Adapting to Learning by Doing (LBD): Challenges faced in implementing the Student Enhancement Program (STEP)

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***Abstract* — Engineering colleges in India have been increasing tremendously in the last 10 years. However, most of these engineering colleges are inadequately equipped with suitable infrastructure and qualified faculty members leading to lack of quality in undergraduate education resulting in unemployable graduates. These graduates lack problem solving skills, soft skills, and are unable to map their academic knowledge to real world problems. To enhance the quality of education in engineering colleges, an innovative Certificate in Information Technology (CIT) program using learning by doing methodology was started. We have worked with over 50 engineering colleges in Andhra Pradesh, India, to train their faculty members and implement student training referred to as STudent Enhancement Program (STEP) at the colleges. This paper focuses primarily on the main challenges that we have faced during STEP implementation. We highlight solutions that we have implemented for overcoming these challenges and discuss how we can scale them further.**

***Keywords*- personalization; learning by doing; mentoring; training**

I. ABBREVIATIONS

CIT	Certificate in Information Technology
IIIT-H	International Institute of Information Technology, Hyderabad
LBD	Learning by Doing
MCIT	Ministry of Communications and Information Technology
STEP	Student Enhancement Program
TTP	Teacher Training Program

II. INTRODUCTION

To make the engineering graduates more employable, the Certificate in Information Technology (CIT) program was initiated by EnhanceEdu and supported by a joint initiative of the Ministry of Communications and Information Technology (MCIT), Government of India and IIIT-Hyderabad (IIIT-H). The objective of this program is to enhance the quality of IT education in engineering colleges so that the shortage of quality manpower in the IT industry can be addressed. The goal of this program is to train 12,000 engineering students per year.

As reaching this goal entailed major work, we enlisted the help of the college management and faculty members to train their students so that the program is successful at their colleges. Thus we consider EnhanceEdu, college management and faculty members as major contributors to this program (refer figure 1).

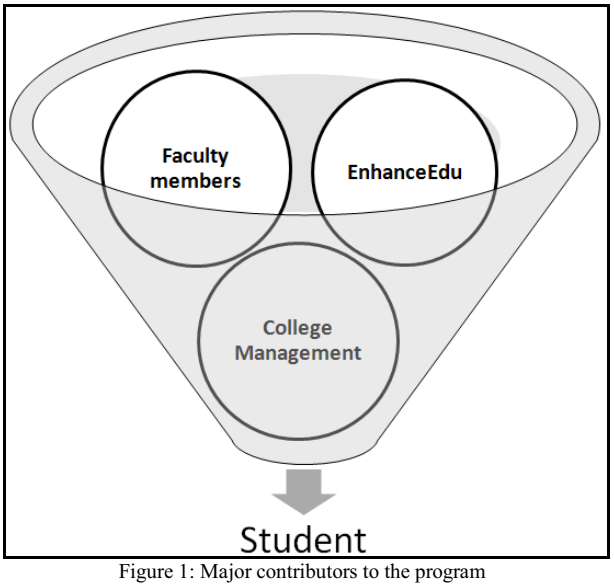

Figure 1: Major contributors to the program

We have outlined the key roles of the contributors as provided below:

EnhanceEdu

- Prepare digital content for the program
- Train faculty members on content
- Support STEP implementation at colleges

College management

- Nominate faculty for the TTP
- Allot appropriate workload for faculty members
- Provide required lab infrastructure for STEP

Faculty members

978-0-7695-4759-6/12 $26.00 © 2012 IEEE
DOI 10.1109/T4E.2012.20

- Undergo the TTP
- Mentor students and provide timely feedback
- Report on STEP progress to EnhanceEdu and college management

A three phase process was adopted in delivering the CIT program [1].

- Content development
- Teacher Training
- Implementation

A. Content Development

During the first phase, the EnhanceEdu team at IIIT-H designed curriculum and developed digital content. The content covered technical areas as well as broader educational courses. The technical content covered the following three courses:

- Computational Thinking
- Object Oriented Programming using Java
- Data Structures

The broader educational courses included "Human Values", "Art of Teaching", "Soft Skills" and "Assessment and Rubric Design".

