
A Holistic Cumulative Approach for a Sustainable Transformation of Engineering Education

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ABSTRACT: *Today engineering education is in a transition state. A comprehensive transformation in engineering education is the prerequisite to empower the engineering students to survive in a competitive global society. The universities and engineering education institutions bring changes into the teaching – learning pedagogy by substituting the traditional teacher centric and curriculum based learning methods with student – centered cooperative and collaborative teaching – learning approach where in students have an exposure to participative learning focused more on linking the theory to practice and attitude of life long learning. Education system, in Indian context, unlike other developed nations, need to introduce changes with in the academic framework designed by the regulating bodies like AICTE, affiliating Universities, government education policies, etc. In this context, the holistic cumulative approach is the best method to adapt changes to the existing curriculum based system of engineering education.*

Key Words: *Engineering Education, Holistic Cumulative Approach, Participative, Collaborative, Co-operative*

INTRODUCTION:

The system of education no longer remains as merely learning process to acquire knowledge. It has emerged considerably as a career making and profession oriented training. The amount of money spent on education does not mean a consumption expenditure; rather an investment for future career. It is inevitable today to work to create a holistic cumulative engineering education system enabling ourselves to think beyond the technology and technical aspects of engineering education. There is a need to transform engineering education system in the context of service to the society and to address the complex challenges of the 21st century innovation driven global society. The educationist have to rethink to broaden the horizon of engineering education adapting modern student - centered approach to meet the needs of engineering professions and the goals of practicing engineering professionals.

OPPORTUNITIES AND CHALLENGES IN ENGINEERING EDUCATION SYSTEM:

The present day Engineering Education System is passing through a most exciting transition phase. The growth of scientific and engineering knowledge, the access to use and application of technology opened a new horizon of possibilities and challenges. The universities and engineering education institutions world over turned out utilitarian in their approach to a greater extent responding to the demands of the innovation driven economies in a globalized education texture.

There exists paradoxical situation wherein the students are prepared to face the 21st century technical challenges just by following the 20th century traditional curriculum and teacher - centered education system. Sustainability of engineering profession and practice in the contemporary ‘innovation driven economy’ demands the engineering profession and practice to cuddle the value of complex thinking system,

understanding of inter-disciplinary concepts and collaborations, socio-economic and environmental aspects of engineering and enable the engineering students and professional aspirants to emerge as technically competent, ethically upright, socially dependable, economically viable as leaders capable to face the challenges at global level.

HOLISTIC CUMULATIVE APPROACH IN TRANSFORMING ENGINEERING EDUCATION:

The best suited method to transform the present day engineering education system to suit the needs of the students to develop them as technically competent manpower is to adopt a ‘holistic cumulative approach’. It is a finest blend of the traditional curriculum oriented and modern student centered learning system. In this system, the teachers’ role is more a facilitator than an information transmitter.

A holistic approach to transformation of engineering education focus on dealing with students’ perceptions, role and the responsibilities of the teachers, changes in teaching pedagogies, outcome based curriculum, creativity and designing skills, promotion of cognitive, emotional, social, artistic and sportive skill, effective communication skills, empowerment of students with knowledge of humanities, arts, and social sciences to develop creative, innovative and explorative attitude, open-minded access to learning, etc. Holistic Cumulative approach is a technique of upgrading the teaching – learning pedagogy by modifying the traditional methods and cumulative addition of modern methodologies of knowledge creation and learning.

Components of Holistic Cumulative Approach:

In order to achieve a holistic cumulative approach in transforming engineering education the following aspects to be considered as components to work with as an addition to the traditional methods of learning.

