Transition from In-Person Learning to Technology Enhanced Learning in Engineering Education: Faculty Challenges

Vijaylakshmi M
Centre for Engineering Education Research
KLE Technological University
Hubballi, India
viju11@kletech.ac.in

Preethi Baligar
Centre for Engineering Education Research
KLE Technological University
Hubballi, India
preethi.b@kletech.ac.in

Kaushik Mallibhat
School of Electronics and Communication Engineering
KLE Technological University
Hubballi, India
kaushik@kletech.ac.in

Sanjeev M. Kavale
School of Mechanical Engineering
KLE Technological University
Hubballi, India
sanjeev_kavale@kletech.ac.in

Gopalkrishna Joshi
Centre for Engineering Education Research
KLE Technological University
Hubballi, India
ghjoshi@kletech.ac.in

Ashok Shettar
KLE Technological University
Hubballi, India
vc@kletech.ac.in

Abstract— **This work-in-progress paper documents the transition of an undergraduate engineering university from in-person, lecture-based instruction to a blended model. The proposed work describes the planning, training, technology deployment, review, and monitoring of the blended learning model. In this process, the faculty were empowered to create content, practice studio etiquettes, edit videos, upload content to a streaming server, and create the courses in Learning Management System (LMS). The qualitative evaluation of this initiative was conducted from a pedagogical perspective using the research question: What challenges are faced by faculty members while transitioning from in-person learning to blended learning in undergraduate engineering education? Thematic analysis of the transcribed data revealed that challenges could be categorized as technical, pedagogical, multiple demanding roles, and nature of courses which further open up opportunities for evidence-based interventions.**

Keywords—Blended learning, Synchronous, Asynchronous, LMS;

I. INTRODUCTION

Higher Education Institutions (HEI) worldwide have seen the rise of the hybrid model of learning in recent years, which combines the in-person learning approach with online learning [1]. The hybrid/blended learning models offer the benefits of combining the advantages of the digital environment and in-person interaction. While significant literature is available on hybrid learning from the developed part of the world, its implementation is scarce in developing nations. The biggest hurdle for developing nations is the investment needed to implement a stable and reliable technology.

Hybrid/blended learning has many advantages. It encourages students to study independently anywhere and anytime using digital technology [2], thus creating a student-centric atmosphere with the benefit of self-paced learning. The blended learning model has increased student engagement and individualized instruction to support students' wide variety of strengths and weaknesses [3][4]. A student-centered atmosphere has been created by a blended learning model, where students put personal efforts to gain knowledge in more meaningful situations [5]. The blended learning model [6] helps arm students with technical skills that benefit them throughout their lives. One more added advantage of this kind of learning model is that it makes assessment and data collection meaningful [7]. Furthermore, grading and reporting will save time.

The urgent thrust to move online has been seen during the recent Covid-19 pandemic, a challenge for faculty and students. The immediate emergency response of educational institutions to offer remote teaching through recorded videos was not well received by the students. Many institutions failed to systematically plan and execute the transition process [8][9]. So, the universities have to innovate in designing and organizing instructional activities using digital technologies to facilitate meaningful online learning experiences through blended learning. Though there are few efforts put in developing part of the world towards implementation of hybrid/blended learning at a topic or course level [10], literature on large-scale implementation across an institute is rare.

There are five types of blended learning models: station rotation, lab rotation model, enriched virtual or remote blended learning model, Flex model, Flipped classroom model [11]. Students rotate among different labs or stations in Station and rotation model, with one Station containing an online station. Enriched virtual model, also referred to as remote blended learning, this model allows most tasks to complete online but requires few sessions of face-to-face interaction with instructions. Flex model instructions are self-guided. It will enable online teaching, with teachers acting as an enabler in the classroom. In a Flipped classroom, the students meet the teacher for a lecture and complete the home assignment. The flipped model helps students gain knowledge during online learning and acquire higher-level thinking during classroom discussions.