The topics included

- differentiating instruction based on students' learning styles
- strategies to engage student attention
- emotional intelligence
- presentation skills
- rubric design, etc.,

The course content was developed by a domain expert in conjunction with a "Learning by Doing" (LBD) methodology expert supported by an animation team. The domain expert and the LBD expert designed the curriculum, broke it down into modules, mapped it to the learning objectives and designed individual tasks and assessments keeping proper instructional design practices in mind.

B. Teacher Training

Teachers are trained using the above digital content and they get hands on experience in "Learning by Doing" methodology during second phase. They are also guided on how to mentor students in their colleges besides undergoing technical training.

Starting December 2008, EnhanceEdu trained 335 faculty members from 54 engineering colleges in six (6) batches on the CIT content in a residential training program spanning two months at IIIT-H.

Personalized mentoring was provided to the faculty members by EnhanceEdu during the training to enable them to relate to a topic better and gain conceptual insights, enabling long term engagement [2]. The TTP was conducted in a format that could be mirrored with the student training program at their colleges. Thus, the faculty members worked on the CIT content in the LBD methodology, took assessments and were given feedback by the mentors. Training in core technical subjects augmented with broader educational courses gave faculty members a holistic training experience. The CIT initiative has now successfully completed three years of training engineering college faculty members. The effectiveness of our methodology in these teacher training programs has been well established [3].

C. Implementation

In the third phase, the trained faculty members train students in their colleges. Each faculty member at any given point is expected to mentor 10 students. This structure offers the possibility for each student to attain mastery.

Once their training was completed at EnhanceEdu, the faculty members went back to their colleges and were ready to act as mentors. They trained the students using the same technical content and methodology that they were trained on in the Teacher Training program.

The CIT program implemented for students at their respective colleges with the help of trained faculty has been termed as STudent Enhancement Program (STEP). We focus on STEP in the next few sections.

III. STUDENT ENHANCEMENT PROGRAM

The STEP implementation involves the following:

1. An orientation program on STEP is conducted for students at the engineering college
2. Students interested in the STEP would then take a screening test after this orientation
3. Students who clear the screening test are eligible to take part in STEP
4. Once enrolled, the student typically spends 10 hours a week in their college on the course in addition to their academic curriculum
5. The trained faculty member acts as a mentor to a group of 10 students and keeps track of their progress and provides for personalization of their learning experience

EnhanceEdu coordinators support and monitor the STEP implementation through use of tools and regular interaction through college visits and Skype calls. (Refer figure 2)

The objective of STEP is to make students better prepared for the industry. In STEP, students are expected to work on tasks/projects that mimic the real world. Students come up with multiple methods of solving these tasks/projects, discuss with their respective mentor and decide on efficient way of solving them. Through this process, students improve their problem solving skills, communication skills and learn new subjects on their own and apply their knowledge to real world problems (refer table 1).

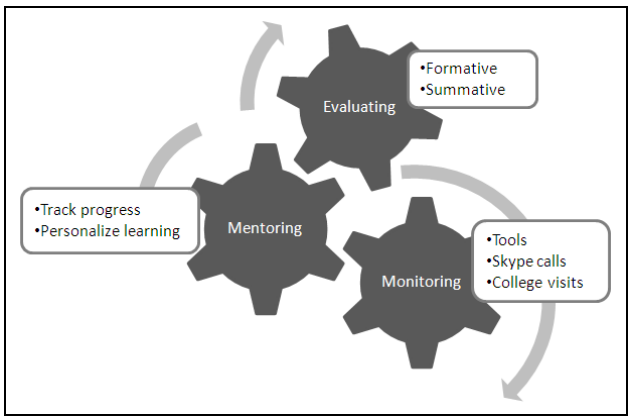

Figure 2: STEP process

We have additionally come up with a set of guidelines for monitoring STEP implementation and measuring its success. These set of guidelines are referred to as the "Start Green Stay Green" (SGSG) and are the following:

- Signing of Memorandum of Understanding (MoU) with IIIT-H
- Identification of EnhanceEdu coordinator for the college
- Availability of Lab Infrastructure to conduct STEP at the college
- Minimum 5 mentors already trained as part of TTP program
- Balanced workload allocation to the trained mentors at colleges (10-15 hours for STEP)
- STEP implementation calendar provided
- Student registration for STEP done

When a college meets the "SGSG", it Starts Green. At any point of time, if the college ceases to satisfy SGSG criteria the college goes from Green to Yellow, and if the issue is not addressed, to Red. If a college is in Green, we consider STEP implementation as being successful and not successful otherwise.

