

# Research Based Curriculum to Improve the Teaching-Learning Experience of Undergraduate Students

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## Abstract

Technical education system in India has undergone a transformation in the last several years. The focus is more on students to make them readily employable and face the competition. Research and teaching are the two important aspects of any higher education system, which complement each other and improve the quality of education. Research is an important component of the teaching-learning process, as it helps in disseminating current knowledge to the students and keeps them updated in their discipline. Thus teaching-research nexus has assumed lot of importance. Involvement of undergraduate students (UG) in research in technical Institutions is a recent phenomenon. It has been a regular feature in Institutions of National importance namely the IITs and NITs, but in private Institutions and Universities it is not happening regularly. There is a need to involve UG students in research, in order to stimulate them towards innovation. A country like India with a huge student population can really make wonders by making this happen and the students can be easily motivated and trained. This requires a 'research-based curriculum'. In this regard, this paper tries to present a perspective on teaching-research nexus and evolve a broad framework for a research-based curriculum, with regard to authors' Institution, which is an autonomous Institution, with lot of flexibility with regard to curriculum. This curriculum can help UG students to get a feel of research, when they are young and motivate them to take up research as a future career and also help them in their placements.

**Keywords:** Curriculum, Research, Undergraduate

## 1. Introduction

Technical education in India has seen lot of changes in the last 67 years after independence. Today it is one of the largest education system in the world, next only after USA and China. More than 15 lakh engineering graduates pass out every year and out of which it has been found that only about 25 % of them are employable. This is a huge crisis, and efforts are being made to address this by providing additional inputs, training for soft skills, which include communication, interpersonal and leadership abilities. These efforts are yielding results, but to a limited extent.

Research is an integral component of any education system including technical. The technical progress and the well being of any nation is dependent on its research capabilities. Research and teaching are two primary responsibilities of any teacher in this modern day world. Today research is an important component of the teaching-learning process, as it helps in generating knowledge and disseminating the same to the students to keep them at the forefront of technology. According to the recently started 12<sup>th</sup> Five year Plan, several initiatives have been proposed to increase investments in research from the current level of less than 1 % to more than 2 % of the GDP. And out

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of many areas suggested to be encouraged, some important ones are - (i) Increased focus on teaching-research synergy, (ii) Accelerated expansion of Doctoral and Postgraduate programs and (iii) Send the faculty abroad to best universities for training<sup>1</sup>.

One area, which has really not caught the attention of the administrators and policy makers is to catch students, when they are young and draw them into research. Involvement of UG students in research is not happening at the level it should happen in a country like India. UG students who are going to be the future teachers, technocrats, leaders and entrepreneurs of this country need to be trained in research, in order to stimulate them towards innovation. This paper touches upon this important topic by emphasizing the need for modification of our existing curriculum and reorient it as a 'research-based curriculum' at the UG level. This paper presents a perspective on teaching-research synergy and tries to provide a broad framework for developing a research-based curriculum for the author's institution, which is autonomous, with flexibility in designing the curriculum. This will help the students to get a feel of research, when they are young and motivates them to involve themselves in research.

## 2. Teaching-Research Synergy

Teaching and research are two important functions a teacher has to perform in institutions of higher learning. Conventional institutions offering UG courses are mainly concerned with teaching, which implies providing students with readymade knowledge, with no much scope for inquiry-based learning. The education today has seen a paradigm shift, from a teacher-centered education to a learner-centered education, with facilities like world wide web, internet and other developments in Information and Communication Technology (ICT) available to the students for learning at their convenience. Hence teachers have a different role to play in this changed scenario, as facilitators, rather than as knowledge providers.

Research is the basis of generation of new knowledge and developments in science and

technology. But teaching is the primary responsibility of any teacher. Studies are being carried out to understand the synergy between the two, in order to exploit the same and improve the quality of education. There is a raging debate going on two propositions namely - (i) research has the potential to support teaching and (ii) teaching has been shown to support research in practice. Whatever may be the debate, it is very clear that both are essential for teachers of today<sup>2</sup>.

According to Rugarcia (1991) and Felder (1994), cited in<sup>2</sup>, research and teaching have different goals and require different skills and personal attributes. The primary goal of research is to advance knowledge, while that of teaching is to develop and enhance abilities. Researchers are valued mainly for what they discover and for the problems they solve, while teachers are valued for enabling their students to discover and solve. Excellent researchers must be observant, objective, skilled at drawing inferences and tolerant of ambiguity whereas excellent teachers must be skilled communicators, familiar with the condition that promote learning and expert at establishing them and be approachable and empathetic. Thus both functions require different skill sets and it is clearly possible and desirable to become successful in both the domains. Both are full time activities and require total involvement. A common contention is that involvement in one takes time from the other. Thus most of the time when efforts are made to study this nexus, it is not surprising to note that, there is no significant correlation between faculty research and effective teaching.

