FACTORS IMPACTING STUDENT PERFORMANCE IN ENGINEERING EDUCATION IN DEVELOPING COUNTRIES

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ABSTRACT

Engineering education in developing countries emphasizes scoring marks in the exams rather than providing a well-rounded education. We examine the factors impacting student performance based on the regulatory standards governing Engineering Education in India and especially the National Board of Accreditation (NBA) standards. From the literature it is evident that additional factors have an impact on performance and learning. Many of these factors are social learning based. Hence, we propose a model based on social learning theory, which is generic to Engineering Education and specific to developing countries. The results will help educators understand how students learn, and adopt specific measures to ensure that students get not just the grades but also the knowledge that the grades are supposed to signify.

Keywords: Engineering education**,** developing countries, model based analysis.

INTRODUCTION

Engineering education is different from other streams of study in its emphasis on solid fundamental theory, application of the theory in practice with mathematically sound models and ingenuity. It is observed that many engineering graduates in the developing countries do not have even one of the above qualities. The education system seems to emphasize scoring marks in the exams rather than providing a well-rounded education. As a result there is a talent gap with industries needing qualified graduates on one hand and many thousands of Engineers not getting a job due to lack of talent on the other. Many studies have focused on this situation in recent years and the common causes identified are the lack of communication, logical and soft skills. Other studies have focused on teaching gaps, background of students and parent's status, etc. Our view is that the term performance must include not just measures of performance in exams such as marks and placement record but also aspects such as knowledge and competence.

There have been many advances in the teaching methods in the past decade. The advent of the technology era symbolized by the Web has meant that a large quantum of information is generated everyday posing challenges in curriculum design. The way students learn is also changing with the increasing usage of social networking technologies. These have meant that theories of education are adopted in a large way to keep pace. The situation in developing countries is however different. Factors such as emphasis on outdated methods of assessment, low quality of teaching, lack of access to good educational strategies in institutions, educational

environment, poor educational system, etc. can have an adverse impact on learning. The learning by the students should not be measured just in terms of the grades or placement record but by a composite measure of understanding of the domain that the students seek to master. A large portion of the graduates have the degrees but not the knowledge the degree is supposed to signify. This lack of knowledge contributes to unemployment, poor performance in the jobs and layoffs in their careers. The problem is not just with the way students learn or how they are being taught, but in the overall environment of learning as well.

In a developing country such as India, the affiliated college system (Bannerjee and Muley, 2007) is followed in many Universities. A large group of colleges come under a common affiliating University. The University sets the question papers and a common assessment system is followed. The teaching is thus geared towards improving the student's scores in the common examinations, which is a major factor along with the coverage of the subject. Engineering education in India is assessed by the National Board of Accreditation (NBA). Every engineering institution follows the NBA guidelines and hence this gives a measure of what the institutions aspire towards. Studies (Viswanadhan, 2008; Varshney 2006; Prasad and Bhar, 2010, Honnutagi, Sonar and Babu, 2011) have shown that the process of NBA assessment is itself subjective and more clarity in the process may be needed. Based on the metrics outlined in the guidelines, the following elements are thought to have a crucial impact on the learning by students Performance in exams, Faculty (quality in terms of research, extension, cadre ratio, student-faculty adequacy), Infrastructure, Institutional processes that stimulate quality, Placement record, Collaboration with Industries and other academic organizations and Co-curricular and extra-curricular activities of students.

There is however a dearth of work validating these conclusions. Also, a detailed study of these parameters will provide useful pointers to the institutions on why these factors are important in the learning process. In addition, there are other factors apart from the above which can impact the learning and performance of students. The role of these factors needs further understanding. Thus, the objectives of this research are to:

- o validate the importance of the factors that are used in the accreditation process in India,
- o identify other factors that can contribute to the performance of students,
- o develop a causal model and relevant hypotheses that is generic to Engineering Education and specific to the situation in developing countries, and
- o validate these hypotheses through empirical research.

