

Evolving Philosophy of OBE in Engineering Physics Course -A case study.

T. Renuka¹, C. Chitra², T. S. Pranesha³

^{1,2,3}Dept. of Physics, B M S College of Engineering, Bangalore, India.

¹trenuka.phy@bmsce.ac.in, ²chitrac.phy@bmsce.ac.in, ³hod.phy@bmsce.ac.in

Abstract— Engineering Physics Course is offered to all the freshmen students entering our Institution. They are introduced to a question and answer platform, [1] and [2] as a flipped classroom in our course. Their adaptability to the new teaching-learning process was put to test after a month into the term. The effectiveness of our teaching and evaluation methodology was tested through an opinion poll, taken voluntarily by the students. The success of the flipped classroom, analysis of the students' survey, the enormous scope it provides for further improvement and some useful inferences that can be included in our pedagogical process in future are compiled in this paper.

Index Terms-Web 2.0 technology, team teaching, discussion forum.

1. Introduction

The Engineering Physics Course offered to first year undergraduate students, has undergone a metamorphosis. It is more of a Physics of Materials course now, than a basic theoretical subject. The educational Philosophy too has transformed into an outcome based one, which is the need of the hour. Since 2008, our Institution has opted for outcome based education and a steady yet gradual shift from the conventional approach has happened. Initially, the course outcomes of the Engineering Physics course, when mapped with the program outcome (PO) have covered the first two, namely, ability to apply knowledge of mathematics, science and engineering fundamentals to solve complex problems in engineering (PO1) and ability to analyze engineering problems interpret data and arrive at meaningful conclusions involving mathematical inferences (PO2). Our motivation for using a new pedagogical tool is to explore the possibility of inculcating some more desired qualities and skills in the learning community, through our course.

The term days are insufficient to realize it. In addition to the regular teaching hours, a need for extra coaching hours to steer the outcome based education into the path of success, was felt by us. We developed a flipped classroom using a popular freeware and introduced it to the new entrants of our Institution. It supports the involvement of the community in evolving it, using open source codes.

T. Renuka

Dept. of Physics, B M S College of Engineering,
Bangalore, India.
trenuka.phy@bmsce.ac.in

Newly admitted undergraduate students, undergo a two days' orientation program, in the very beginning of the academic year, during which they are given an insight into the outcome based education. Equipped with this awareness, they are systematically taken through our teaching -learning process. Usage of Information and Communication Technology tools is limited in the pre-university course. Very few students are exposed to these tools. During the semester, we have to adhere to the lesson-plan strictly, making it very difficult for us to provide them with some additional resources. Hence, we introduced our students to the web2.0 tool called piazza.com. The following features recommended the usage of this particular tool:

- Accessibility: Our students can connect through the internet, as our whole campus is wireless network enabled, making the e-learning platform readily accessible.
- Portability: There is a free mobile app for android phones making it, "anywhere and anytime" classroom [3]. The ease and readiness with which they can log into the site is another key feature.
- Advancement: Students of the teenage group are used to the friendly, wiki-style format which this site uses which is similar to some of the social web sites, enabling them to participate better in a single space.
- Collaborative learning: The contents and the contribution of Instructors and the students can be stored and kept track of. Special features like filtering of posts in this virtual class room are helpful to the Instructors.
- Motivational: Good answers can be endorsed by the Instructors, which work as an incentive for the students, boosting their morale.
- Environmental -friendly: Digital files replacing printed notes on paper, no fuel wastage to commute and attend this course conducted after- class hours, exploiting young brains to engage in fruitful discussion empowering them for future with minimal consumption of energy are some of the eco -friendly features.

The following six challenges which this learning platform posed for the students were also kept in mind while designing the course:

- Adaptation to the flipped class room
- A suitable degree computer skill levels
- Development of habit of discussion

- Motivation towards self study
- Identification of the slow learners early and aligning them with the mainstream, at the earliest
- Assessment of their enthusiasm to use the flipped class room to work towards the successful learning outcome.

2. The Information And Communication Tool

The rugged path of traditional pedagogical approach and conventional curriculum was smoothened with this free, open source-ware and has paved a progressive way for the learners to pace their self- study, comfortably.

