Competency Profile – An Evaluator's Perception on Outcome of Professional Education

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Abstract
Quality of an Engineering Education Programme, till the recent introduction of Outcome Based Education (OBE) by NBA in India, was assessed mostly from resource perspective or process perspectives or some combination of the two. While resources and processes are essential components of any programme, most of the accreditation boards for engineering programmes around the world give more importance to the outcomes in their assessment process. This paper attempts to define a 'Competency Profile Model (CPM)' that relates the quality to the 'Outcomes' of the programme. Findings of some previous studies of the authors led to the development of the model. The model facilitates a self-assessment mechanism and provides a 'Competency Profile' for the visualization of the quality of the programme. A case study is presented to demonstrate the features of the model. Usefulness of the model is tested through an expert survey. The model expects to serve as a platform for continuous assessment and improvement of Engineering Programmes.

Key words: Quality assessment; Engineering progammes; Outcomes; Competence

1 Introduction
Quality of an engineering programme was assessed mostly from resource perspective or process perspectives or some combination of the two in India. Resource perspective is the characterization of an educational programme by the resources or inputs that are considered necessary and desirable for providing good quality engineering programme. The resource approach assumes that resources such as land, buildings, laboratories, faculty, staff, students etc. directly determine the quality. Here, quality index is considered as a function of the indices associated with different resources. This approach follows an additive model by adding the scores assigned to different resources. Such a model, while allows us to acknowledge the importance or criticality of some resources by giving more weights, gives room to overcome the deficiency in one critical resource through creating a surplus of another less critical resource.
Process perspective is the characterization of an educational programme by the processes followed in creating the desired outcomes. In the process approach, quality is determined by how well the processes are being carried out. When the outcomes are not clearly identified, different stakeholders can end up having different perceptions of the outcomes, and tune their effort according to their perceived outcomes. In Indian context, this can lead to the following scenario

- The “managements” of engineering colleges desire to achieve better pass percentages.
- The short-term goal of any student is to pass and get better grades.
- The processes associated with conducting examinations for large numbers of students impose several conditions on the nature of examination paper.
- All the processes related to teaching and learning tune themselves to ensure better pass percentages in substandard examinations.

It leads to a situation where most of the stakeholders seem to be comfortable, and yet the knowledge and skill levels of the graduates do not match with the expectations of the potential employers. In addition, process characterization can be very difficult and subjective.

While resources and processes are essential components of any programme, the outcomes that result from their successful utilization are much more important. Many innovations are possible and normally do happen to overcome deficiencies in some resources or processes, if there is clarity and concurrence with regard to the expected outcome. Every stakeholder will be able to understand the impact of any of his/her or others’ actions on the outcomes. Besides, the most effective manner in which the nature and quality of a programme can be influenced is through redefining its outcomes.

2 Programme Outcomes

Most of the accreditation boards for engineering programmes around the world give more importance to the outcomes in their assessment process. The main criteria for their processes are the clear definition of the ‘programme educational objectives’ and the achievement of the ‘programme outcomes’. The General criteria of the Accreditation Board for Engineering and Technology (ABET, 2013) of United States, are ‘students, programme educational objectives, student outcomes, Continuous Improvement, Curriculum, faculty, facilities, and institutional support’. Engineering Council, which is the accreditation agency of UK, specifies the output standards for accredited engineering programmes, as ‘General learning outcomes’, which can be stated as “Graduates with the exemplifying qualifications, irrespective of registration category or qualification level, must satisfy the criteria: ‘Knowledge and understanding, Practical skills, and General transferable skills’”(EC, 2013). Specific Learning Outcomes in Engineering are ‘Underpinning science and mathematics, and associated engineering disciplines, as defined by the relevant engineering institution, Engineering Analysis, Design, Economic , social and environmental context’. The Japan Board of Accreditation of Engineering Education’s accreditation criteria are ‘learning outcomes (abilities a to i), educational methods, achievement of learning outcomes, and educational improvement’. (JABEE, 2012).

Institution of Professional Engineers New Zealand (IPENZ) emphasizes on a ‘Graduate capability profile’ that defines the skills, attributes and broadly defined competencies required of a graduate engineer (Hodgeson, 2004). Accreditation Board for Engineering Education of Korea (KEC, 2005) follows an eight criteria accreditation process for their engineering programmes. They are ‘Program Educational Objectives, Program Outcomes & Assessment, Curriculum, Students, Faculty, Institutional Support, Program Improvement and Program Criteria’. Considerable literature exists that discusses how an outcome based assessment can be developed and implemented to satisfy the outcome criterion (Bakos, 1999; Kerns and Orr, 1999; Soundararajan, 1999; Schmidt et al, 1999; Stephanchick and Karim, 1999; Lyons and Bayoumi, 2000; Besterfield et al, 2000; McMartin et al, 2000; Butler et al, 2001; Felder and Brent , 2003). These works are reported from engineering programmes in USA and UK offered by autonomous organizations (Universities), which can plan and implement all the activities connected with the programme independently, starting from the statement of goals until the assessment of their accomplishment. However, in India where hundreds of colleges are affiliated to one University, these approaches are not readily applicable.

