on lightweight LMS features rather than multimedia-intensive tools.

Administrators' concerns point to a broader strategic question: how to scale BL responsibly while meeting

accreditation outcomes and ensuring technology investments deliver measurable gains. The discussion suggests that analytics (tracking engagement, correlating online activity with grades) could justify investments, but such systems were rudimentary in the pre-2016 period.

## CONCLUSION

Blended learning in engineering colleges prior to 2016 was characterized by cautious adoption, uneven infrastructure, and emergent pedagogical practices. The supplemental and partial replacement models dominated, with flipped classrooms gaining traction where faculty champions existed. Stakeholders perceived clear benefits—flexibility, improved engagement, access to resources—but also noted substantial challenges in assessment integration, workload management, and institutional support.

The research underscores that successful BL integration requires more than technology deployment; it demands coherent instructional design, supportive policy, and equitable access. While our study is temporally bound to pre-2016 conditions, its insights remain relevant: institutions launching or expanding blended programs must plan for faculty development, provide robust infrastructure, and align assessments with learning activities.

## Recommendations

1. Establish instructional design and technology support units to assist faculty.
2. Integrate blended learning outcomes into accreditation and appraisal frameworks.
3. Provide subsidized devices or data plans to reduce the digital divide.
4. Adopt iterative design cycles informed by analytics and student feedback.
5. Align assessment strategies with blended activities to reinforce engagement.

## SCOPE OF THE STUDY

This study focuses on a formative historical window (pre-2016) and examines blended learning within engineering colleges. Its scope is limited to institutional models, stakeholder perceptions, and basic outcome indicators. It does not include controlled experimental comparisons of learning outcomes, nor does it explore post-2016 transformations such as large-scale MOOCs integration, AI-driven tutoring, or pandemic-induced remote learning shifts. The geographic scope is limited to five purposively sampled institutions, which, while diverse, may not represent all engineering colleges nationally or globally.

## Limitations

1. **Sample Size and Sampling Method:** The purposive sample of 100 participants may not generalize to all engineering colleges.
2. **Self-Reported Data:** Perceptions may reflect biases or recall errors.
3. **Temporal Constraint:** Findings are contextualized to pre-2016 conditions; technology and policy have evolved since.
4. **Instrument Constraints:** Although reliable, the BLPS may not capture the full complexity of pedagogical design quality.
5. **Lack of Objective Performance Data:** The study did not triangulate perceptions with detailed academic performance metrics or learning analytics.

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