A. Setting up of class room:

During the first week of the course, we created a classroom called "I Sem Engineering Physics theory", in piazza.com.[1], to cater to first semester mechanical engineering students of section E and "203 D sec Engineering Physics Course"[2], for another set of mechanical engineering students of section D. Course description, syllabus, course objectives, contact hours of the teacher and a welcoming note with the instructions about joining the virtual classroom were added under appropriate headings.

B. Setting up of Q&A page:

Appropriate folders for the lessons were created in an orderly fashion and contents were added under suitable folders. To start their participation in discussion forum and to gauge their willingness, they were asked to write an introductory note, about themselves and post it for the benefit of their fellow learners.

C. Enrollment and customization:

We enrolled the students of both the sections into the question and answer platform, by adding their email addresses and joining instructions were mailed to them. We have added the lecture notes of the first two units which we have planned to teach in the first month. The classroom notes in digital format help us to add it as a ready resource. Editing its content during the change of syllabus, cloning for another class where the same course is offered and sharing it through different applications become very easy. Some interesting audio visuals, NPTEL (National Programme on Technology Enhanced Learning) and other MOOC (Massive Open Online Course) course-materials have been added under additional resources. A PowerPoint presentation regarding an open ended

experiment has been uploaded to evince their interest in Inquiry through experimentation. We have created groups with light-hearted names like, "Fine artists", "ardent quizzers", "Sporthusiasts", "bookworms", "healthy hackers" to which students are free to join and benefit from like-minded company. Another set of five groups are formed and they have been asked to make posters under five topics, covering all the five units in the syllabus.

D. Team-teaching: In addition to the other features available for the students, we have introduced team teaching for D section students. A second Instructor's details were added to facilitate team-teaching. It was planned to keep the second Instructor's role only through the virtual classroom in answering queries, providing additional resources and allocating co-curricular activities to the teams.

E. Discussion forum:

Students can post their doubts in understanding the concepts, queries regarding derivation, and in short, anything pertaining to the course and any notes which they want to share with their colleagues. Posts by students, their questions along with their colleagues' response, students' answers to the Instructor's queries, unresolved questions needing immediate action, creating groups among themselves, adding themselves to any existing teams are highlighted. The Instructors can endorse answers to keep the class on track which is to the students' advantage. It encourages every student to participate in the discussion forum, as anonymous posting is possible.

F. Classroom Statistics:

The usage trends as to the number of users/posts per day, top student contributors or the active learners, the number of days they are online, the number of passive watchers, instructor's participation report regarding her contributions to the student queries, students participation report detailing their contribution to the discussion forum, are some of the reports which are authentic and transparent to anybody who follows our progress by following the links [1] and [2].

G. Opinion Poll:

The most exploited feature of Piazza.com is its highly customizable online polls. The evaluation of the new pedagogical process was done by posting an online poll. All the students of the class can be respondents of the opinion poll as all their names have been enrolled. But only one third of the class participated in the first two days which decided the outcome.

3. The Survey

A. Objectives :

Conviction in the outcome based education system and the dedication to make it work have given us the impetus to find out whether any new entrant into our Institution has his own personal objective of self learning and if it matches with the program educational objectives of the branch into which he has enrolled. Our course objectives and the outcomes are nucleated around student-centered learning. Thus some more desired proficiency, like conduct investigation of complex problems (PO4), modern tool usage (PO5), individual and team work (PO9) and communication (PO10) have been added. In the spiraling cycle of continuous improvement, reappraised outcome of the course taught in the previous term sets the new goal for the next term [4].

CO	Program Outcome											
	1	2	3	4	5	6	7	8	9	10	11	12
1	60	60	-	60	60	-	-	-	60	60	-	-
2	60	60	-	60	60	-	-	-	60	60	-	-
3	60	60	-	60	60	-	-	-	60	60	-	-
4	60	60	-	60	60	-	-	-	60	60	-	-
5	60	60	-	60	60	-	-	-	60	60	-	-

Fig. (1): Expected CO to PO mapping for Engineering Physics

B. Population and sampling:

There are roughly about six hundred students taking up the introductory Engineering Physics course every semester. This pilot project of flipped classroom pedagogy is being carried out in two sections of mechanical engineering discipline namely sections D and E, comprising of 120 students. Out of this population, the number of respondents for the opinion poll is 19 and 29 respectively, who voluntarily participated, taking the total of stratified sample to 48.

