Blended Learning, an Integrated Learning Solution in Undergraduate Engineering Education: A Case Study

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***Abstract*— In the 21st century, learning opportunities and experiences of students have greatly improved with blended learning. This paper presents the case study of one such delivery method in undergraduate engineering education implemented for the programme of Quality Enhancement in Engineering Education (QEEE) at BMS College of Engineering, Bangalore. The programme covered courses across various engineering branches. The course structure included modules for live classes, virtual labs, tutorials, bridge courses and MOOCs. Roles and responsibilities of the various stakeholders along with the infrastructure requirements for participating in QEEE are presented here. The paradigm is well accepted by both students and staff in the first year of its implementation. The evaluation data collected in this study include responses of all stakeholders collected through interviews and a questionnaire survey.**

***Keywords*— Blended Learning, QEEE, Virtual labs, MOOC**

I. INTRODUCTION

Over the recent years, there have been several definitions for blended learning. According to Charles Dziuban et al. [1] it is an approach that combines the effectiveness and the socialization opportunities of the classroom with the technological enhancements of online learning. It offers the best of both the physical and instructional worlds. Charles R.Graham [2] describes the historical emergence of blended learning as the convergence between traditional face-to-face learning environments and computer-mediated (or distributed) learning environments. The advent of worldwide communications and powerful computer technologies has paved way for this approach of education technology.

Under the Outcome Based Education (OBE) model of Engineering, the graduates have to demonstrate that they possess a number of abilities and skills. Besides learning engineering math and conducting and analyzing experiments, students have to demonstrate the ability to work in teams, to communicate, to be lifelong learners, and to understand the broader issues of society [3]. Hence a series of online courses alone cannot shape an engineering professional. Old-fashioned face-to-face classrooms along with e-learning which is the essence of blended learning can only meet the special needs of engineering education. Blended learning makes learning time efficient and empowers engineers for life.

The Indian Ministry of Human Resources and Development (MHRD) with a mandate to bring about comprehensive reforms in technical education has initiated the Quality Enhancement in Engineering Education (QEEE) programme. The programme under QEEE is aimed to facilitate the integration of superior external scholastic inputs into current pedagogical practices of technical universities across the country.

II. METHODOLOGY AND ITS IMPLEMENTATION

Both synchronous and asynchronous learning is achieved through the five modules of the programme. Synchronous learning refers to real-time learning events in which all students share the learning experience and may interact with each other at the same time. Learning sessions that can be accessed at different times are known as asynchronous learning. Participants interact with each other through chat or discussion forums.

A. Live Lectures

This module implements synchronous learning with a virtual classroom instructor led training. Here a part (about 15 sessions) of the selected courses lectures is delivered live from the IIT classroom to all participating colleges at different locations using the QEEE platform. Lectures are being delivered by the IIT professors. The schedule of lectures is preset and made available in advance to all participating colleges. At the slated time, the lecture will be brought live to the classroom, with the professor inside the classroom playing the role of moderator. The session mimics a live classroom with opportunities for sharing and interaction between students and instructor. Fig. 1 depicts the delivery model of these live lectures. The recorded videos of the sessions are also available to the students later through the institute server which enables asynchronous learning.

Out of the 12 and 15 courses which were offered as “Live Classes” in the QEEE phase I and II respectively, our institution opted to take up 8 and 6 courses. The remaining was dropped mainly because those courses were not offered in our autonomous institution in that current semester. The details of the courses, the semesters and engineering branch for which they were offered are as shown in Table 1.

