A Result Oriented Perspective towards Enhancing Student Learning Outcomes in Indian Private Engineering Colleges

Sarath Chandar Rao Sanku and Ranjit Abraham

***Abstract*—India has made tremendous strides in the past twenty five years in various segments of economic progress and much of this growth has been spurred along by developments and investments in Engineering and Industrial areas. The tremendous focus on education in technical and engineering areas has led to a mushrooming in engineering colleges. Presently, there are more than three thousand engineering colleges and several hundred more are planned for in the years to follow. Despite this surge, the industry often laments the lack of trained and sufficiently qualified engineers and is concerned about the quality of graduating engineers. In this paper, we analyze the ailments that affect the state of engineering education in the private sector. The key factors are categorized along the seven dimensions namely, Methods, Skills, Manpower, Tools-curricula, Environment, Policies and Layouts. We identify the strategic issues and the operational ones as well and we select those that can be specifically addressed at the college level. We propose a few solutions which are both practical and implementable within the constraints of administration. Some of these solutions are simple like a semester plan for studying with continuous assessment, presentation of lesson plans and guidelines, aligning the student learning outcomes with an effective pedagogic methodology and lastly but not the least, a method to improve proficiency in English. These methods have been implemented in the freshman class of a college and the results have shown significant improvements in student learning outcomes and in increased motivation as well. In our conclusion, we suggest some further avenues for research and thus bring about verifiable changes as an added benefit.**

***Index Terms*—Ishikawa Diagrams, constructive alignment, semester plan, communication.**

I. Introduction

India achieved independence in 1947, and soon after, sanctioned the intake of 2,500 students for engineering education across the nation [1]. Sixty years later, India has witnessed intakes of more than 800,000 students from various engineering Institutes under the supervision of more than 500 Universities. The global demand for engineers and the opening up of several multinational companies within India have played a significant role in creating the high demand for graduate engineers [2]. Figure 1 shows the Institute wise distribution of sanctioned intake of engineering graduates [1] for 2006 in India. Private engineering colleges have a sanctioned intake of about 400,000 (76%) while the government institutes account for about 100,000 sanctioned intake (21%). The share of Tier 1 Institutions (7 Indian Institutes of Technologies and the Indian Institute of Sciences) is just about 1% and that of the National Institutes of Technology is at 2%. There are roughly about 1100 private engineering colleges and about 320 government engineering colleges. The top-tier engineering colleges are the Indian Institutes of Technology (IIT) at Bombay, Delhi, Kanpur, Kharagpur, Madras, Guwahati, and Roorkee, which were established as "Institutions of National Importance" by the Institutes of Technology Act of 1961. They are controlled by the central government and are "globally competitive and contribute significantly to development of technical manpower and technology development in the country". Since these engineering Institutes are not subject to the same market forces as privately funded colleges and are also not profit-seeking, it is not surprising that the decrease in quality does not apply to them.

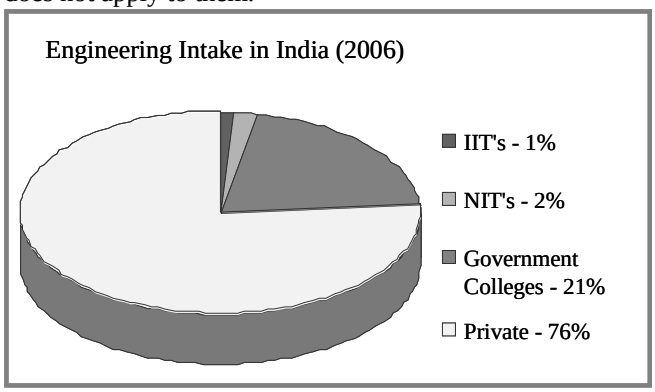

Fig.1. Engineering student intake in institutes –India: 2006.

A 2005 McKinsey Global Institute survey of corporate human resource managers revealed that while eighty percent of US engineer graduates were globally employable, just about twenty five percent of the Indian engineers were similarly employable [3]! Several reasons have been quoted in literature for the poor quality of engineering graduates and some of them include for instance, the Indian engineering education market, particularly the private institutions which are driven largely by economic considerations and administered solely for profit in spite of legal prohibitions. The present situation then makes it extremely important to review the state of engineering education in India and to determine means to improve the process.