C. Instrument:

Our instrument was a set of ten queries prepared and posted as an opinion poll in Piazza to find out about the attitude of the beginners for any transformation. The opinion poll to the students contained questions regarding (i) the educational stream in which they had studied up to pre-university, for more than six years, (ii) whether they had used any web 2.0 tool of this kind, (iii) the ease with which they

are able to use the platform through which we offer our virtual class room, (iv) if the learning of the course material through Piazza happens at a comfortable pace, (v) awareness of OBE,

(vi) the role of additional resources in visualizing the abstract and difficult concepts and the teacher's role as facilitator, (vii) usefulness of open ended experiment (viii) whether slow learners are identified and remedial program has started (xi) encouragement of team/ group work. In totality, we want to find out whether our new pedagogy significantly contributes to the curricular, co-curricular and extracurricular activities.

4. Data Analysis

The parameters for evaluation are the following:

(i) Modern tool usage: The statistics offered by the e-learning itself will gauge their enthusiasm to use this progressive tool. In addition, the students were asked to rate the ease with which they could use it. We wanted to know the role of educational stream of a student, in his initial enthusiasm to use an e learning platform. It was checked by our first query and the stratified bar diagram Fig. (2) Shows that the students of CBSE have outnumbered the other streams in their initial response, the reason being their level of computer skills.

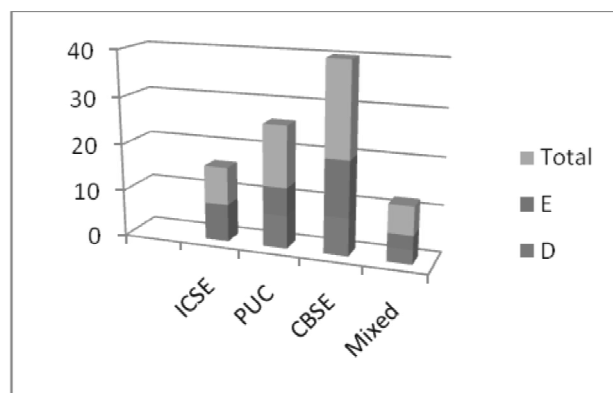


Fig. (2): Educational stream of students till class 12.

The myth that the current generation of students is digital learners is broken by their confession that they have not used any such learning tools earlier. Even though only 14 % of the respondents have used any web 2.0 tool prior to their university education, Piazza has been rated as easy and medium to use by 92% of the respondents, and we are equally happy with the orderly and organized way in which the activities of

the classes happen, the transparency in the discussions and the opinion poll, a little bit of mentoring activity that goes through the platform, and the real time communication with the students through the internet. Fig (3) shows the line diagram indicating that most of the respondents are enthusiastic of using it.

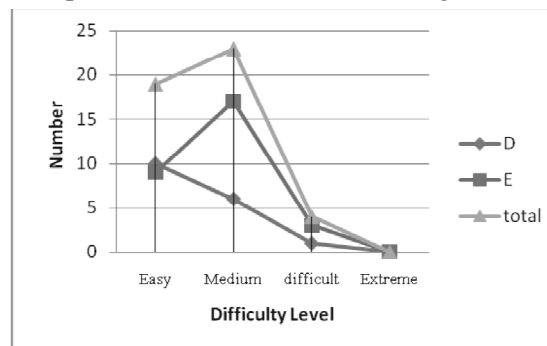


Fig. (3): Students rating of the difficulty level of the platform.

From the statistics given by the site, the minimum number of students congregating per day is 10% and maximum is as much as 50 %. The class report is periodically recorded and downloaded as .csv file for future analysis. 45 total posts, 367 total contributions, 6 Instructor's responses and 2 student responses are not very encouraging. Even now, nearly, half of the class has not come forward to use this tool as the statistics show. They shy away from even sending an introductory note about themselves. Not all students are able to harness the potential of socio-constructional environment. Online learning aptitude demands a particular behavioral pattern of collaborative learning [7].