In the changed global scenario, efforts must be made to strengthen this nexus in order to provide a complete learning experience to the students, who will become 'Global Engineers', which is one of the desirable graduate attributes as per ABET Accreditation requirements<sup>3</sup>.

## 3. Undergraduate Research - Status and Its Need

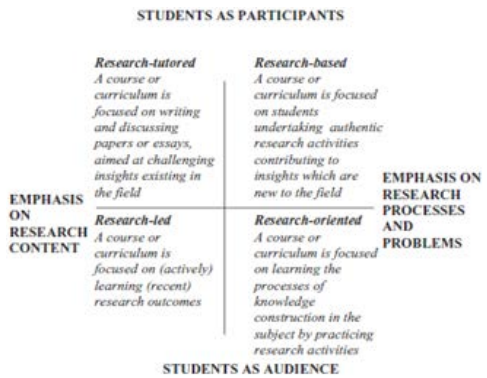
In the context of strengthening the teaching-research nexus, the major issue would be how to

use research in order to support teaching and how to make faculty to bring their research into the classroom. Humboldt's vision for higher education has been to reinvent or reinvigorate the curriculum to ensure that all undergraduate students in all higher education institutions should experience learning through research and enquiry. Thus the key strategy is to integrate undergraduate research and inquiry into the curriculum and evolve a 'research-based curriculum'<sup>4</sup>.

According to Healey (2005) cited in<sup>5</sup> UG students can be engaged with research and inquiry in four main ways:

- Research led - learning about current research in the discipline.
- Research oriented - developing research skills and techniques.
- Research based - undertaking research and inquiry.
- Research tutored - engaging in research discussions.

This model has been suitably modified and is given in Figure 1<sup>4</sup>



**Figure 1.** Curriculam design and the research-teaching nexus (Adapted from Healey, 2009<sup>6</sup>).

There are two axes in this model, one classifies the ways students may be engaged in research and inquiry according to the extent to which students are treated primarily as the audience or as participants and the second classifies the approach as emphasizing on research content or research processes and problems. An ideal curriculum would

need to engage students with research and inquiry through all the above mentioned four ways.

According to Healey and Jenkins (2009)<sup>6</sup>, in most of the higher education institutions, the teaching-learning process happens in the bottom half of the model, wherein the students are in the role of an audience, whereas there is a need to engage student in the role of participants and facilitate teaching-learning to happen in the top half of the model, wherein they will learn and benefit from their involvement.

The involvement of students in research is dependent on the level of teaching-research synergy achieved by the concerned faculty. To understand the status of this nexus, several efforts by organizations and government bodies have been made, which include Boyer Commission report of 1998, the AUCC's Commission of Inquiry on Canadian University Education Report of 1991, The Australian Department of Education, Training and Youth Affairs Report of 2001 and the UK Department for Education and Skills Report of 2004. These studies have provided meaningful insights about this nexus, correlation studies, critical analysis of methodologies, attributes of research-informed learning, student experience of research, impact of government funding policies and practices on this nexus and strategies to facilitate and enhance a positive teaching-research relationship<sup>7</sup>. Healey and Jenkins (2009) presented several case studies on involvement of UG students in research and inquiry and have made findings regarding experience of students and staff<sup>6</sup>. In addition several other researchers like Myatt (2009)<sup>8</sup>, Short et al.,(2010)<sup>9</sup>, Hajdarpasic et al., (2011)<sup>5</sup>, Jusoh and Abidin (2010)<sup>10</sup> and Ozay (2013)<sup>11</sup> have investigated the involvement of UG students in research based learning and inquiry. Most of the studies strongly support this research based learning and have highlighted benefits like motivation to pursue higher studies like PG and PhD, taking up research as a career and also helping them in their placements.

Thus there is a need to evolve a research-based curriculum, which can change the role of students from audience to participants. In the next

section, a broad framework for a research-based curriculum will be presented in connection with an autonomous Institution which has the freedom to frame its syllabi.

## 4. Design of a Research-Based Curriculum

Griffiths (2004), cited in<sup>4</sup> examined different forms of knowledge production in research and discussed the implications of these differences for teaching. Based on the differences between research and knowledge production in technology and other fields, he suggested that there are qualitatively different ways to strengthen the research-teaching nexus. Accordingly he described the following curriculum models of the teaching-research nexus:

- The curriculum can be *research-led*.
- The curriculum can be *research-oriented*.
- The curriculum can be *research-based*.
- The curriculum can be *research-informed*.

Based on this work of Griffith, Healey (2005), cited in<sup>4</sup> analysed the teaching-research nexus considering students as audience and participants and whether the emphasis is on research content or processes and problems and whether the teaching is teacher-focused or student-focused.