In this paper, we have analysed the key factors ailing the private engineering institutions in India. These key factors that require attention have been duly categorised and are as follows: methods for improving the quality of education, policies of Government and University, skills to be corrected and implemented, tools and curricula, environment for

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quality education, efficient manpower and finally a properly conducive location and interior layout. Addressing these key factors would help the private engineering institutions to be suitably changed for the better with the necessary reforms in place.

We have also categorized the important key factors affecting private engineering colleges on an operational and strategic perspective, and then highlight the measures required to improve the institution. Importantly, most of the strategic issues lie under the purview of the Government and overseeing University but some of the Operational issues can certainly be managed at the Institute level. We thus address the issues that come under the purview of the Institute and attempt to split them into action stages. The solutions put forward are in sequence: the Semester plan for study and continuous assessment, Presentations for class lectures, Course aligned with outcome methodology and improving the student's English proficiency and all these have been successfully implemented in an engineering institution and the students have shown significant performance improvements in learning outcomes.

II. The Malaise Affecting Indian Private Engineering Education

Before we attempt to analyze what ails Indian private engineering education it would be appropriate to take into perspective a student joining an engineering undergraduate program in India. The Undergraduate engineering courses in most of the Indian states are of four years' duration, coming after 12 years (10+2) of higher secondary education. The eligibility criteria require that the candidate must have passed his/her Higher Secondary School Certificate examination with at least 50% marks in aggregate in the following subjects: Physics, Chemistry and Mathematics with 50% marks in mathematics exclusively. Since undergraduate professional engineering courses are in high demand, admissions are strictly on a merit basis (usually based on an entrance exam run by the State Government). Candidates are admitted according to the merit list prepared with exceptions for a few percent that can enter through the Non Resident Indian (NRI) quota. The majority of the Institutions have a somewhat common syllabus for the first year engineering courses that has been formulated by the University with the approval of the All India Council for Technical Education (AICTE).

We have further analyzed the state of education in Indian private engineering colleges and made an attempt to further categorize each of the reasons responsible for the poor quality of education. For the purposes of logical clarity in depiction, the Ishikawa Diagrams were used as shown in Figure 2 and we portray the issues identified along the seven key factors affecting the same namely: Methods, Skills, Manpower, Tools-Curricula, Environment, Policies and Layouts. In view of the scope of this paper, our analysis is restricted to the most important issues.

Owing to the lack of adequate resources (financial and human) and the administrative efforts involved, it is a huge challenge to address all the issues identified in Figure 2. However, it is possible to delineate the matrix along Strategic or Operational issues as depicted in Figure 3. The strategic issues are either under the purview of the overseeing University or are purely external criteria which cannot be immediately influenced for change. From operational perspective, at the college level, we are presented with a set of challenges.