Project-based learning, where a learner creates a survey on a real-life issue, uses online information to build a project. Flexibility is one of the advantages of the blended learning model, amplified by the number of teachers and universities' variations. As there are many blended models, it is imperative to reflect upon the objectives and needs of

the learner and instructor before selecting any particular model. The pedagogy used for delivering the content in online mode has to be carefully chosen by the course instructor such that the expected learning is not hampered. Students' role in terms of attention, motivation, capacity to stay on the task, executive function, and ability to shift tasks are essential in the blended model for a practical learning experience. Even the teacher's role is crucial in designing practical modules, activities and engaging students [12].

II. CONTEXT OF WORK

A private engineering university in India leveraged the disruption caused by the Covid-19 pandemic to begin a new era of learning on campus: a strategic shift from in-person learning to Technology Enhanced Learning (TEL). One such TEL method, Blended Learning (BL)[13], focuses on this paper. The Centre for Engineering Education Research (CEER) at the university led the effort to conceive, design and deploy the BL model. In this process, the faculty were empowered to create content, practice studio etiquettes, edit videos, upload content to a streaming server, and create the courses in Learning Management System (LMS). The proposed work describes the planning, training, technology deployment, review, and monitoring of the blended learning model.

Although many existing articles describe the creation of a BL environment [14] [15], this work is unique as it outlines the systematic process followed for 250 courses at undergraduate engineering education across five schools and three departments. The entire process of design to deployment was completed in 50-60 days.

A. Model for Blended Learning

In response to the Covid-19 Pandemic, the university adopted the bichronous online learning model [16], which brought together the optimum blend of asynchronous (ASYNC), i.e., on-demand-online and synchronous(SYNC), i.e., live-online delivery, to ensure students' effective learning engagement.

This model aims to: -

1) Develop and adopt an online delivery model to ensure adequate student engagement in learning.
2) Evolve best ways to blend asynchronous and synchronous online delivery modes
3) Setup appropriate infrastructure and digital platforms to provide seamless access to world-class content and learning experience
4) Even the model helps mitigate the downsides of asynchronous online learning alone, like audiovisual communication, interaction, community, and immediacy. [17]

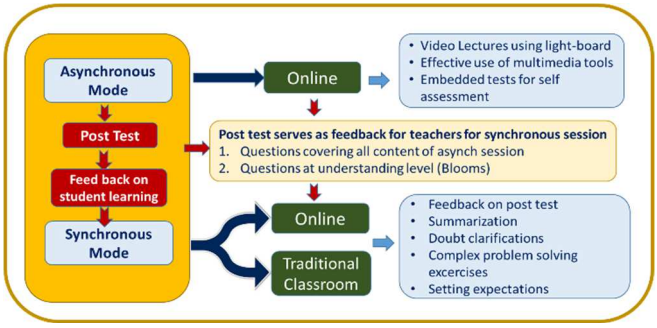

Figure 1. Implemented Bichronous model

Figure 1 shows the bichronous learning model at the author's university. It brings together the technological and pedagogical elements which are unpacked subsequently. In addition, to check the learning level of the students on the asynchronous content, a concept-based post-test is planned. Student feedback can foster a learner engagement and experiences with asynchronous video content [18] [19] [20] [21] [22].

A. Asynchronous content creation

The first challenge was to train 300 faculty members to create asynchronous online content for 250 courses. The authors conducted an institute-wide, phase-wise training to initiate faculty to map their in-person content into chunks suitable for online learning. The training focused on content chunking [23], type of content (factual/conceptual/procedural, principle, process-oriented) [24], instruction methods, resource formats, assessment strategies, and how to facilitate learner engagement in online learning.

B. Operationalizing the Bichronous model

While the academic calendar at the author's university spanned 16 weeks with in-person learning, the bi-chronous learning model brought in systemic changes in semester execution, and the semester was increased to 24 weeks with two cycles of 12 weeks each by spreading the courses across both the cycles thus reducing the students' cognitive load and bandwidth issues. Table1 shows the first four weeks of the 12 weeks cycle.