The current curriculum emphasizes on research content and treats students as audience with the focus on teacher. It is in the lower half of the Healey model<sup>4</sup>, wherein it is either research led or research-oriented. There is a need to modify the curriculum suitably to shift it towards the upper half of the model with student as participants and learning being student focused. Mariken et al., (2009) have used Healey's model to analyse existing UG courses focusing on the research-teaching nexus implementation. Examples of best practices of courses from some leading Universities in the world were considered where research places a central role and analyzed the outcomes. The courses were analysed based on the following four parameters: course objectives or aims, role of the teacher, students' learning activities and the course outcomes<sup>5</sup>.

### 4.1 Broad Framework for a Research based Curriculum

A typical UG curriculum for a Bachelor's degree in Engineering in the author's Institution has 200 credits with the breakup as follows - Basic science and core courses (30 credits), Engineering science core courses (30 credits), Humanities and Social science core courses (10 credits), Professional core courses (80 credits), Professional elective courses (20 credits), Open electives (10 credits) and Major project work (20 credits).

The four curriculum models can be incorporated while designing the curriculum of the different courses. The models can be incorporated considering the four parameters. Also the mixture of the models should be consistent with the aims of the respective disciplines, the kind of placements they get, number and capacities of the students enrolling in the discipline. With regard to the breakup of the courses, the models of curriculum development for each course can be selected and accordingly the students may be trained and oriented as follows –

#### 4.1.1 Basic Science and Core Courses and Humanities and Social Science Courses

The curriculum can be research-led, the emphasis being on transmission of information, with focus on research interests of the faculty. Students understand the concepts; they are provided an overview about the course, with recent developments. Teachers follow the traditional classroom teaching and motivate students to develop interest in certain areas for research. Students can make presentation on some research topics of their interest and they get a basic understanding about research.

#### 4.1.2 Engineering Science Core Courses, Professional Core and Elective Courses

The curriculum can be research-oriented or research-based, depending on the courses. To provide the students the fundamental knowledge of the courses and motivate them for an inquiry-based

learning. Students can design and work on mini projects to understand the basics of research and gain practical skills and knowledge, which may help them in their future career. Teachers should not only be supervisors, but also act as facilitators in answering their queries, provide them with regular feedback. Students can be motivated to write research proposals on their topics of interest and suitably guided.

#### **4.1.3 Human and Social Science Courses and Open Electives**

The curriculum can be research-informed, where the teachers inquire into the teaching-learning process itself. Teachers can design the courses in such a way that they are able to assess the learning outcomes.

#### **4.1.4 Major Project Work**

The curriculum can be research-based. Students can be motivated to take up projects, which are research oriented. The projects can include funded projects of the faculty. The students gain practical skills and knowledge, which they can apply after graduation. The faculty working as guides has to clarify all their doubts about their problems. Students can be motivated to write research proposals and get funding from the Institution or funding agencies. Students working on research projects can be given some financial assistance or may be given certificate of appreciation.

Further to design a research-based curriculum, the students can be trained in the basic knowledge and skills about research by including courses at the basic or advanced level or through electives. For eg. Research methodology could be introduced as an elective course in the third year of study, which can be taken up by students who want to take up research-oriented projects. A series of seminars and workshops can be organized to provide the basic training necessary for doing research by in-house and external experts. Regular or value added courses on 'Technical paper writing' can be included in the fourth year of study, to train them in writing skills and encouraging them to write technical papers and reports about their research work in conferences and journals. At the individual department level, regular lectures by faculty in

the department can be arranged from the second year of study, about their research work to motivate students to take up related research projects. Students interested in taking up small research projects can be encouraged from their second year of study itself, which can be given credits if possible, or can be given certificates of appreciation, which can be treated as value addition.

The institution can formulate necessary policy to connect teaching and research, provide necessary support which includes financial and infrastructural. There is a need to implement this 'research-based' curriculum throughout the institution, by creating necessary awareness about the same in the students and faculty. The departments should regularly update their curriculum with a research orientation. Faculty should obtain funding for research projects by involving not only PG and PhD students, but also UG students. The faculty should be suitably rewarded for these initiatives. Overall the Institution and management should create a supportive 'ecosystem' for strengthening this nexus and increase the involvement of UG students in research.

## **5. Conclusion**

This paper tries to emphasize the need for a 'research-based' curriculum, to improve the teaching-learning experience of undergraduate students. There is a nexus between teaching and research as they support each other. Teachers have to involve students in their research projects/work and bring research in the teaching-learning process. This will provide them a research-oriented learning environment, where teaching-learning is based on inquiry. A broad framework for a research-based curriculum has been suggested for implementation in the author's institution based on the current curriculum which is a mix of different courses.

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