3 Programme Outcomes in the Indian Context

The initial versions of accreditation criteria of National Board of Accreditation, India have followed a combination of resource and process approach (NBA, 2000 & 2004). The NBA accreditation process had given less importance to the 'Outcomes' - 50 % weight to processes (500 points), 41 % to resources and only 9 % to the outcomes. In 2011 version (NBA,2011), the weight of 'Outcomes' had been increased to 17.5% (7.5% to Student performance and 10% to Programme outcomes and assessment).The outcome variables used by NBA for assessment of programme performance were 'Academic results, Performance in competitive examinations, Campus placements, Employment in past year, Admission to PG courses, and Employers' feedback. Except 'academic results', all others are only indirect indicators of quality of education provided by the programmes, and are dependent on many variables, which are outside the purview of the programme. The 'campus placements' and 'employment in past year' are complex functions of the quality of the academic programme, location of the college, business scenario, and the special effort put in by the management. Many colleges cannot even get companies to visit the campus for recruitment. The motivation to appear for GATE and to perform well in competitive examinations is functions of quality of the academic programme, job scenario, access to coaching, family concerns etc. Feedback from the employers will again be a complex function of the quality of the academic programme, effectiveness of employees, nature of employment etc. Besides, getting adequate number of samples from employers of similar categories will be very difficult. In view of the complexity associated with these measures, it is difficult to use them as measures of the quality of the programme.

The conclusions from some of the previous studies also point to the necessity for a change in the assessment of quality of engineering programmes. The studies on the effectiveness of NBA processes (Viswanadhan et al, 2005a) concluded that the NBA assessment is very subjective in nature, and is ineffective in assessing the variability of performance of the programmes. It was also established that it is necessary to redefine the criteria and the associated variables (Viswanadhan et al, 2004, Viswanadhan et al, 2005b). The differences in the conclusions of two comparative studies on the performance of engineering programmes using NBA data (Viswanadhan et al, 2006a) and faculty survey (Viswanadhan et al, 2006b) pointed out that when the outcomes are not clearly identified, different stakeholders can end up having different perceptions of the outcomes. Hence, clearly defined outcomes and well-defined methods of measurement are important in the assessment of quality of a programme.

The measures to characterize the outcomes should also be able to assess the matching between the needs (as defined by professional bodies) of the industry, who are the employers of graduate students, and the competencies achieved by the students. In addition, these measures should also serve as vehicles to provide relevant and focused information to educational planners, Boards of studies of universities, employers, and teachers.

Educational and professional accords for mutual recognition of qualifications and registration have developed statements of graduate attributes and professional competency profiles (IEA,2013). Graduate attributes form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practise at the appropriate level. The graduate attributes are exemplars of the attributes expected of graduate from an accredited programme. The graduate attributes are intended to assist Signatories and Provisional Members to develop outcomes-based accreditation criteria for use by their respective jurisdictions. The Washington Accord (WA) provides for mutual recognition of programmes accredited for the engineer track. According to this, the engineering programs must demonstrate that their graduates have acquired the following ‘Graduate Attribute Profiles’.

1. Engineering Knowledge
2. Problem Analysis
3. Design/ development of solutions
4. Investigation
5. Modern Tool Usage
6. The Engineer and Society
7. Environment and Sustainability
8. Ethics
9. Individual and Team work
10. Communication
11. Project Management and Finance
12. Lifelong learning

An analysis of these Attributes in the context of present Indian scenario would facilitate their translation into a set of measures that stakeholders can identify with.

- Attributes 1 and 2 can be measured through “competence” achieved through the relevant courses in the programme.
- Attributes 3 and 4 can partially be measured through the competence in the laboratory courses.
- Attributes 4 and 5 can be addressed through measuring the competence in project work.
- Attributes 6, 7 and 8 are not addressed in engineering curricula barring a few institutions. In some institutions, these are addressed through compulsory formal courses. In such cases, competence in those courses can be used as a measure of these outcomes.
- Attribute 9 can be addressed through measuring the competence in laboratory courses and project work.
- Attributes 10 is addressed sometimes directly and mostly indirectly in colleges. Communication abilities can be measured through the competence in those subjects/exercises.
- Attribute 11 can partially be addressed through competence in project work.
- Attribute 12 is not directly addressed in most of the colleges.