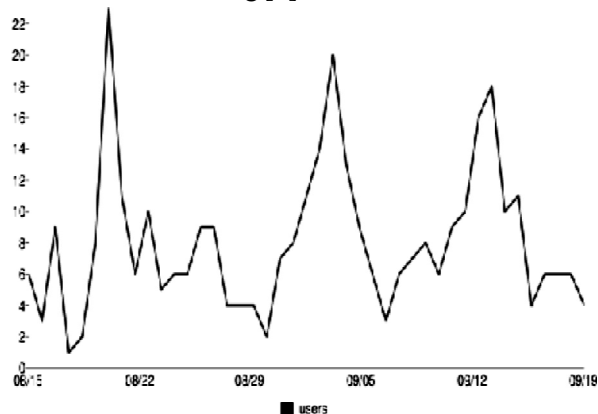


Fig. (4): Number of users per day of the e-learning platform

ii) Remediation: Prior knowledge of the course objectives set the direction for the students to move forward and give them some stability during quiz and

the tests, in the first month. Earlier, the previous years' question papers were their only help. Methods adopted to realize the objectives for the Quantum Mechanics course has to be visual to explain abstract ideas like wave- characteristics of matter. The links to public video presentations have replaced thousand words of explanation by one picture. The test scores of 50% of the population have been supreme in the first test and the quiz. The possibility of conducting the parallel coaching classes for slow learners and low scorers is being explored with a little apprehension, as it takes time to make them get used to virtual class room.

(iii) Conduct investigation of complex problems: From the introduction to open ended experiment given to the students, their interest in designing a component of a mechanical system, namely a cantilever, its safety and other considerations are to be found out. The development of content specific, technology enhances learning opportunities, facilitates the transition to student-centered learning and experimental inquiry experiences [5]. 66% of students have come forward to perform the open ended experiment during the semester holidays. The first step towards attaining PO4 will be accomplished when they design and assemble simple machines, learn the principle, perform the experiment and apply it to analyze the elastic properties of materials. Thus the self-efficacy of students is put to test successfully with our pedagogical process [6].

(iv) Individual and team-work: We have created five teams in each of the sections based on their interest. Some of the proactive students were encouraged to take part in poster making, covering the entire syllabus. The topics are focused on the basic concepts, scientists, physical phenomena, experimental or analytical procedures, engineering materials like dielectric substances and application of LASER and optical fiber technology, specific to their engineering discipline. The posters are to be judged by experts and awarded with prizes and certificates of participation for their team work. Richness of resources, participation of students and expanded interaction with peer group promotes ubiquitous learning [5]. We are hoping this small step taken by a minor group of students may lead to a giant leap of the whole of population, by the end of the program. The response of the students regarding team work is given as a pie chart. Higher level of thinking like creative writing, logical presentation, reasoning, and application of assimilated knowledge to restructure more complex

problems can pave way for achievement of PO. It would complement both individual and shared learning [8].

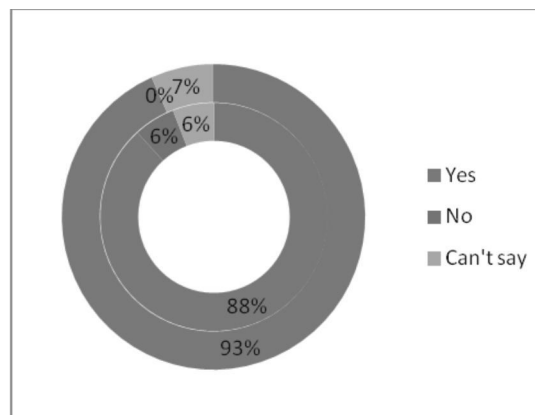


Fig. (5): Percentage of sample liking the team-work activity.

(v) Communication: The two-way communication between the Instructor and the learners had never been easier earlier. Through this learning platform, even the shy and introverts can come forward to participate through the forum. The maximum contributors to the discussion forum are some of the highest scorers of first test and quiz. A causative relationship between the test scores of the respondents, plotted on a scale of ten and the same sample of students who have made use of additional resources shows a low positive correlation and the correlation coefficient was calculated to be 0.14 from the bi-variate data.