The STEP program was initiated at eighteen (18) colleges starting September 2009. However, we determined that STEP could not be implemented successfully across all engineering colleges that participated in the program. Though all the colleges started Green, eight (8) of them could successfully stay Green and implement STEP successfully. The others slowly moved into Yellow and then Red and could not implement STEP successfully.

In the next section we identify the issues we consider as challenges for successful implementation of STEP. We have considered 5 colleges where STEP was not successful and conducted our study at these colleges.

IV. OBSERVATIONS

In a STEP student survey which was given to 128 students from the 5 colleges under study, we observed that STEP implementation was hindered primarily because of mentor unavailability due to the college workload, students requiring additional explanation in the content and students being unable to adapt to LBD methodology.

A. Mentor unavailability due to college workload

A mentor's role during STEP implementation is to:

- provide appropriate clues and hints to solve a problem
- give constructive feedback to students and indicate their areas of improvement periodically (i.e. timely feedback)
- give feedback on the conduct of STEP course content and contribute to improving the quality of STEP
- ensure classes are held as per the STEP calendar

STEP guidelines suggest that a mentor dedicate a full 10 hours for STEP. Since STEP is offered to students outside of their academic curriculum, mentors needed to commit an additional 10 hours to the program. Because of their workload as regular faculty members, mentors were unable to allocate the full 10 hours to the program.

The importance of providing/receiving timely feedback has been emphasized in the past [4]. Waddick demonstrated that providing constant, immediate feedback on students' progress helped them improve more than classroom instruction did [5]. This was not consistently carried out in the colleges because of the mentor's college workload.

While some students were capable of tackling tasks with minimal help, other students required a high level of support and required constant monitoring as well as assistance from their mentor. If a mentor was not available to offer assistance at the required time, the student's difficulties were not addressed in a timely manner. We observed that these students did not complete the tasks expected of them as they had doubts that needed clearing.

In addition, each student expected feedback on his/her progress in a timely fashion. There were sections which a student needed to re-visit to understand concepts presented and to practise tasks. However, often, by the time feedback was provided, the student had progressed to a different section and found it difficult to transition back to a previous section. Thus, mentors who were unavailable due to their college workload were unable to provide timely feedback to the students and guide students to complete tasks on their own which affected the implementation of STEP in the colleges.

We understood (from anecdotal feedback) that students faced this difficulty in the formative stages of their course and found it difficult to attempt their summative assessment. Some students even became apprehensive of taking the summative assessment for fear of failure and thus lost motivation in doing the course.

B. Students requiring additional explanation in the content

The STEP content which was given to the students evolved from six (6) TTPs and was well received by the faculty. Though students from the colleges where STEP implementation was successful found the content to be complete, the same was not true for students of colleges under study where STEP implementation was not successful. These students felt that they needed more examples and videos (refer figure 3) to help them understand advanced topics like recursion and function calls better.

In addition, 30% of the students from the colleges under study felt that there was a gap between tasks and content as indicated in Figure 4. Tasks were also found very difficult by 12% of the students. These survey results, therefore, highlighted that concepts in the content needed to be further elaborated and customized for students based on their level of understanding into basic, intermediate and advanced.

C. Adaptability to LBD methodology

Students were traditionally used to a lecture based approach and found it difficult to adapt to the LBD methodology. LBD methodology emphasizes a learner centric approach, where the learner's comprehension levels and technical ability are crucial. In our survey, 84% of the students felt that LBD methodology was beneficial (refer Table 1), however they were not able to completely adapt to it and preferred a blended learning approach.

A further study was conducted on student preferences for blended learning composition. The survey consisted of the following options:

A. 100% Learning by Doing (LBD)
B. 75% LBD & 25% lecture based
C. 50% LBD & 50% lecture based
D. 100% lecture based.

The survey results showed that only 3% of the students preferred a purely lecture based approach and the rest preferred LBD blended with a small component of lecture based instruction (refer figure 5).

Our survey results showed that ~60% of the students felt that they had difficulty in accomplishing the tasks without mentor help and ~50% of the students felt that they could not read and understand concepts on their own. As Pituch indicates, the use of an e-learning system is affected by a user's "computer self efficacy" [6]. Since students lacked the ability, they found it difficult to adapt to LBD methodology.