4 Competency Profile Model (CPM)

We propose engineering competencies as the main outcomes of an engineering education programme. We use the word 'competence' in a generic way to refer to some aspect of engineering competence. However, we may wish to measure competence of the students at the end of the programme, in a stream of related subjects, at the end of a semester, at the end of a year, or in each subject. Competence, at whichever level it is measured, is defined as 'the level to which the student acquires a defined knowledge-skill set'. Usually, the students put their maximum efforts to meet the assessment requirements (Thorpe, 1998). This concentration of effort results in assessment being one of the main influences on student learning (Northcote, 2003). Acknowledging this pattern of student behavior, some of the online units of study now use the assessment tasks to drive the entire learning experience (Donan, 1996; Hargreaves, 1997). Hence, the quality of testing can be treated as the most important factor that influences the quality of outcome of a programme. Hence, marks/grades obtained by a student cannot be taken as the only indicator of 'competence'. Higher marks/grades can be a consequence of low standard of test/examination instruments, liberal evaluation and low standard of syllabus. For the same reason, low scores can be the consequence of tougher examinations, tough evaluation or due to heavy course contents. Whatever may be the reasons, the potential employer evaluates the student for his competency and not by the marks he scored, unless it can be established that the marks and grades are truly indicative of the competencies. While one may find such a situation in a limited number of autonomous institutions in India, marks are not indicative of the competencies in majority of the Indian institutes. They may be used for comparing students in the same institution. Hence, we may conclude that if 'competences' have to be used as indicators for the outcomes, they can only be measured as functions of marks/grades, quality of test instruments, quality of evaluation, and quality and scope of the syllabus. This may be expressed generically as

Competence = f (Examination/Test scores, Quality of test instruments, Quality of evaluation,Quality and scope of syllabus)

4.1 Structure of CPM

This functional relationship of Competence, as a first approximation, can be assumed multiplicative in nature. It is convenient to measure each one of these variables on a scale of zero to one. Then, the maximum value for 'competence' would be one. However, situations can arise wherein the examination papers are of difficulty levels higher than what normally would be expected from the syllabus under consideration, the evaluation by some evaluators can be more severe than normal levels or the syllabus for the concerned subject can be heavy in its scope. In such cases, it may become necessary to use maximum values greater than 1 for some of the variables.

Competencies, in the context of engineering programmes in India can be classified into three categories.

- C1 - competence in a subject or group of subjects in which end semester examinations are conducted.
- C2 – competence in a laboratory course or a group of laboratory courses
- C3 – competence in a project or a series of projects. Project related competencies could be measured in terms of the competencies gained through the projects done at different stages of the programme.

These competencies can be further classified into subcategories or more competencies can be added as needed.
The main customers for the graduating students are the employers/organizations who are involved in creating wealth. It becomes necessary to redefine the competencies from time to time as the needs of the economy change. Mechanisms that permit periodic redefinition of competencies and serve as vehicles for continuous improvement of quality, in a manner appropriate to the Indian scenario, need to be formulated.
The three competencies that were defined in the Indian context
Competence 1 = (Examination/Test scores) * (Quality of test instruments) * (Quality of evaluation) * (Quality of syllabus)
Competence 2 = (Lab exam scores) * (Quality of test instruments) * (Quality of Evaluation) * (Content & organization of lab experiments)
Competence 3 = (Project score) * (Quality of test instruments) * (Quality of evaluation) * (Quality and Scope of project work)
Other competencies, if considered as important indicators, can be added for measurement in a similar framework.
These relationships may be graphically represented as shown in the Figure 1.