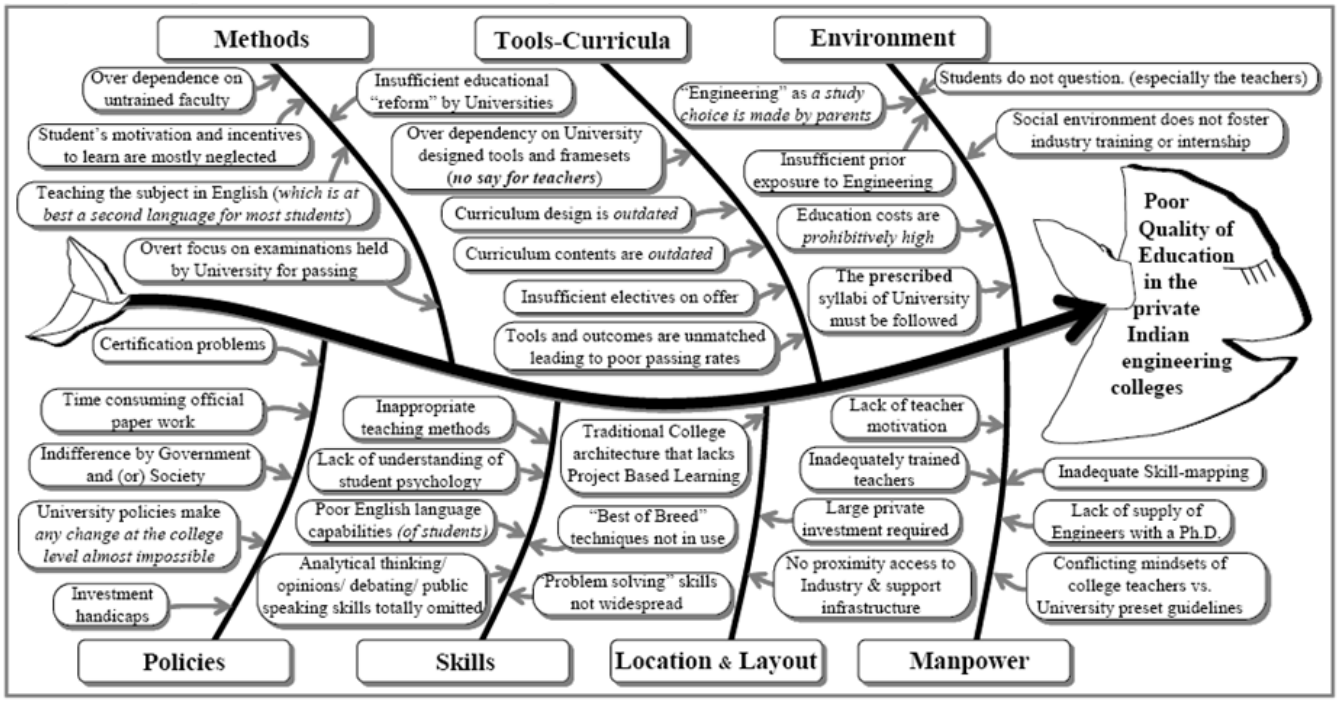

Fig. 2. The malaise affecting Indian private engineering education poor quality.