LITERATURE REVIEW

The existing literature in the domain of engineering education and student performance is summarized below in Table 1. The literature suggests that social factors seem to play an important role in the development of knowledge and soft skills in students. The analysis of the existing literature shows the importance of factors such as Student attendance, Background of students, Mentoring, Teaching methods, Research and Teacher-student relationships

Table 1: Summary of Existing Literature on Factors Influencing Student Performance

Category	Key Points	Reference

Attendance	• Attendance helps performance. But the reasons for non-attendance is complex and can be based on:
	  o Living arrangements (those who live closer to the University attend more)
	  o Gender (females attend more)
	  o Teaching
		(Clifford et al, Eastwick 2011)

	• Attendance is linked to perceptions about passing grades	(Rico et al , 2011)
	• Class attendance is proportional to the grades • Students with higher grades are more likely to attend classes regularly in the next semester.	(Cheung , 2009)
Background	• Parents' educational performance has a role in the academic achievement in the Science subjects	(Jabor et al, 2011)
	• Previous academic achievement and performance matters	(Sorge & Schau , 2002)
Mentoring	• Mentoring matters	(Chikumba 2011)
Teaching	• Problem based learning	(Ditcher 2001)
	• Outcome based learning	(Vaithilingam & Rajkumar , 2011)
	• Research matters	(Prince et al, 2007)

Models in Engineering Education

There have been many efforts aimed at creating causal models that capture the various antecedents that impact student performance in engineering education and help explain the overall situation in terms of various factors. Some of the salient aspects of these works and the factors these models incorporate are given below in Table 2.

Table 2: Models for Student Performance in Engineering Education

Models	Factors Considered	Reference
	Background in terms of: • High School Academic Achievement • Quantitative Skills	(Veenstra et al , 2009)

Model for academic students retention	• Study Habits • Commitment to Career and Educational Goals • Confidence in Quantitative Skills • Commitment to Enrolled College • Financial Needs • Family Support • Social Engagement Matters	
Structural model of students' success and persistence	• Participation in a first-year seminar • Academic motivation • Institutional integration (faculty and student) • High school rank • Scholastic Aptitude Test scores (SAT math and verbal) • Cumulative grade point average (GPA) • Enrolment status • Declared academic major	(French et al, 2003)
Structural equation model of Faculty distance	• Self-efficacy • Academic confidence • Self-regulated learning behavior • Effort, critical thinking, help-seeking and peer learning • GPA	(Vogt , 2008)
Constructing College Learning Effectiveness inventory	• Academic Self-Efficacy • Organization and Attention to Study • Stress and Time Press • Involvement with College Activity • Emotional Satisfaction • Class Communication	(Kim et al , 2010)
Multiple logistic regression model for completion of course	• High school GPA • Gender • Ethnicity • Quantitative SAT scores • Verbal SAT scores • Citizenship	(Zhang et al, 2004)
Analytic hierarchical process	• Faculty Adequacy • Student Performance, • R&D activities • Financial Resources • Performance Appraisal & Development mechanism	(Viswanadhan , 2007)

RESEARCH MODEL

While each of the above mentioned models focuses on a particular aspect and not all of them can be directly co-related to performance, it is instructive to consider the impact particularly in the Indian context. In our view, teaching and Engineering Education performance is directly linked to social factors. The theories of social learning (Vygotsky, 1978) have a direct impact on student learning and performance. Vygotsky's model emphasizes learning in the university in terms of the zone of proximal development which the learner is capable of reaching under the guidance of teachers or in collaboration with peers. The underlying theory is social constructivism, which is both intrinsic and extrinsic. While social constructivism can be applied in any discipline of study, the nature of engineering education make it suitable applying social theory and constructivism model (Josef, 2009). Engineering is uniquely situated for the integration of social constructivism because of its emphasis on experiential education, problem solving, and working in groups.

Our view of engineering education is that of a facilitation environment wherein the institution through its best practices, environment, and teaching facilitation of the faculty provides ample opportunities for learning to take place. Thus, we have developed a model taking into account: a) the accreditation process of engineering education in India, b) prevailing literature in terms of performance co-relation and causal modeling, and c) the social constructivism theories.

Based on our analysis, the factors which can directly impact the performance of students are teaching methods, socio-economic backgrounds of students, performances of students in their schooling, relationships with faculty, involvement in extra-curricular activities and the environment at the university.

The research model incorporating these factors is given below in Figure 1. While there are many factors that can contribute towards student learning, teaching methods and pedagogy is one of the major contributors. Teaching methods are a reflection of the practices that are adopted for knowledge dissemination. This depends on the program of study, the methods of teaching, and best practices followed by the faculty members, etc. The objective will be to find if there is a common set of practices followed by the departments of study, the extent to which teaching practices of the individual faculty members contribute to understanding in the program of study, does the teaching quality depend on the content of the subjects, etc.

The academic environment can differ from college to college and even vary across departments. The aim here is to understand whether a free academic environment contributes to the learning as opposed to tightly controlled environments. The Faculty quality is a product of their qualifications, teaching skills, inter-personal skills, research emphasis and other activities. Good student faculty relationships can contribute to increase in motivation levels among the students.