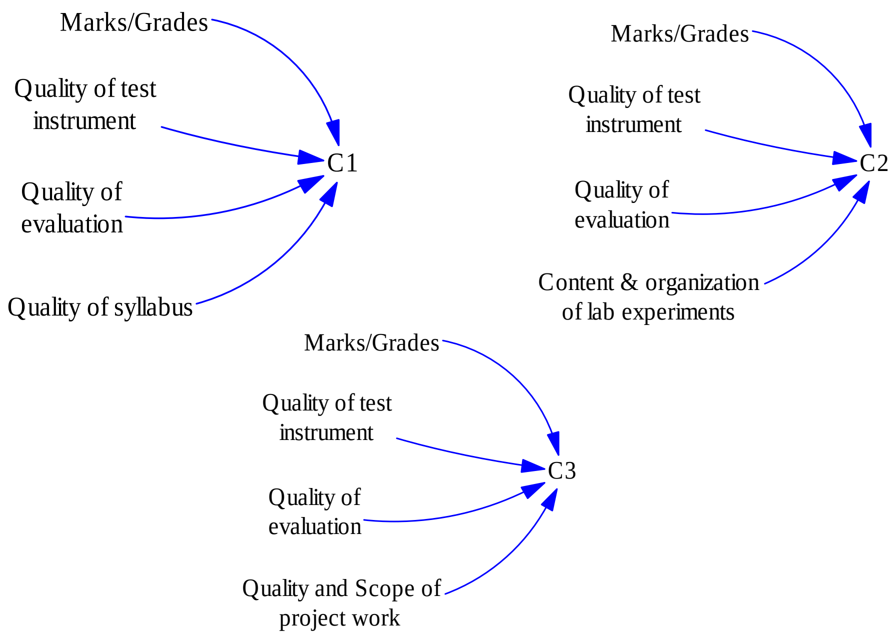

Figure 1: Measurement of the three competencies

If the quality and scope of contents are of good standard, evaluation is as per accepted norms and the tests are designed compatible with the learning objectives, the marks/grades can be used as good proxies for competencies.
Appropriate measurement instruments need to be developed for all the variables identified in the causal relationship diagrams. Let us consider some methods of measurement. Quality of tests will depend on how well the test questions are designed to test the learning objectives defined at the beginning of the semester. The learning

objectives can be defined in the context of Bloom-Vincenti framework (Bhat and Rao, 2005). This framework enables the instructor to prepare learning objectives of a course in the context of identified competencies to match with the needs of the industry. The levels of knowledge in the cognitive domain are Recall, Comprehension, Application, Analysis, Synthesis and Evaluation (Bloom, 1956). The test questions should be distributed appropriately among the six levels of Bloom's taxonomy while paying attention to the relevant categories of knowledge. The relative weights given to the six levels need to be fixed in advance by a group of experts. The quality of test paper can be ranked between 0 and 1.5 depending upon how close the questions are distributed as per the prescribed weights. The quality of evaluation can be measured on a scale 0 to 1.5 as determined by two or three independent experts from the manner examiner evaluated the answer scripts. Similarly, a group of experts drawn from academic and industry sectors can evaluate the quality and scope of the syllabus on a scale of 0 to 1 in the context of stated programme objectives and curriculum design.

It is not necessary to measure all the variables all the time to develop a system for measurement of quality of the programme. A group of experts can evaluate the majority of the variables once in a semester or a year. The grades or marks obtained by students in all mid-term tests and final examinations can be captured at the end of each semester in a tabular column. Combined with the other measurements it is possible to create feedback reports to the individual faculty, the Heads of departments, the Principal/Director and the Management and any other regulatory authorities.

4.2 Implementation of CPM

The Competency Profile Model (CPM) presented here, besides serving as a means for measurement of quality of engineering programme for accreditation, also serves as a platform for continuous evaluation and improvement from course level to programme level and a source of information to which all stakeholders can be connected. However, a number of measurement instruments need to be developed and validated on a large scale. The sequence of tasks to be undertaken to establish a mechanism to monitor the state of a programme on continuing basis are:

- Develop instruments to measure 'quality of test instruments', 'quality of evaluation', 'quality of syllabus', 'content & organization of lab experiments' and 'quality and scope of project work'.
- Establish procedures for scheduling these measurement and the mechanisms of measurement.
- Establish a method of warehousing the collected data tagging with metadata related to students and programmes.
- Work out dependency maps for all the courses in all programmes.
- Prepare learning objectives at programme, course and module levels.
- Develop a method that would periodically review and modify the curriculum and syllabi of all courses with the help of industry experts and experts at other academic institutes and
- Develop a method of creating feedback reports to all the stakeholders.

The proposed framework asks for certain amount of homework from faculty and administrators. A Schematic diagram of entire performance evaluation cycle that includes all the P-D-M-A (Plan- Design-Measure- Analyze) activities are displayed in Figure 2. The performance evaluation cycle is developed on three major processes.

They are Learning objective setting process, Outcome assessment process and Programme improvement process.