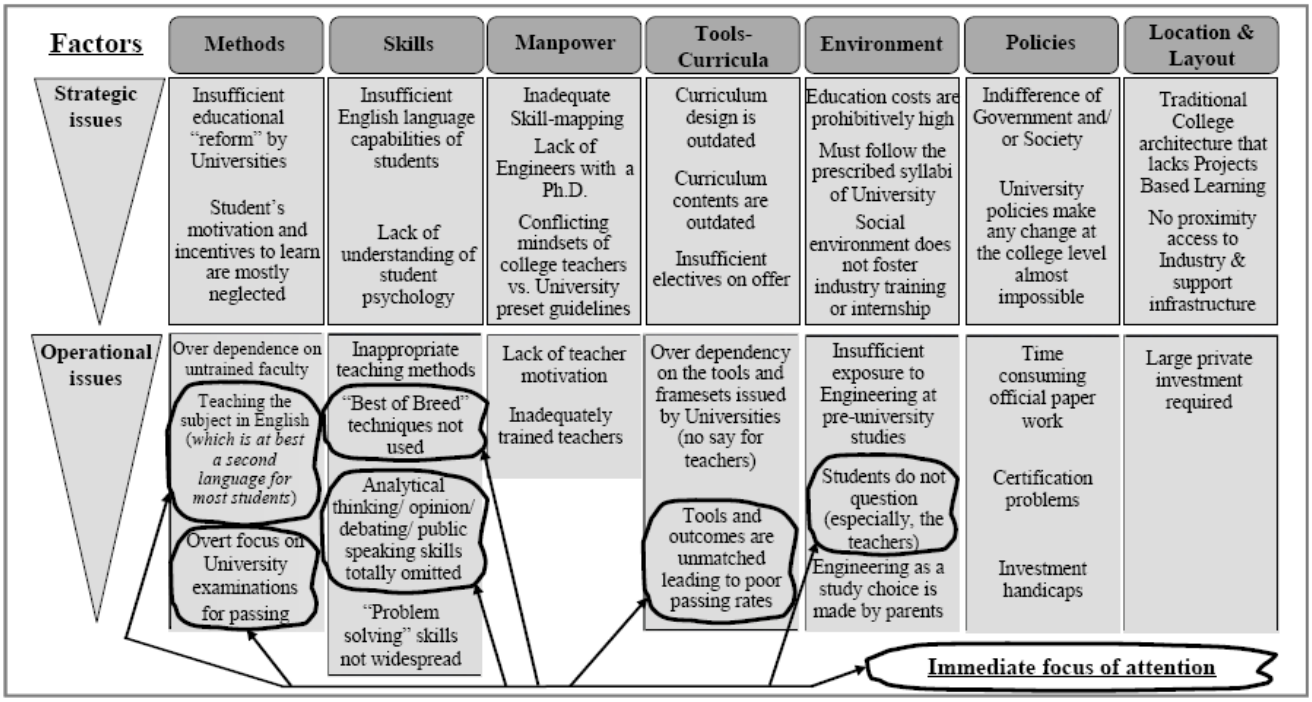

Fig. 3. Viewing issues from a strategic and operational perspective.

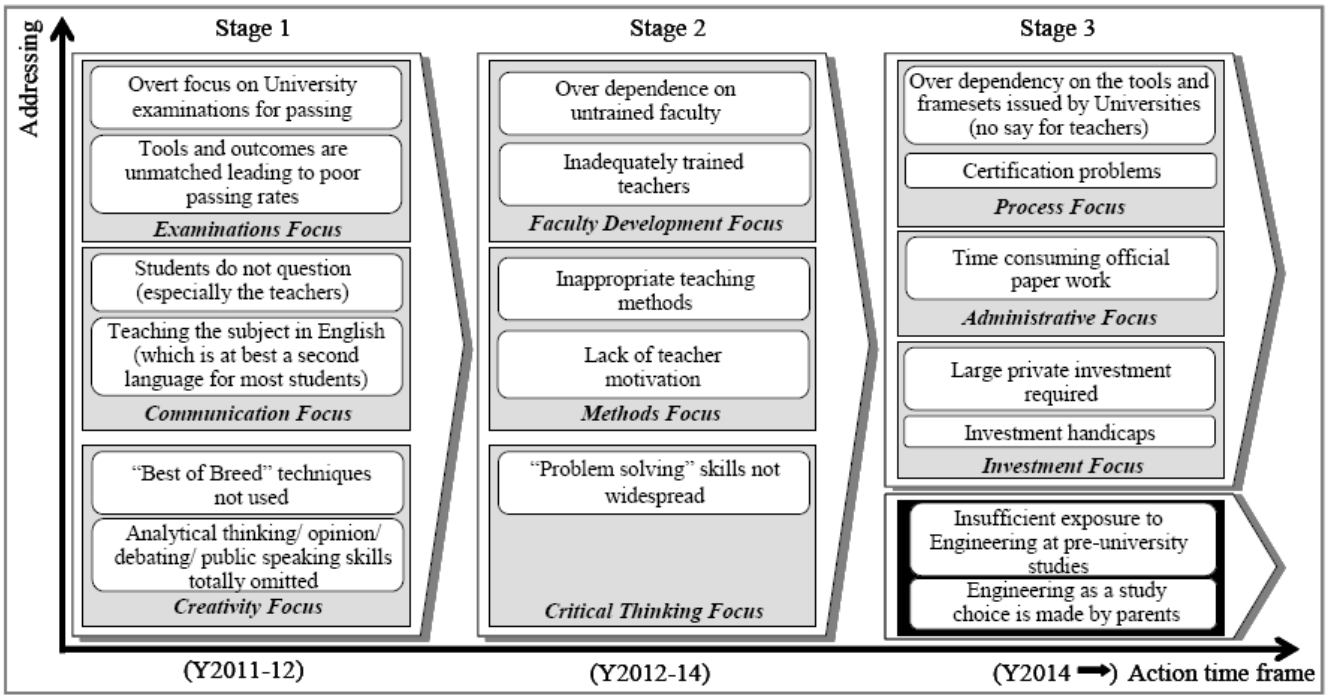

Fig. 4. Prioritization of issues to be addressed.

Figure 4 lists the issues after duly being prioritized and split into stages based upon the immediate needs of the students and the college requirements. (The black box outline in the bottom half of Stage 3, are those that are strictly Attitude driven)

The task is then simplified to carrying out the following:

- Improve upon the student focus on University held examinations
- Improve the student's ability to understand the course subject matter in English and to write effectively.
- Use some of the modern theories in student-teacher engagements ("Best of Breed" techniques).
- Enabling tools/ methods such that teaching methods and student's learning outcomes are well matched.