1. **Perceptual Change in Learning** - The perception of both the students and the teachers regarding the learning process need to undergo a considerable change to adapt to the modern learning system. There is a need to identify the students’ perceptual feedback and modify the teachers’ actions and teaching methodology accordingly.
2. **Encourage faculty development and training programmes** - Using both the internal and the external sources of training and development.
3. **Teaching Tools** - Encourage the teachers to adopt and use the modern teaching techniques and tools and also develop and use the inter-disciplinary learning labs^[13], etc., to hold the interest of the students in learning and knowledge creation.
4. **Introducing the Students’ Centered learning** - Adopting such teaching strategies to promote students’ participation, creative actions, autonomy and personal responsibility instead of working along the age old traditional teachers’ centered learning process characterized by transmission and reproduction system in a restricted and time bound learning premise. The role of the teacher has to be redefined as a facilitator and coordinator of students in groups to accept their responsibilities in the process of knowledge creation.
5. Initiatives to introduce a **participative, collaborative** (a group based learning process)^[1] and **co-operative** (it is an active learning process which has a structured form of group work based on five principles – a common goal, individual responsibility, mutual interdependence, fact to face interaction, effective interpersonal skills and regular assessment of teamwork)^[1] learning system.
6. **Substituting the traditional class room lecture method** (if not completely, but to a certain extent) adopting outcome based teaching strategies to develop procedural skills to complement the scientific knowledge. In this direction the incorporating teaching strategies like apprentice system, industry internships, working on community projects (the community project oriented subject – **EPICS** introduced by the Purdue University as a core paper in the curriculum)^[15], teaching of industry specific subjects as part of the curriculum.

7. **Granting full or partial autonomy** to the educational institutes and universities in curriculum design, internal and external evaluation system maintaining the uniformity at the aggregate level of education system.
8. Consider to certain extent the **students' role in designing the engineering education curriculum** to motivate and involve them in learning process.
9. Encourage students to work on Team Projects, Trans-disciplinary work teams, open-ended problem solving, learning groups, etc., to create an environment of experiential learning and develop an attitude of life long learning.
10. Integration of **Thinking** (brainstorming, idea generation, etc.), **Experiencing** (hands on learning, working on prototype projects with community relevance, understanding the procedural aspects of theoretical learning) and **Contributing** (realization of the application and usefulness of engineering designs and projects to the community at large and develop a sense of social responsibility)^[10]. Exposing the engineering students to hands on projects helps them to broaden their vision of engineering knowledge and reasoning ability. Working on project prototypes makes the learning more interesting converting engineering education as an artifact (activity) to experience various aspects like products, processes, systems, etc. It enables the students to understand the application part and societal use of the engineering knowledge and skills. **Charles M. Vest** rightly stated, “experiential learning – a real science of learning.....”.^[3]
11. Effective use of the quality standards and accreditation systems, such as ISO Certifications, NBA Accreditation, NAAC Accreditation, ABET Accreditation, etc., to streamline the day to day functioning.
12. Work on effective teaching pedagogy encouraging innovation in education and learning system.
13. Encourage regular ‘industry – academia’ interaction and feedback from the industry to the academia. Promote the possibility of industry experts to extend their teaching and training to the academia.
14. Establish pro - learning environment introducing effective student – teacher relationships.

Role and Support of the Management:

The management has to provide the necessary encouragement (financial and moral support) to place the institution at the helm of engineering education. The efforts have to be made to upgrade the quality standards (to match with accreditation standards such as NBA, NAAC, ABET and also ISO certification). Investments on infrastructure, labs, library facilities, work space and transportation, hostels, gymnasium, playgrounds, and such necessary facilities and also to upgrade the existing ones are regularly made.

Faculty Involvement:

At the institution level, all facilities to improve teaching – learning standards must be made available. The major institution level activities should involve

-) Faculty quality improvement programs (staff training, workshops, conferences, seminars, etc.),
-) Promotion of research culture, staff involvement and participation in curriculum design, sponsored projects and student team projects
-) Effective student – teacher relationship structure and interactions with empathy, engagement, reflection, participation and discussion, etc.
-) Involvement of the faculty in various institutional and department level activities such as coaching, tutorial and special classes, student training on subject and project specific special skills, student association activities, placement related trainings, staff and students’ community projects, industry internships, etc.
-) Involvement of faculty members in various Industry collaboration programs
-) The departments and the faculty members need to enjoy autonomy to bring in new ideas, creative actions, innovative research and development programmes, participation in curriculum design, and such other activities.