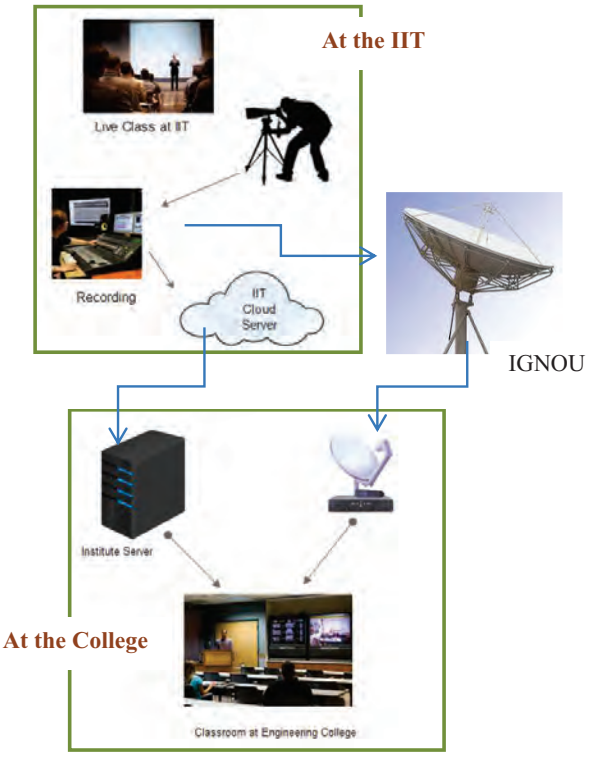

Fig. 1: Schematics of Live Lecture delivery

TABLE I. COURSES OFFERED UNDER LIVE LECTURES

QEEE Phase I (Jan 2014 – Apr 2014)			
Sl. No	***Course Title***	***Semester***	***Engineering Branch***
1.	Wireless Communication	6	Telecommunication
2.	Electromagnetic Fields	4	Electronics & Communication
3.	Linear Algebra	8	Mathematics
4.	Computational Methods in Thermal and Fluid Engineering	6	Mechanical
5.	Operating Systems	6	Telecommunication
6.	Heat Transfer	4	Chemical
7.	Geotechnical Analysis	6	Civil
8.	Probability and Statistics	6	Information Science
QEEE Phase II (Aug 2014 – Nov 2014)			
9.	Analog Circuits	3	Electronics & Communication
10.	Introduction to Database Systems	3	Information Science
11.	Mass Transfer	3	Chemical
12.	Digital Signal Processing	5	Telecommunication
13.	Machine Design	5	Mechanical
14.	Fiber Optic Communications	7	Telecommunication

B. *Virtual Labs*

With virtual labs, students can access the real laboratory equipment and carry out traditional laboratory exercises from their own places of study [4]. It creates an opportunity to work on a real lab experiment tailored to suit their syllabus and curriculum and also access quality resources and materials. A remote tutor facilitates the students with the conduction of experiments with a set of prior instructions and loaded theory content. Fig. 2 shows a remote laboratory setup used in this project.

Each lab included approximately 8 three hour sessions, with one session conducted per week. The lab experiments synched with the appropriate live lecture course. Virtual labs for Smart Structures and Digital Signal Processing were conducted at our institution during the two semesters of QEEE.

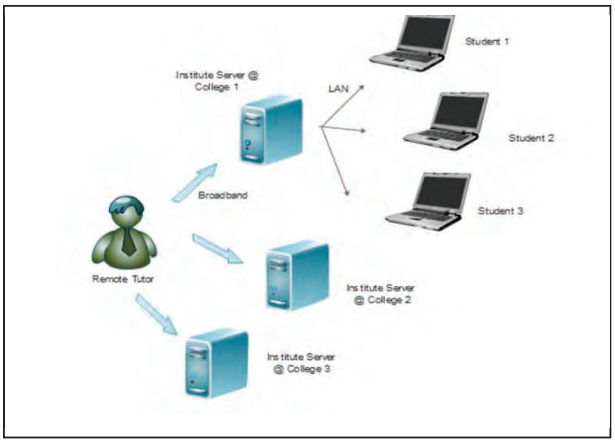

Fig. 2: Schematics of Virtual Lab delivery

C. *Tutorials*

Most engineering courses include tutorial sessions along with lectures and laboratory work. During these sessions, students work in groups to solve a set of problems leading to enhanced understanding of that particular topic.

Initially in QEEE, this was implemented in synchronous mode in the presence of teaching assistants at the IIT campus and students communicating with them through the institute server. Later it was switched to asynchronous mode, allowing previously delivered as well as new academic content to be reviewed by students amongst their peer group without the virtual presence of the instructor.