Table 1 Semester delivery Plan

Mon	Tue	Wed	Thu	Fri	Sat
W1.1	W1.2	W1.3	W1.4	W1.5	W1.6
Release videos	Watch Video	Watch Video	Watch Video	Post-test	Post-test

Mon	Tue	Wed	Thu	Fri	Sat
W2.1	W2.2	W2.3	W2.4	W2.5	W2.6
Release videos/ SYNC session	SYNC Session	SYNC Session	SYNC Session	Post-test	Post-test

Mon	Tue	Wed	Thu	Fri	Sat
W3.1	W3.2	W3.3	W3.4	W3.5	W3.6
Release videos/ SYNC Session	SYNC Session	SYNC Session	SYNC Session	Post test	Post test

Mon	Tue	Wed	Thu	Fri	Sat
W4.1	W4.2	W4.3	W4.4	W4.5	W4.6
SYNC Session	SYNC Session	SYNC Session	Formative assessment		

It indicates how the week unfolds for a student. The week began with the release of asynchronous content followed by synchronous engagement. A graded post-test was conducted at the end of every topic to ensure student engagement. Based on the student's responses in the post-test, the faculty developed the content for synchronous engagement. During synchronous engagement, the faculty also solved team-based problems and addressed students' learning issues.

At weeks 4 and 8 formative assessment was scheduled. The summative assessment was scheduled for week 12, with week 11 being a study week.

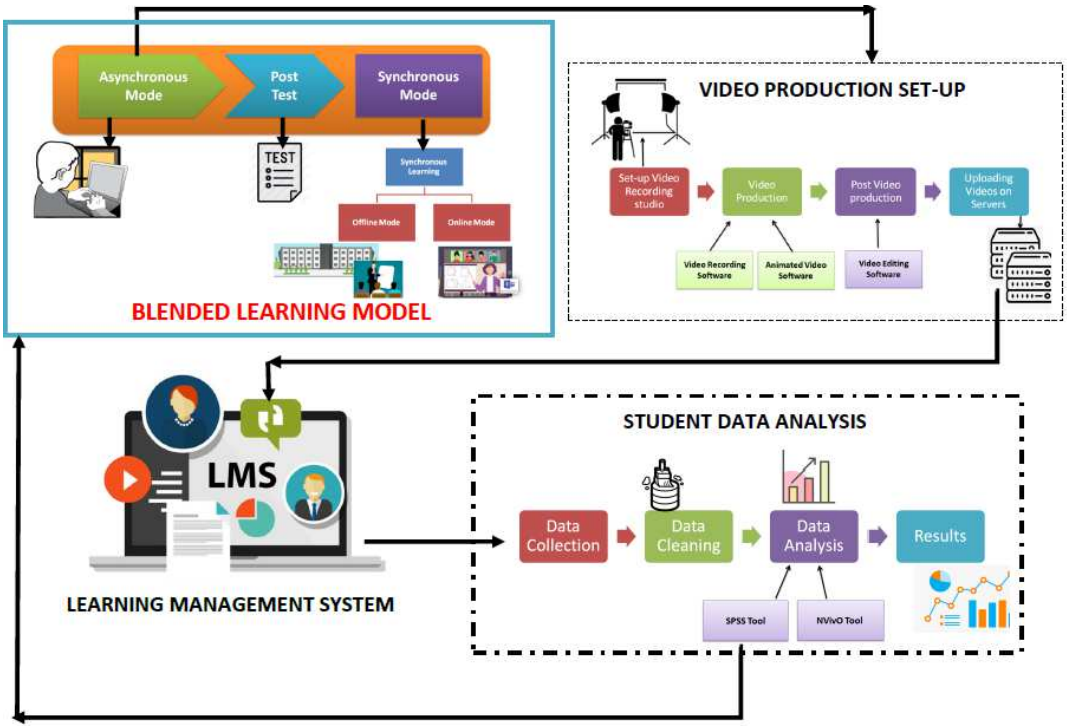

Figure 2. Different Elements of the Bichronous Model

C. *The online learning environment*

Several infrastructural and technological elements were introduced to create, roll out, and support the bichronous learning model. Twelve recording studios with light board technology were set up for recording content. Adobe Premiere pro was used to edit the video content. Students accessed the Moodle-based Learning Management System content, which served as a one-stop solution for all academic-related information. The videos themselves were stored on a separate video streaming server by the name Vimeo. While all these catered to asynchronous sessions, the synchronous sessions were conducted through the Microsoft Teams video conferencing platform. Figure 2 depicts the online learning environment and shows the interplay between the bichronous model, infrastructural elements and students' data.