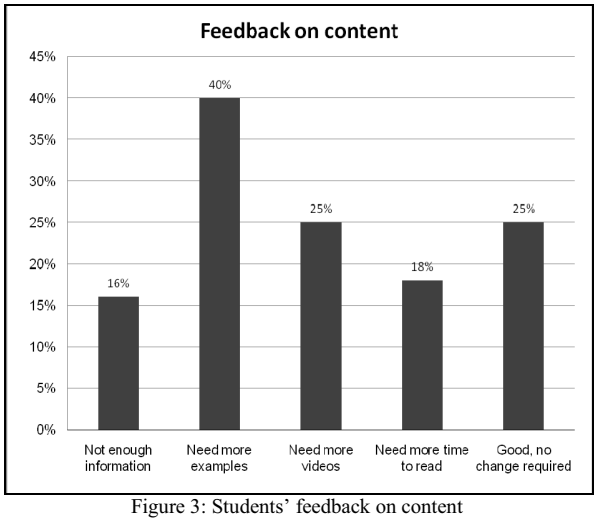

Figure 3: Students' feedback on content

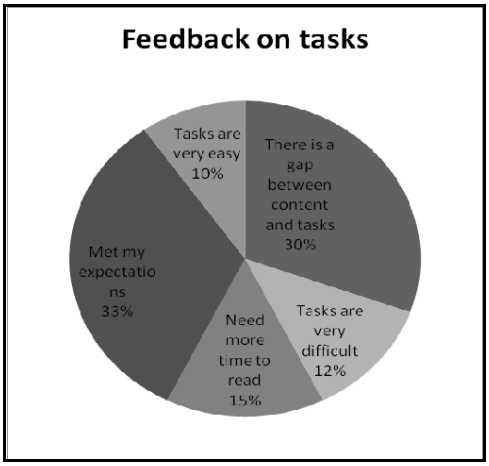

Figure 4: Students' feedback on the tasks

Rank	Benefits of LBD
1	I developed skills to learn new subjects on my own
2	I see improvement in my problem solving skills
3	I developed confidence to learn new subjects on my own
4	I have become confident in using a computer to do my work
5	I am able to map academic knowledge into real world problems
6	I have improved my academic performance
7	I have seen an improvement in my understanding of English
8	I see improvement in my communication skills

Table 1: Students' ratings of benefits of LBD

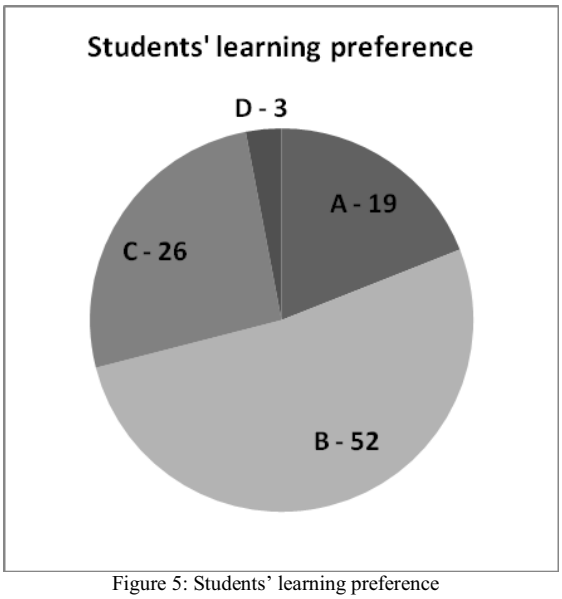

Figure 5: Students' learning preference

V. SOLUTIONS

We focused on the following aspects to overcome the challenges discussed in the previous section. However, these solutions may be adequate to address the challenges discussed, but are not exhaustive.

- Blended Learning
- Availability of collaborative support and timely assistance
- Enhancement of course content
- Improved mentoring
- Management support

The above solutions have been tried on a small group of students and faculty members and have proven to be successful.

Blended Learning

Our survey results show that students faced difficulty in understanding the course content and accomplishing the tasks on their own. 52% of the surveyed students preferred LBD supported by classroom lectures. The findings of this survey suggest that though the students have accepted STEP through LBD well, blending it with a few lectures will help them in adapting to the new course and the new teaching methodology.