Following tabulated values are calculated from the data collected through the opinion poll. The null hypothesis that, "the OBE awareness level of the population is less than 80 % level" has been tested for possible rejection, at a significance level of 5 %, using the t-test for single mean. Another hypothesis that more than 80 % of population uses our pedagogy for learning additional resources is also proven at a significance level of 5 %.

No	Statistical Parameter	D Sec	E Sec
1.	Mean . OBE Awareness	91.1	91.793
2.	Standard deviation – OBE Awareness	18.4	14.54
3.	Mean – Additional resources	90.667	93.5
4.	Standard deviation– Additional resources	21.99	16.24
5.	Level of significance	5%	5%
6.	Critical value	1.943	1.943
7.	Test statistic – OBE Awareness	2.55	2.47
8.	Test statistic- Additional resources	1.99	2.61

Fig (6): t-testing for single mean.

5. Scope

Firstly, the possibility of students spending more time with their classmates, performing group activities, creating long term social contact and relationship, spending less time in other unproductive distractions provides for the betterment. Secondly, integrating this technology into the educational system of the Institution, in the absence of a formal management system enhances the progressive experience. Thirdly, the interoperability of this particular platform with any new Learning Management System, if it is introduced in our Institution makes it a more suitable one for the students to get use to, in the very first semester. Finally, the statistics presented in this study may be far from satisfactory, but it is expected to get better in the coming semesters.

The disadvantages namely, a lot of clerical work which demands more of our time, reluctance on the part of some senior faculties to break away from conventional process of teaching and training, their inhibition to master simple steps of class management are some issues which we are yet to address. Engineering Physics being an Institutional core course, there is very limited scope for us to actually realize the other program outcomes, namely, design and development of solution(PO3), engineers and society(PO6), environment and sustainability (PO7), ethics(PO8), Project management and finance(PO11) and lifelong learning(PO12).

6. Conclusion

Teaching the under graduate engineers using a technical tool, synchronous with class room teaching has been advantageous, as our data analysis has shown, in four ways, namely, Remediation, Co-participatory activities , self-paced learning and scientific inquiry. Computer skill levels need to be upgraded to make the discussion forum, a happening place, after class hours. Self-paced learning is yet to become a trend among undergraduate students. The interest shown by students in participatory activities should be sustained throughout the term. There are

many emerging opportunities for research in digital learning to improve the learning experience and optimize learning outcomes as well as guarantee high quality learning design and instruction [9]. At the institutional level, and at the core-branch level, the students can be motivated to take responsibility for their learning which has not yet attained a satisfactory mark.

Acknowledgment

The authors thank Dr. Kanmani.B, Professor and Head of the department of Telecommunication, BMSCE, Bangalore and Dr.K.Mallikharjuna Babu, Principal, BMSCE, Bangalore for their encouragement.

References

- [1] <https://piazza.com/class/id8ds5p38gt6sp>
- [2] <https://piazza.com/class/ie82xyinlwg3cg>
- [3] R.B.Wang, C.T.Du, (Dec 2014), Mobile social network sites as innovative pedagogical tools, Journal of computers in education, Vol. 1, Issue 4, 352-370.
- [4] Kanmani.B, K.Mallikharjuna Babu, (2014) Defining Course outcomes, WOSA, Vol. 30, 1-19.
- [5] Jennifer L Maeng et al, (Dec 2013) , Using Technology to support Inquiry Instruction, Journal of Science education and Technology, Vol. 22, 838-85,.
- [6] Yao Xiong et al, (Sept 2015), Assessing learners perceived readiness for CSCL, a study on initial development and validation, Journal of computing in higher Education, 1-25
- [7] Jacob Enfield, (Nov 2014) , Looking at the impact of flipped class room model of instruction on Under Graduate multimedia students at CSUN, Tech trends, vol 57, issue 6, 14-27.
- [8] Mary Webb, (June 2014), Pedagogy with ICT in transition, Education and Information Technology, Vol.19, Issue 2, 275-294.
- [9] Dirk Ifenthaler et al, (July 2014), Challenges for education in a connected world: Digital Learning Technology, Knowledge and learning, Vol. 19, Issue 1, 121-126.