III. RESEARCH QUESTION

The evaluation of this initiative was conducted from the implementation perspective using the research question: What are the challenges faced by faculty members while transitioning from in-person learning to blended learning in undergraduate engineering education? Implementation of blended learning is not new. Literature on blended learning is available in abundance. This research work is different and significant because the developing nations have rarely tried this mode of learning. Not much of literature is available on the difficulties faced by the engineering institutes while implementing blended learning in developing nations. COVID situation has forced many institutes and universities across the globe to think of alternative modes of learning. This article is helpful for those institutes which are in the developing part of the world and are willing to implement blended learning.

IV. METHODOLOGY

A qualitative evaluation of the blended learning model was conducted to understand the challenges faced by the faculty members.

A. *Sampling*

The above-mentioned blended learning model is implemented in 250 courses offered by five schools and three departments across the university, affecting 4500 students. For which more than 150 faculty involved in the operationalization of this approach. For this qualitative study, randomly faculty were selected from four engineering departments and interviewed until saturation in the responses was reached, which was achieved at a number of seven. The teaching experience of the faculty in the sample ranged from 8 to 30 years. The sample consisted of faculty who engaged courses that have theoretical/conceptual, numerical and tutorial nature of the content.

B. *Data collection and analysis*

Standard qualitative interview process was followed which includes seeking consent of the interviewees, scheduling and conduction of interview in a controlled environment, transcribing and member checking. The questionnaire was validated by conducting a pilot run on the interviewees. The transcribed data was thematically analyzed to identify the core challenges faced by faculty. Three researchers analyzed the themes, and any conflicts were resolved through discussions.

V. RESULTS AND DISCUSSION

This work-in-progress paper focuses on the challenges that faculty members faced while transitioning from in-person content delivery to blended learning. Results revealed that challenges could be categorized as technical challenges,

pedagogical challenges, multiple demanding roles, and the nature of courses. The specific challenges are described below: -

A. Technical challenges

At the start of recording, challenges like content-chunking, script-writing, video recording, and editing were faced. These issues overwhelm a faculty even with 30 years of content mastery and are not related to the faculty's proficiency in teaching-learning processes. The cognitive readiness required to convert hourly lectures into 10-15 minutes sized multimedia chunks is something that traditional faculty are technically unprepared for, even if they have the confidence. As one faculty member lamented, "During the creation of resources in the form of video lectures, faculty faced hiccups of facing the camera as a result; faculty lost the natural way of delivery."

While these challenges are real, they bring down faculty's motivation and confidence during the initial months of content recording. However, they are short-lived, as the authors can infer from this: "I initially practiced in front of the mirror. It wasn't about content delivery, and it's the way I look at the camera when I deliver it. News readers have teleprompters, and we didn't. So, we had not only to look natural but also think while doing so. It wasn't easy during the first 15-20 videos. Now, I have no problems". Another faculty spoke in anguish, "I look at students and teach. I never imagined that I will ever fix my gaze at the camera lens and deliver my basic electronics course! I need nods, question marks on students' faces when I engage them. With them behind the screen, I had no way of knowing how they perceived me". Despite appearing unsurmountable, over a period of time, faculties were able to overcome these issues.

There are multiple roles to be played by a teacher in implementing blended learning. Multiple competencies are expected by the teachers. Teacher becoming a technologist is also important role in facilitating online education [10]. In the author's university, this was achieved through training programs and hands on experiences.