Improve upon the student's ability to question, understand and respond to peers or teachers and keep the student well motivated to learn.

III. Towards Re-Genesis

By conducting regular workshops and holding effective class study sessions during the first-year of engineering education, we increase student motivation, while also helping in further clarifying the relationship between the theoretical and the practical aspects of engineering, thereby leading to

better success in future careers for the students. We digress here to state that the teaching modes and instructions for about eighty percent of the undergraduate programs in engineering colleges are controlled by the Universities (The Universities have the power to grant affiliation to such colleges). The Universities prescribe the courses, set the standards for the colleges, conducts the final examinations and awards the degrees. This obviously restricts the flexibility of the teachers in the use of teaching methods and content as well [4]. To overcome this, the first and foremost requirement is that the students remain constantly motivated and the teaching process is based upon John Biggs constructive alignment. Accordingly, the teacher's intention, student's activity and exam assessment outcomes have to be aligned with each other [5]. An aligned course then matches the teacher's intention with the "examination's assessment" while the student's interaction and activities help the student in dealing with the assessment exams. The teachers need to adopt the process of formulating intended learning outcomes to the existing University course syllabi based on the principles of Constructive Alignment [6].

Given the unique nature of the Indian school education environment, most students enrol in the private Engineering Colleges as dependent learners and accordingly, rely upon their instructors to present, organize, and interpret knowledge. According to Perry's model [7], dependent learners have a dualistic world where every point of view is either right or wrong, all knowledge is known and obtainable from teachers and texts, and the students' tasks are to absorb what they are told and then demonstrate having done so by repeating it back. It then becomes the responsibility of the teachers to transition the students from the dependent stance to being independent learners; and make them realize that all knowledge is not necessarily known and that different points of view may come in shades of gray; and, that the student is tasked with acquiring knowledge from a vast variety of sources while subjecting the same to their own critical evaluation. The teacher also introduces the peer group as a powerful learning resource and thus, the students working with their peer group identify the relevant resources and distil the info, learn the ability to discern and thereby identify the cause or effect. The teacher will furthermore, formulate the learning objectives and criteria, then assess the extent to which the students can believe what they read, and learn from lecture classes and communicate this newly-acquired information to others (peers). Such teamwork should enable the students to confront the technological and social challenges facing engineers and will help them acquire the communication skills that cross disciplines, cultures, and languages [8]. Revisiting the fundamentals of a course should be given appropriate importance for all the courses that are taught especially since, many of the course contents could be new material and necessitates that the teacher help students to relate them to what the student already knows from their own experiences or from prior courses taught at the school. Students who understand the fundamentals tend to score better in class tests and exams. Further, effective learning needs motivation and learning needs repetition. Motivation meaning that learning needs attention and requires feelings while repetition is required since a pattern, an event, a procedure, a rule or a strategy that is repeated several times becomes something worth learning**.** [9].

Although students may attend every class and complete given homework and assignments, it is their preparation for the tests that determines the breadth and depth of their learning. Tests can indeed motivate the students to learn at a deep level, but also may lead the same student towards demoralization and hostility (both of which correlate with poor performance) if not carried out in an appropriate manner. These tests should motivate and help students to learn what the teacher wants them to learn and to enable the teacher to assess the extent to which they have succeeded in doing so. The best way to do it is to have short duration class tests once every two-three weeks for the portion of the course covered just before the test and after the previous class test. Interactive classes are held for those students who have either failed or absented themselves and these are conducted immediately after the results of the class test are announced. This also provides the opportunity for both the students and teachers to evaluate the effectiveness of the teaching done, the difficulties faced by the student and the like.