Students' motivation and participation:

The students need to be encouraged to manage the responsibilities of various academic and co-curricular activities with in the campus and out side. In addition to the regular class room teaching and lab sessions, the students take part in various tasks assigned to them either individually or in teams. Modern tools available to the teachers and the students to enhance the quality of teaching pedagogy and the teachers encourage the student-centered learning environment to empower the students to bring out their best performance. In order to showcase the talents, creative skills and knowledge creation, the students must involve themselves in organizing various technical and cultural fests, competitions, symposiums, workshops, seminars, expert lectures, etc., and it also enable them to inculcate most desired organizing and leadership skills. The institution and management to encourage the students' initiatives like

1. **Learning through Peer Helpers** - the formation of the study groups (learning groups) wherein the selected students from the peer groups interact and guide the needy students in some of the topics enabling them to interact, discuss, involve, participate and contribute to the better understanding of the subject that has already taught by the teachers.
2. **Training by the Senior Students** – The students from the higher semester classes of engineering volunteer to train the junior students on basics of the core engineering subjects and other required skills.
3. **Alumni Interaction and Learning Sessions** – Alumni of the institute work as support to empower the students providing better insight of the engineering education and professional practice. They in teams educate the students about new inventions and innovations, applications, possibilities and challenges in the field of engineering profession. The faculty coordinator of Alumni Association manages the responsibility of organizing these alumni interactions and sessions.
4. **Students' Associations** – In addition to the professional students' chapters (IEEE, ISTE, IE(India), CSI) and department level branch associations, the students work in teams and groups at various other general category student clubs (may be related to cultural activities, music, dance, fine arts, humanities, skill formation and training, etc.).
5. The students are encouraged to work on **community based projects** to find solution to the societal problems which are to technical nature developing working prototypes. The proposal is made to include such community based project an open elective credit based task as a part of the curriculum.

METHODOLOGY OF STUDY:

In order to make an evaluation of the students' preferences and perceptions about the existing teaching – learning pedagogy a sample case study was conducted. The aim of the study was to introduce the necessary changes to the teaching – learning process to bring the holistic transformation in engineering education system of the Institute. The study was carried on with a sample size of 250 students from various branches of engineering with diverse socio-economic backgrounds at random. The study was focused to analyze the situation understanding the students' preferences about traditional curriculum based and also teacher centered learning, student centered application oriented (project based) learning system, their opinion on teacher-student relation structure, teaching pedagogy, tools, labs and other learning equipments, preference to work on social (community) projects as a part of the curriculum, present evaluation system, etc.

A simple questionnaire was issued to the students to answer with yes/no and also space to add up any specific information descriptively. The questions were framed in such a way that, students could respond to each one of them indicating their views about the class room teaching, project based learning, teacher-student relationship, group study and case study based approach etc.

FINDINGS OF THE STUDY:

The study revealed that the majority of the students (87%) favour a student – centered, participative, collaborative, and cooperative learning. However, a greater section (67%) of the students prefer the teachers as the most sought after source of information to the internet (web) sources, libraries, etc. The students (89%)

highlight the importance of effective training on language and communication skills and activity oriented curriculum (case studies, expert panel discussions, community based projects, etc.) that makes the learning more interesting and expose them to creative ideas, application and outcome oriented knowledge creation and learning.

CONCLUSION:

The engineering profession and technology play a pivotal role in making the growth of the present day society a reality. Similarly, the engineering education play an important role in the creation of the most needed technical manpower and knowledge base. Today's engineering education need to pass through a transition stage by corroborating the holistic approach which is a proper blend of traditional teaching-learning method and the modern cooperative and collaborative learning approach. Transformation of the engineering education should happen by linking the theory and practice and integrating the knowledge and skill with practice. It makes the education more interesting and truly makes 'learn to learn; not just to earn' a reality.

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