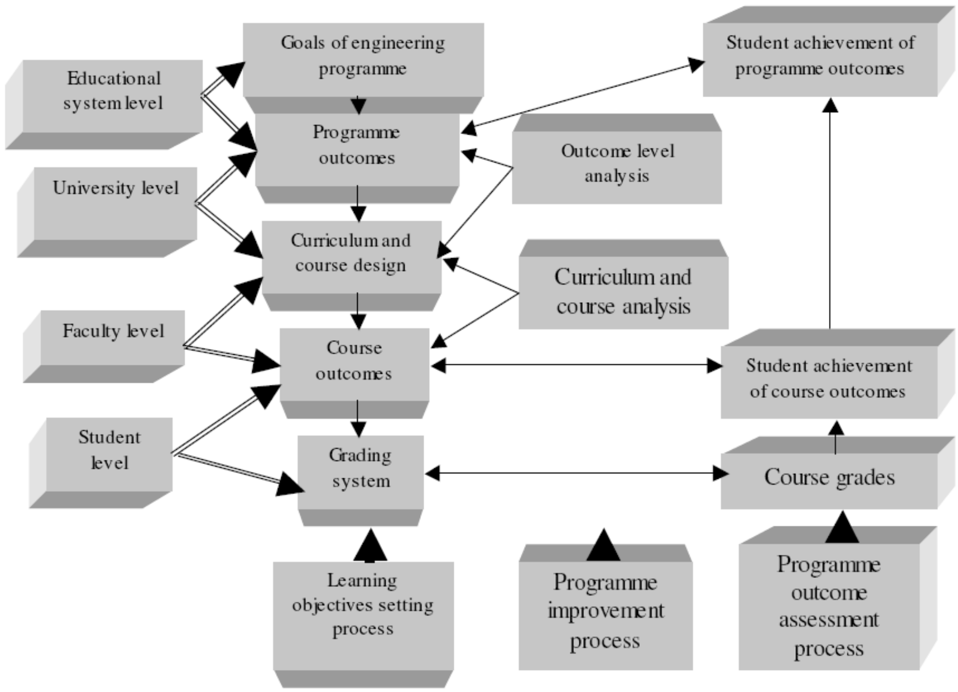

Figure 2: Performance evaluation cycle

Learning objective setting process: This process begins by the decision on the goals of undergraduate engineering education at the level of policy makers like AICTE and UGC. By considering the achievement of this major goal, the goals of programmes affiliated to a university can be set at the University level. This will lead to the decision of programme outcomes, which should be achieved by the students at the completion of their studies. Now the design of the curriculum and the course content can be developed by the Board of studies of the University, which comprises of the faculty members of the concerned programmes. The faculty members teaching these courses, after considering the background of the students studying the courses, can finalize the expected course outcomes and the grading system for assessing the achievement of these course outcomes.

Outcome assessment process: This process begins with the assessment of student performance in the testing methods associated with the grading system. As the testing methods are designed to measure the achievement of learning objectives, the scores obtained by the students in them will give a direct indication of the achievement of course outcomes. The cumulative course grades of all the subjects coming under a programme will give the status of achievement of the programme outcomes.

Programme improvement process: The success of a programme can be viewed in two planes, one internal and the other external to the programme. The internal success can be assessed by the attainment of programme outcomes by the students. If the student grades are poor, it is an indication of internal failure. This situation arises out of two reasons. The first one is grading system is good but student quality or quality of instruction is poor. Second reason might be that the grading system is poor to reflect the student achievement of course outcomes or of high standard and hence the students cannot perform well in the testing methods. The external approval of the programme depends on the quality of curriculum, quality of syllabi and quality of testing methods. Proper actions should be taken by considering these aspects and after analyzing the various constituents of the performance evaluation mechanism.

4.3 Self-Assessment Mechanism

The activation of these processes asks for the development & maintenance of a centralized database system. A data warehouse, which warehouses information in a secured computing system environment, can provide the means and support for the assessment activities. This data warehouse will allow multiple users to extract meaningful, consistent and accurate data for analysis and decision-making. A well-designed data warehouse creates an assessment environment in which human energy can be focused on the process and not on the gathering of facts. One of the main advantages of the proposed framework might be the provision of self-assessment of student performance, courses performance as well as programme performance. This self-assessment mechanism is demonstrated in Figure 3. The process begins with the setting up of course objectives by the faculty for the courses designed by the Board of studies of the University. It proceeds through the course delivery, assessment of performance and analysis of results. The mechanism also includes a feedback process for the corrective actions, if needed.

4.4 Competency profiles and measurement of quality

Pending the development of all measurement instruments, procedures, models and infrastructure, it is still possible to make an effective use of the CPM. For example, the competencies can be averaged (Arithmetic mean) over a stream of subjects to determine the competency of the student in that stream. This method can be followed for any stream of subjects including theory papers and laboratory courses. The Competency profile of a particular student at the end of the programme can be viewed as a set of numbers associated with different competencies and streams. The programme can be characterized either as averages over all the students of a batch or as minimum-maximum-median of a batch or any other method of aggregation.