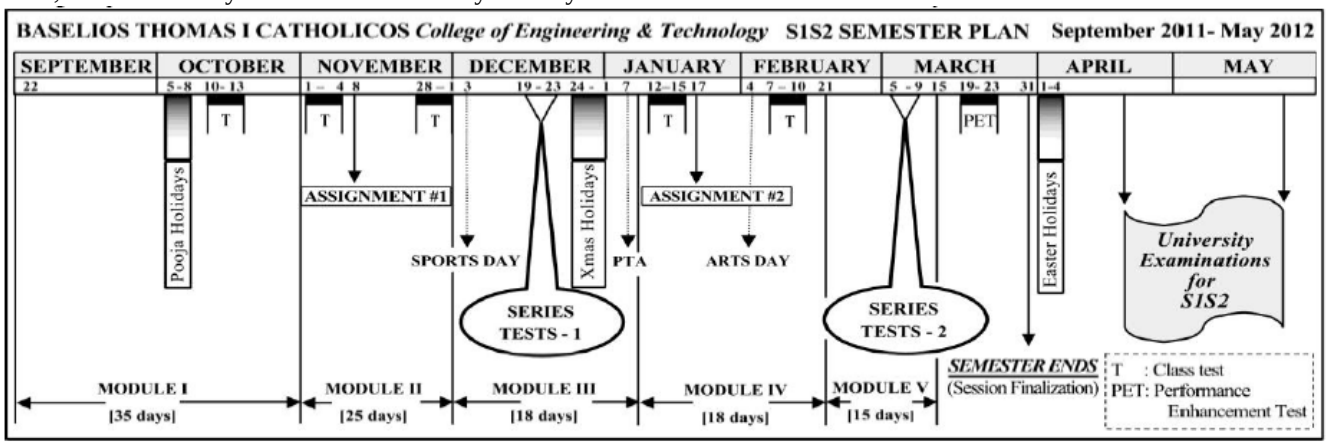

Fig. 5. Semester plan.

Despite the legacy of English (post British occupation) in India, many of the students enrolled in engineering and technology courses in India do not necessarily have English speaking backgrounds. The first year engineering undergraduate curriculum for various engineering courses includes the subject of Professional Communication in English and the All India Council for Technical Education (AICTE) has designed and published the model curriculum for the first-year undergraduate program in engineering [10].

Experience has revealed that the English communication course must be structured more methodically and in an objective manner. We however do submit that in view of time availability constraints for the freshman students, emphasis on written English (where English is the medium of instruction) be paramount.

IV. The Approach

We have taken the following four steps as listed below to resolve the key issues identified in Stage 1 in Figure 4.

A. The Semester Plan for Study and Continuous Assessment

A visual effective Semester Plan for both the students and teachers helps both to focus upon the timing of events during the semester and to prepare themselves for the tasks. Figure 5 is a sample Semester Plan especially designed for the BTC college of Engineering & Technology. The five modules correspond to the division of each course. The students who fail/ fare poorly in the "two-three" weeks spaced class tests are tasked with attending the interactive class sessions where each student is asked to come in front of the class and answer questions posed by the teacher. The student response helps the teacher to align the lecture classes to the student's activity and the examination's assessment at large. This is an essential element for constructive alignment. As Shuell [11] put it: "If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving those outcomes. It is helpful to remember that what the student does is actually more important in determining what is learned than what the teacher does."

B. PowerPoint Presentation for Each Class Lecture

DEPARTMENT OF MATHEMATICS Module 1, Session 1 - Plan

Duration (Min)	Content	Methodology	Faculty Approach	Student's Activity	Learning Outcome
5	Introduction	Presentation	Introduce Facilitate	Participates	Remember Intra-personal
7	Matrices	Demonstration Presentation	Facilitates Monitors Guides	Discusses Participates	Understand Intrapersonal
15	Different types of matrices	Presentation Demonstration	Explains	Classifies	Remembering Intrapersonal
18	Different operations on matrices	Presentation Problem solving	Explains Facilitates Monitors	Participates Demonstrates	Understanding Applying Interpersonal
5	Conclusion	Question & Answers	Facilitates Questions	Answers	Remembering Understanding Intrapersonal Linguistic

Module 1, Session 1 – Objective:

At the end of this Session, the student will be able to:

- Define a matrix.
- Explain the different types of matrices with examples.
- Explain the different operations of matrices.

Teaching Learning Material

- Blackboard
- Presentation slides

Fig. 6. The Power point plan with framework and objectives.