D. *Bridge Courses*

These courses aimed at making students industry ready and employable by training them on non-curriculum courses. Two such courses on spoken English and CII industry bridge programme were implemented in Phase II. Spoken English classes were conducted on Saturdays for 10 weeks focusing on communicative English, fluency, attending interviews and writing resumes. CII industry bridge sessions were conducted atleast once a week with industry experts delivering lecture and also interacting with the students.

E. Massive Open Online Courses (MOOC)

MOOC is a delivery style of engaging students in the learning process through online courses. Open course ware enables customized anytime anywhere learning through the internet. This was implemented in QEEE along with Microsoft Research and Online courses of NPTEL. The Massively Empowered Classroom (MEC) programme of Microsoft Research offered 1 and 4 courses respectively in the two semesters. Similarly two courses were offered on the NPTEL portal in Phase II.

III. Roles and Responsibilities of Stakeholders

The key stakeholders in the QEEE programme have been identified as QEEE coordinator, system administrator and the local faculty. All stakeholders shall work towards effective implementation of the programme. The roles and responsibilities expected of the stakeholders are as outlined below:

A. QEEE Coordinator

They serve as a liaison between the QEEE team at IIT and the people present locally at the college. They ensure that the issues related to hardware, classroom, connectivity and QEEE software interface are resolved. To ensure minimum interruption to the academic calendar of the college, the timetable is synced with the QEEE schedule.

B. System Administrator

System administrator sets up and maintains the infrastructure in the college as per the requirements specified. Registeration of the students, local faculty for the courses in the QEEE software interface is also one of his/her responsibilities.

C. Local Faculty

Faculty at the college guiding the students during live lectures, virtual labs and tutorials are termed as local faculty. They would moderate to ensure active participation of students during the session.

IV. College Infrastructure Requirements

The colleges participating in QEEE are expected to meet the infrastructure specifications. The hardware requirements include an institute server, a classroom PC, two projectors and other audio visual accessories like microphone, camera, speakers and audio mixer. The QEEE interface software runs on the Centos 6.5 installed on the institute server and classroom PC. The participating college is expected to have a dedicated 4 Mbps internet connectivity and a global IP address for the institute server as part of the connectivity requirement. To receive the classes via DTH, a DTH dish along with set top box is to be installed. More details about the infrastructure requirements is found at [5].

V. Evaluations

A questionnaire survey at the end of phase I was conducted for students and teachers involved in the programme. The evaluations across all the modules were completed and are as shown in Table 2. Students and faculty who participated in the feedback process were 278 and 19 respectively. The video of the interview with the stakeholders is found at [6].

The observations revealed that the learning model was accepted by both faculty and students. The fruits reaped were live interaction with IIT faculty and discussion about advanced topics related to the course. The drawbacks witnessed were bandwidth issues, mismatch in the syllabus and schedule in some scenarios. Overall the conclusions were drawn to continue the programme with minor modifications. It is planned in Phase III of QEEE scheduled to start from Jan 2015 to reduce the number of sessions of live lectures for effective delivery. Prior sessions between local faculty and IIT faculty are being conducted to ensure relevance of the topics to be covered in each course.

TABLE II. Overall Feedback by Students and Faculty

	Students			**Faculty**		
	Exceeds Expectation	***Below Expectations***	***Neutral***	***Exceeds Expectation***	***Below Expectations***	***Neutral***
Live Lectures	35%	35%	30%	64%	9%	27%
Virtual Labs	39%	17%	44%	35%	-	65%
MOOC	61%	25%	14%	40%	20%	40%
Overall	**45%**	**30%**	**25%**	**53%**	**11%**	**36%**

VI. Conclusions

Only online courses would not be sufficient for engineering education as it emphasizes on both formula manipulation and laboratory work. Hence a new educational method of blended learning has been experimented with few courses of engineering at the under graduate level. This paper has presented such an implementation under QEEE. The model has been successful in providing an efficient and effective learning experience to both students and faculty. The obtained results indicate that this paradigm be adopted for various courses in large number of engineering colleges across the country.

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