B. Pedagogies for ensuring student engagement

Faculty new to creating online learning content were mostly focused on addressing the inward-challenges related to the previous theme. Though they were aware of this critical factor that decides quality of online content i.e., engagement, they were only able to cater to it progressively. As one faculty stated, "I slowly got a hang of how to do it. Of course, we were trained on the methods to ensure engagement through interactive content using H5P technology. I wished to do more animations, simulations and podcasts. However, I wasn't able to during the first version of the recording. Now that the recordings are in place, I will enrich all videos. with more engaging content". This quote summarizes the thoughts of other faculty members as well. Student engagement is a big concern in hybrid learning environments [25]. A movie created in film studio by a veteran director and actors may be very exciting to the viewers. However, the video content made ready by a teacher will definitely not as exciting as a movie, at least in the first few attempts of video making, because of lack of experience in this regard. In the authors' university, the content created were ensured to be interactive and engaging by training the faculty, frequent audits on the content created and feedbacks from the students. Like mentioned during the interview, the competence of creating content which engage students can be grown over experience.

C. Multiple-demanding roles

As discussed earlier, enriching education experience for the learner is an important component of effective student engagement [26]. This need demanded that faculty resume multiple demanding roles that included developing scripts and teaching resources (presentations, animations, visualization, and task-aids). The faculty interview data and the authors observations validate the multiple roles played by the faculty. Some of the faculty quotes include "Every faculty in the team has to play multiple roles and take up multiple responsibilities during the process." "Content development needs a team". "A team of faculty is required in the process of transforming an in-person course to a blended course." While Boyer[27] had stated the three roles of a faculty: teaching, research and service, the faculty were dazed when online-content development was added to this list.

The trainings conducted at the institution not only should help the faculty to overcome the technical challenges and pedagogical challenges but also to develop the competence among faculty to play multiple roles. In the authors' university, various tasks and roles were assigned and trained to different faculty to optimize load on each faculty[28]. Also, the authors observed that the roles played by the faculty further depended on the nature of courses which is explained in the next section.

D. Nature of courses

The interviewees were sampled to include a representative set of courses from different streams of engineering including theoretical courses, mathematics and its application, tutorial courses, project-related courses and visualization-intensive courses. While this was done to identify if the type, of course, led to different sets of challenges, this categorization revealed interesting findings. A mathematics professor quoted "I was involved in making ready the resources for the online content where I spent most of my time in learning the tools for writing the equations and notations". While an electronic professor quoted "I spent my most of the time in creating assessment questions that ensured conceptual clarity" While a professor from biotechnology said that "We as a team spent lot of time in creating task-aids that suited online mode of delivery for a PBL course".

The authors observed that visualization intensive courses were effort-intensive; they were easier to develop content for compared to theoretical/conceptual courses. The main issue in project-related courses was creating task-aids to ensure interdependence between students, training students on online tools to convert in-person primitive interaction to teamwork through online tools. Mathematical courses posed another set of challenges since they are mostly procedure-oriented. As a faculty stated, "I created content for a tutorial-related course. This needs lots of back-and-forth discussions between instructors and peers. While in a class, I used the jigsaw to structure team-based interactions; I could not do the same effect in its online version as I could not hold students individually accountable immediately despite using breakout rooms on Microsoft teams to facilitate these small-group

interactions. I have finally realized that while technology is an enabler, its effective use depends on students' motivation!"

VI. CONCLUSION AND FUTURE SCOPE

This study is a work-in-progress version of the Blended-Learning model implemented in a private engineering university in India. The first implementation was qualitatively evaluated to understand what challenges the faculty faced during this transition which revealed four distinct themes. While this study documents these challenges, the future scope of this study is to design interventions to address these challenges at all three levels, including course, faculty and program. These can be posed as below mentioned questions for further study.

1. How do administrators ensure that faculty are empowered in content development for blended learning in the least possible time?
2. While content development needs a triad of knowledge and skills: content, pedagogical and technological, how can these be developed among engineering faculty and what counts as a motivation?
3. What are the pedagogies to ensure engagement in blended learning specific to the types of courses: theoretical courses, mathematics and its application, tutorial courses, project-related courses and visualization-intensive courses?

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