The Competency profile of a particular student at the end of the course can be viewed as a three dimensional figure with the three axes representing the competencies in theory subjects, laboratory, and project work. The Competency profile of the programme at any instant of time can be viewed as a four dimensional figure, three axes of which are the averaged competencies of all the students studying in that programme at that instance of time and the fourth axis representing quality of curriculum. Hence, two sets of Competency profiles can be used for the assessment of performance, one set connected with students and the other with the programme itself. Visual representations of Competency profiles of the students as well as the programme in terms of various competencies can be prepared using Radar charts. It can be noted that all the stakeholders in the engineering education system including students and faculty members can readily associate with the variables of this model. This enables the model to serve as a platform for continuous assessment of the status of the programme and initiate steps and processes that would lead to continuous improvements.

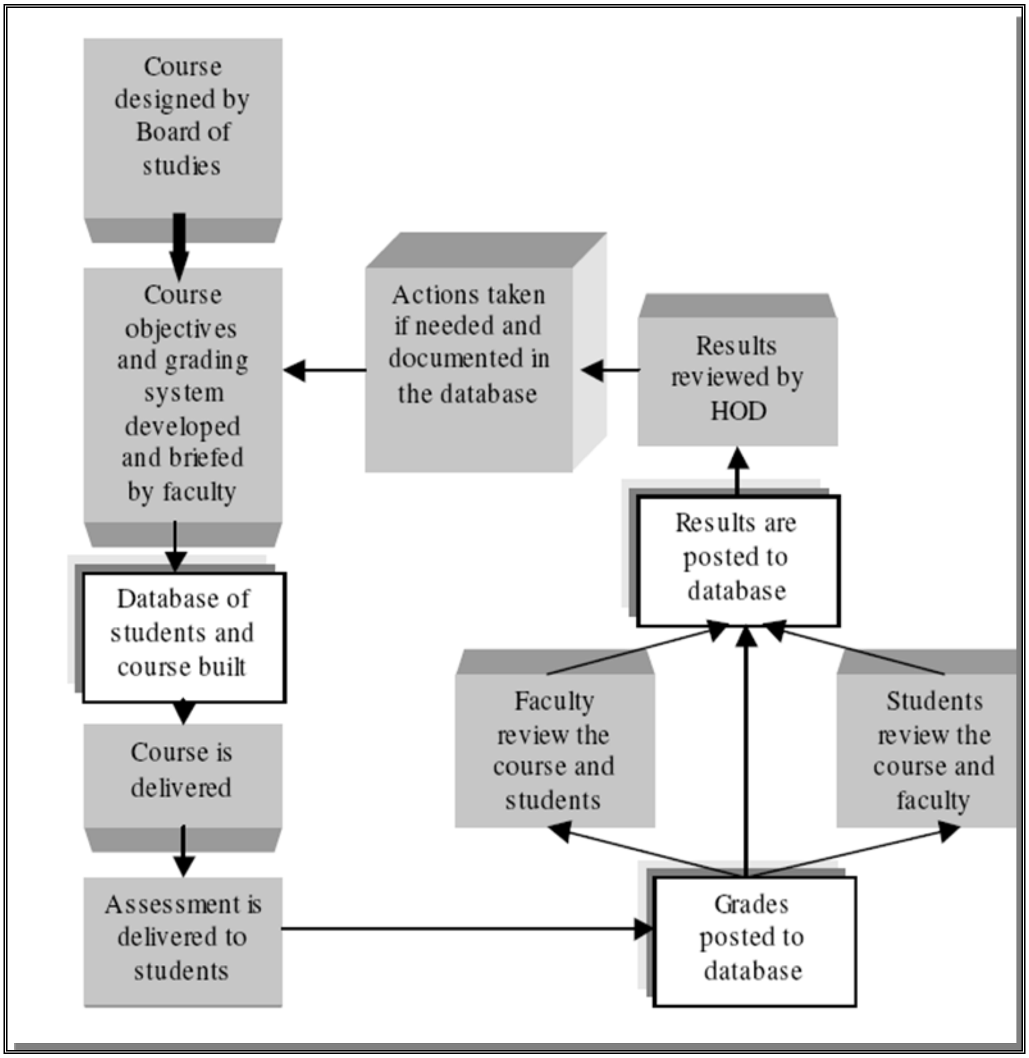

Figure 3: Self-assessment mechanism

5 Case study

A case study is presented in the following to establish a prima-facie case for usefulness of CPM model. A B.Tech. (Mechanical Engineering) programme from an aided college affiliated to a University is selected as the case. The programme was of eight-semester duration. One of the researchers personally visited the college and conducted interviews with the Head of the Department, faculty, staff and students. Data connected with the various components of the Competency profile model for one batch of students have been collected for their entire period of residence (eight semesters) in the college. The details of the programme and the analysis conducted during the case study are depicted in the Tables 1 through 5.