We applied the blended learning approach to a pilot group of 11 students undergoing the Computational Thinking course. We found that their performance increased and they passed the re-assessment. We also found that in cases where we have had successful implementation of STEP, we had observed that the teachers sometimes supplemented the content with lectures and hence successful. We need to extend blended learning to a larger audience and measure how students adapt to it.

Availability of collaborative support and timely assistance

We have customized MOODLE [7], a learning management system, to be a platform for providing timely feedback for the students' tasks and for answering their queries. Students submit their tasks through the MOODLE portal and EnhanceEdu Coordinators assess and give timely feedback, in case mentors are unable to do so. Moreover, students can seek answers through discussion forums and on-line chat. Since MOODLE links all 18 colleges, students from various colleges participate in online discussion forums and they can benefit from collaborative learning. In this manner, students are able to receive timely feedback and help even if their own mentors are not available. We have also discussed with college management to ensure that workload on their teachers be balanced per the SGSG model. Additionally, MOODLE supports features which help to periodically measure and communicate the students' progress throughout the course. We have observed improved student interaction and increased motivation levels through the use of this portal.

Enhancement of course content

We have enhanced our content by providing more videos and examples after we received feedback from students. Also, we have created a pre-assessment module that integrates the concepts from all sections and requires higher order thinking skills. The idea is that students learn from each other and are able to solve demanding questions before they appear for an assessment. This module is not time bound and can be solved through group work. This module is designed to bridge the gap between content and tasks as well as tasks and assessments.

Improved mentoring

In the LBD methodology, effective mentoring is very crucial. We have conducted two workshops on "Art of Teaching" for 42 of our trained faculty members to improve their mentoring skills. The workshop was well received by the faculty members and the preliminary results indicate that the motivational levels of the faculty had improved. We believe that conducting such workshops for all our faculty members will help in motivating the faculty and in effectively mentoring the students, thus leading to a successful STEP implementation.

Management support

Our study on colleges where STEP was successfully implemented indicated that college management was fully involved in identifying appropriate faculty for TTP, assigning appropriate workload to mentors and improving quality of mentoring by regular monitoring of STEP sessions and students' progress. Based on these observations, we propose that college management be aware of STEP challenges, ensure balanced workload for mentors and regularly monitor STEP progress at their respective colleges.

VI. FUTURE WORK

We have tried the above solutions on a limited set (5) of colleges with initial success. We intend to apply the solutions to a larger number of colleges and

- measure the impact of blended learning
- emphasize the importance of monitoring mentors and conduct an impact study on how personalized mentoring leads to improved student learning
- measure the effect of enhanced course content on student learning
- focus on continuous improvement of course content, teacher training techniques and other remote mentoring methods

We propose to collect and maintain a repository of information so that learning analytics can be performed on student data [8].

In addition, we plan to collect data related to

- learning behaviour (e.g., number of times a student accessed content, amount of time spent on the sections/tasks/resources) to identify strengths and weaknesses of a student
- engagement in the STEP program (through task/assessment submissions, activity in the discussion forums)
- refine existing screening mechanism in order to classify students into groups based on their background and interests and map them to the appropriate mentor and measure student interaction with mentors

We expect that such data collected and analysed combined with metrics we are working with will lead to a better understanding of student engagement and identification of success factors thus leading to an effective STEP implementation in colleges.

VII. CONCLUSION

In this paper, we identified key challenges and possible solutions for successful STEP implementation. The improved mentoring combined with enhanced course content offered in a blended learning approach will enrich the student learning experience and lead to better quality in engineering education. As these solutions were initially successful for a limited set of colleges, we propose to scale these solutions and apply them to all 50 partner colleges along with the use of tools like Moodle, AVIEW [9], Skype and other collaborative means.

Further, the data collected as part of learning analytics will give us additional information on areas that need improvement and help us predict upcoming challenges both for colleges and for students [10]. In addition, this will help us further validate our approaches and also identify new methods and processes for an efficient and effective STEP program delivery.

ACKNOWLEDGMENT

The authors thank MCIT for the guidance and support provided in carrying out STEP. The authors thank the management of the participating engineering colleges and the faculty members for their support in implementing STEP at their college.

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