The attendance by the students can depend on gender, place of stay of the students, quality of teaching, institutional policies, etc. While there is a great deal of evidence that attendance affects the performance of students, it will be interesting to understand the views of the students in this matter. The involvement of students in the departmental activities and the college activities can bring in a sense of belonging and togetherness. This in turn can contribute to performance.
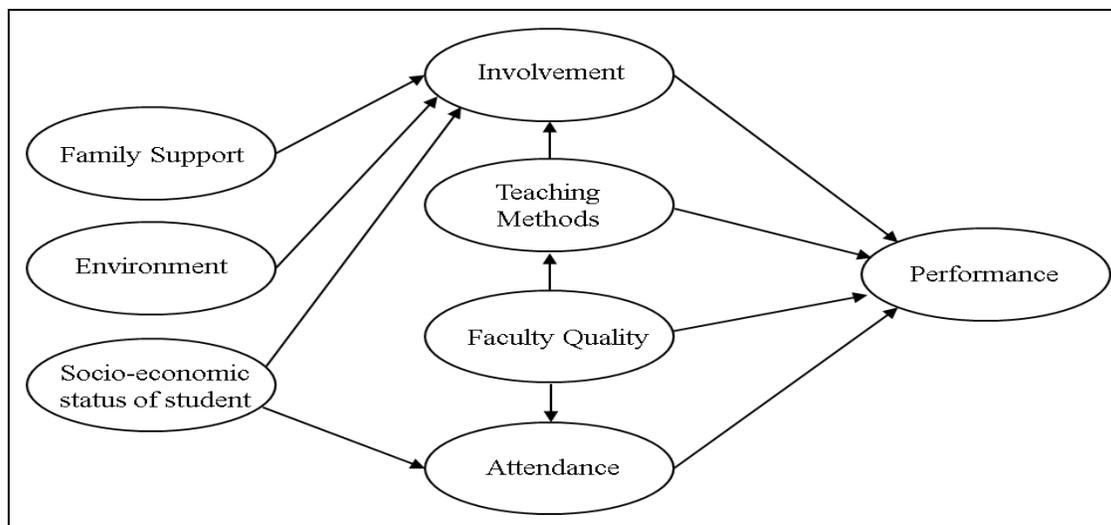
Figure 1: Research Model for Performance in Engineering Education

In India, students from diverse socio-economic backgrounds in terms of demographics, medium of study, economic levels, family backgrounds, etc. can study together. The correlation of the factors with performance will yield valuable indicators for the administrators. Lastly, the level of involvement and support of the family can make a valuable difference to the performance. While all these factors are important, the study will seek to understand the inter-linking of the factors and also whether the causal effects hold true.

METHODOLOGY

Based on the research model shown in Figure 1, the following set of hypothesis can be postulated and these hypotheses will be tested using a survey. These hypotheses based on the causal model will provide valuable pointers in understanding the performance of the students.

H1: The exam grades reflect the depth of knowledge levels of the students in the courses
H2: The Faculty qualification impacts the learning by students
H3: Infrastructure in the College has an impact on the overall learning
H4: The placement record of the University motivates students to develop their skills
H5: Extra-curricular activities by students have an impact on the learning
H5: Involvement in co-curricular activities in the Departments gives a sense of ownership and motivates students
H6: Attendance in class has a positive impact on the knowledge level gained
H7: The socio-economic background of students impacts the learning process
H8: Good relationships between Faculty members and students can help students learn better
H9: Interactive Teaching methods can impact learning
H10: Research in the Department motivates students to learn

A set of survey questions is currently being developed on the basis of the model and the student responses will be gathered. The survey will be administered to current and former students. The student responses will be analyzed and the hypotheses will be validated based on the results. The

study will focus on knowledge levels, performance and satisfaction of the students. Our study will be unique in that it will also analyze the factors that contribute to student learning from among the parameters set out by the NBA and yield important results that can help the educators. The importance of the factors that contribute to student performance will be derived which is of vital importance to the academic community in developing countries.

CONCLUSION AND FUTURE WORK

This paper has discussed the factors that contribute to the performance of Engineering College students and summarized the relevant literature. A model of student performance based on the literature in terms of the factors that contribute to performance, other models and parameters used in the accreditation process in India has been proposed. The survey instrument is currently being developed and pilot tested. The survey will be administered to a large number of engineering students at a big university in southern India and the data will be analyzed subsequently to validate the hypotheses. The results will be presented at the conference.

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