5.1 Quality Indices

'Quality of curriculum' can be determined from the result of these comparisons in consultation with the experts in the field. However, as the role of programmes/colleges (coming under non-autonomous category) in curriculum planning is nominal; the 'Quality of curriculum' is taken as '1' for the present study. A panel comprising of experts from academics and industries is selected for analyzing the quality of university question papers. Two faculty members and one expert from the industry assessed each question paper. Average scores were calculated from expert opinions. Quality indices of testing methods for all the subjects are displayed in Table 1. Various factors connected with the quality of lab experiments and project work were determined and given in Tables 2 & 3.

Table 1: Case study - Quality indices of university question papers

Subject code	Quality of testing	Subject code	Quality of testing	Subject code	Quality of testing
101M1	0.64	403HM/C	0.60	704MD1	0.65
102EPHY	0.83	404MM/C1	0.75	705TE2	0.45
103ECHE	0.65	405TE1	0.45	706ELE1	0.48
104EM	0.65	501MIV	0.59	801GD	0.45
105EG	0.80	502CP	0.60	802PE2	0.48
106BCE	0.70	503MP	0.53	803MD2	0.70
107BME	0.70	504MMC2	0.50	804PPC	0.70
108BEE	0.80	505TD	0.85	805ELE2	0.46
109BECE	0.75	601HMT	0.60	806ELE3	0.70
301M2	0.64	602MM	0.95		
302FM	0.75	603PM	0.25		
303MDR	0.90	604PE1	0.56		
304MMS	0.35	605I&C	0.42		
305SMSE	0.70	701CADM	0.52		
401M3	0.68	702DM/C	0.80		
402ET	0.80	703IE	0.44		

Table 2: Case study - Quality of lab experiments

Lab code	Quality of Testing	Content & organization of lab experiments
ENG110	0.7	1
M306	0.7	1
M307	0.75	1
M406	0.85	1
M407	0.75	1
M506	0.7	1
M507	0.7	1
M606	0.7	1
M607	0.7	1
M707	0.7	1

Table 3: Case study - Quality of project work

Project Code	Quality of testing	Quality and scope of project work
M807Project & Seminar	0.6	1

Quality of question papers seemed to be low. A detailed study of the performance of the students has been conducted to find out the impact of the same. Average marks scored by the students, especially in internals seemed to be very high. It is an indication of poor quality testing methods of internal assessment. However, as the testing methods of internal assessment were not available for analysis, the entire set of internal marks is discarded from the present study. Marks of University examination also seemed to be very high. The low quality testing methods explain the reason for higher marks in university examinations.

5.2 Competencies and Competency profiles

Competence of a student in a subject can be found out as the product of the marks obtained in university examination, quality of syllabus and quality of testing of that subject. Competences of all the students in all the subjects are found out in this manner. Competencies in experimentation are determined by finding out the product of the factors viz., student performance in lab examinations, content & organization of lab experiments, and quality of testing in labs. Stream wise competences of the students are determined by averaging the competences in various subjects coming under that stream. Competencies in project work of students are calculated as the products of student performance in project work, quality and scope of project work and quality of testing. From these competencies, Competency profiles of students as well as programme are calculated. They are displayed in the Tables 4 and 5. Competency profile in terms of various competencies of the sample programme using Radar chart is depicted in Figure 4. This provides a visual representation of the quality of the programme.