A well designed framework via PowerPoint presentation (A sample plan is shown in Figure 6) is used during each lecture class and this details the intent of the class, the key points/ words /formulae being used or demonstrated during the class, the lecture class summary and conclusion with examination questions at the end. This also serves as a lesson plan for the period and includes the following information (Opener, Objective(s), Prerequisite learning, Content (or instruction), Learner Guidance, Practice lessons, Feedback and lastly Closure). The head of the Institution such as the Principal / Head of the Department, as a senior mentor reviews these presentations and content. The effectiveness of each presentation is evaluated and corrected periodically based upon the learning outcomes – especially from the interactive classes for those who have failed/ fared poorly in the class tests. Hence, a continuous quality improvement measure is always in place. It is important to emphasize that the periodic revision is an essential element which ensures that contents are relevant, modern and in tune with requirements.

C. Course Aligned with Outcomes

In accordance with John Biggs' Constructive alignment theory [6], all of the teacher activities, student's learning approaches and the educational outcomes being interactively related, the courses are thus aligned as depicted in Figure 7. Teachers also emphasize interactions with the student's peers to learn faster and more importantly outside the classroom. The students will learn what they think they will be assessed on, not what is in the curriculum, or even on what has been "covered" in class.

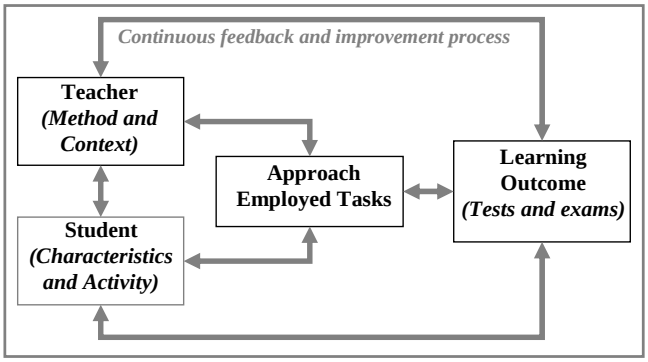

Fig. 7. Continuous outcome improvement program.

The emphasis is, then, to make sure the assessment tasks mirror the ILOs. This continuous revision process is the third most important element in bringing out positive results. As a direct consequence of our alignment, the student learning outcomes have shown constant improvements thus proving nurturing is possible and the college can impact the students significantly.

D. English Learning

We seriously emphasize the use of written English in the first year despite the time constraints for completion of a large number of prescribed technical courses and workshops in the study schedule. The English sessions also focus on spellings, use of connectivity words (utilizing engineering terms) and précis writing. It is vital that the student understands what is expected and, what will be assessed ahead of time to facilitate education, learning and the generation of desirable characteristics, thereby delivering formative (feedback) and summative (evaluation) assessment [12]. For those very weak in English and her usage, we permit the usage of local/ regional language as needed for communication. This last element ensures that the student

outcomes are positively charged. As an additional consequence, such language learning helped take the focus away from learning Engineering concepts and makes them comfortable. Similar findings have been demonstrated by Joseba [13] who shows the students' demonstrated greater emphasis on instrumental reasons for learning the English language including utilitarian (e.g. enable me to get a job easily) and for academic reasons (e.g. enable me to carry my tasks more efficiently, it is a university requirement and to further my education). This apparently reinforces the idea that the students see English as playing a vital role in their lives, either currently or in the future. This finding is quite consistent with Joseba's [13] view pertaining to the current need of engineering students as far as learning English is concerned.

V. Inference And Conclusions

The authors have put the above approaches into practice at the Baselios Thomas I Catholicose College of Engineering & Technology and these measures have demonstrated significant improvement in performance averages for the freshman students. The PowerPoint presentations in class lectures and the interactive classes held after the evaluation of class test results have helped the teachers to suitably tailor their teaching methods and context, while also motivating the students (who failed or have fared poorly) to improve upon their examination grades. The English language classes have contributed to increased confidence and to better written skills. We believe that our preliminary efforts are likely to pave the way to better student outcomes. While our immediate focus has been on freshman classes and the results are quite heartening and deeply revealing, we do admit that much more needs to be done as revealed in Figure 4 for improving engineering education in India. As envisaged, we expect to implement the various steps listed in Stage 2 & 3 towards improving the engineering education and we expect to publish more of our results as we continue to expand our focus of attention and our scope.

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