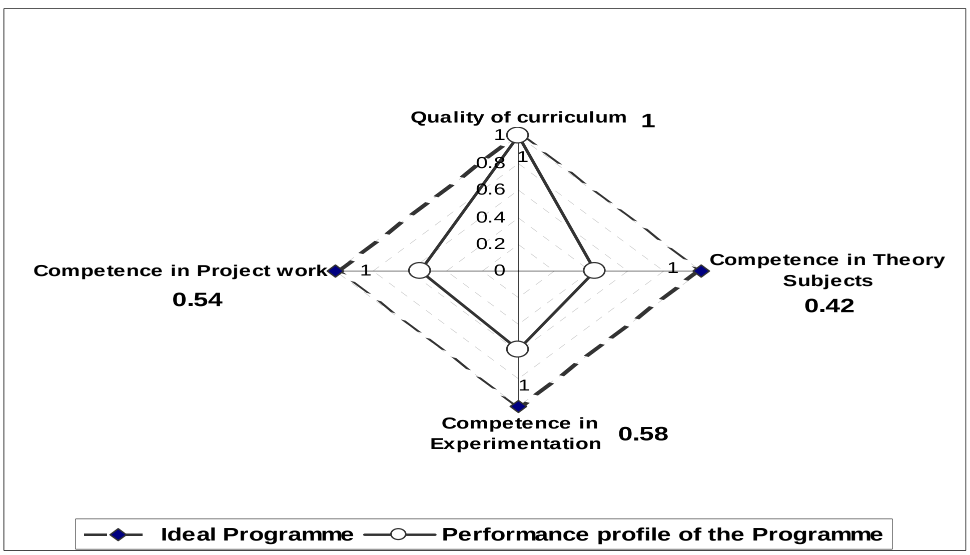

Figure 4: Performance profile of the programme

Table 4: Case study - Performance profiles of students

Roll No.	Competence in stream of subjects							
	Design	Manufact	Thermal	Managemt.	Maths	Theory	Expts	Project
1	0.52	0.38	0.48	0.26	0.52	0.45	0.62	0.53
2	0.45	0.29	0.41	0.28	0.45	0.37	0.6	0.55
3	0.52	0.34	0.5	0.28	0.56	0.46	0.55	0.52
4	0.49	0.42	0.43	0.35	0.43	0.42	0.59	0.56
5	0.59	0.41	0.55	0.34	0.6	0.51	0.66	0.55
6	0.48	0.36	0.43	0.3	0.47	0.4	0.58	0.55
7	0.44	0.35	0.44	0.27	0.52	0.4	0.59	0.48
8	0.45	0.38	0.43	0.29	0.46	0.41	0.58	0.55
9	0.51	0.4	0.49	0.36	0.57	0.47	0.58	0.51
10	0.53	0.4	0.45	0.31	0.46	0.43	0.62	0.52
11	0.38	0.37	0.4	0.29	0.23	0.35	0.56	0.54
12	0.53	0.41	0.52	0.32	0.5	0.46	0.66	0.57
13	0.38	0.31	0.4	0.29	0.45	0.37	0.48	0.58
14	0.57	0.4	0.47	0.29	0.54	0.47	0.59	0.53
15	0.48	0.36	0.4	0.27	0.52	0.41	0.57	0.53
16	0.4	0.38	0.46	0.28	0.5	0.4	0.6	0.58
17	0.48	0.37	0.43	0.27	0.54	0.41	0.61	0.56
18	0.55	0.39	0.53	0.31	0.58	0.49	0.63	0.56
19	0.35	0.31	0.24	0.23	0.3	0.29	0.46	0.55
20	0.45	0.35	0.41	0.25	0.52	0.39	0.52	0.44
21	0.48	0.39	0.42	0.3	0.54	0.42	0.6	0.58
22	0.54	0.39	0.54	0.33	0.6	0.5	0.6	0.58
23	0.51	0.38	0.49	0.36	0.53	0.46	0.56	0.55
24	0.49	0.39	0.47	0.27	0.55	0.45	0.58	0.56
25	0.39	0.31	0.39	0.24	0.47	0.36	0.47	0.52
26	0.42	0.3	0.39	0.27	0.35	0.36	0.54	0.55
27	0.54	0.43	0.53	0.37	0.58	0.5	0.64	0.56
28	0.55	0.39	0.5	0.32	0.55	0.49	0.6	0.57
29	0.54	0.37	0.49	0.3	0.57	0.46	0.6	0.58
30	0.49	0.38	0.47	0.28	0.54	0.43	0.59	0.54
31	0.53	0.42	0.51	0.29	0.57	0.48	0.63	0.53
32	0.39	0.31	0.41	0.23	0.42	0.33	0.58	0.53
33	0.47	0.36	0.42	0.26	0.32	0.4	0.5	0.49
34	0.43	0.38	0.43	0.27	0.3	0.38	0.6	0.55
35	0.51	0.34	0.43	0.26	0.49	0.43	0.52	0.57
36	0.52	0.39	0.47	0.31	0.41	0.45	0.59	0.54

Table 5: Case study - Performance profile of the programme

Quality of curriculum	Competence in stream of subjects		
	Theory	Experimentation	Project work
1	0.42	0.58	0.54

6 Conclusions

Competency profile Model provides an objective method of measuring the quality of Engineering education Programmes. It provides freedom to NBA to define the accreditation criteria from time to time without fundamentally altering the variables and methods of measurement. However, widely accepted measuring instruments need to be developed and validated. It has been established that all the stakeholders in the engineering education system including students and faculty members can readily associate with the variables of this model. This enables the model to serve as a platform of continuous assessment of the status of the programme and initiate steps and processes that would lead to continuous improvements. Besides, the associated data warehousing would greatly help the management in discerning the trends and make appropriate policy changes if necessary. Detailed design, development and implementation of the model as well as an analysis of performance of engineering programmes based on this model are recommended for future research.

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