

# OUTCOME BASED ENGINEERING EDUCATION: A CASE STUDY ON IMPLEMENTING DMAIC METHOD TO DERIVE LEARNING OUTCOMES

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## ABSTRACT

*Define, Measure, Analyze, Improve and Control (DMAIC) tool used in Six Sigma (invented in 1980's at Motorola company) is a world-wide renowned quality improvement methodology that is used on removing defects from the products, services and the processes. Even though DMAIC was limited to manufacturing and production industries in its initial applications, has spread to other sectors with its increasing popularity. The researchers have applied DMAIC methodology to improve the student performance and a study was conducted using the DMAIC methodology in the Outcome based Education (OBE) to improve the performance of students and improve the teaching and learning process. The paper discusses about how the DMAIC methodology can be used to improve the outcome of the teaching-learning process and enhance the teaching process by applying quality assurance tools in an engineering education environment*

**Keywords:** Outcome Based Education, DMAIC, Fishbone Analysis, Teaching and Learning Process, and Learning Outcomes

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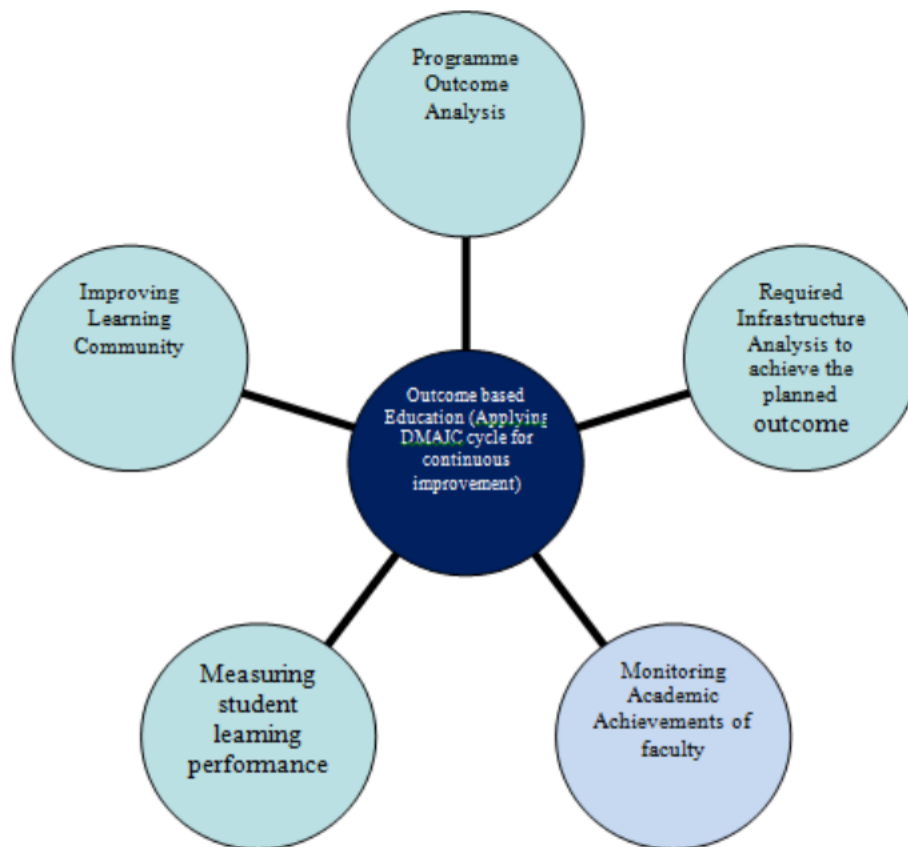
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## 1. INTRODUCTION

The departments have to pursue such a path to achieve achieved a range of performance goals, including increased success rate, campus placements, industry readiness, and higher studies enrollments. The departments focus on ongoing commitment to academic quality improvement efforts that are evidence-based, integrated into the daily work of the faculty, an effective

monitoring and assessment system and the processes that are effective, efficient, and finally lead to desired students outcomes. The continuous improvement in teaching and learning practice would also improve the operational practices of the departments. We started our initial research into the department's processes and defining problem areas. The continuous improvement initiatives in OBE are usually deployed through the Define, Measure, Analyze, Improve and Control (DMAIC) phases which is depicted through the following diagram transforming the quality of teaching & learning process and thus improving the learning outcomes (Fig. 1).



**Figure 1** transforming the quality of teaching & learning process and thus improving the learning outcomes

## 2. DMAIC METHODOLOGY

### 2.1. Define the problem

The Define phase of the DMAIC process is to determine what areas need to be improved. The departments of Computer Science and Engineering and Electronics and Communication Engineering understood that there is a need for improvement due to the lack of proper engineering process and practices specific to the outcomes of the teaching-learning process with respect to the results, career and placements of the students. We are also concerned that the students have gaps in their learning process that lead to skill deficiencies. The students are not participating in extended academic learning opportunities to improve their skills and proficiency. At the same time we are concerned that the more number of faculty members lack the skills and strategies to support the unique educational needs.

The following are considered during this phase in order to understand how each member understands the teaching-learning process and areas of improvement needed. The challenge with concentrating on small number of goals to reach than more number of goals at a time is there will be a high number of competing demands that schools currently manage. Nonetheless, ensuring that goals are clear, measurable, and actionable, while reducing their number as feasible, can support continuous improvement efforts.

The following activities are carried out during this phase:

- i. Conducting SWOT analysis involving the faculty members (faculty of Department of Computer Science and Engineering and the Department of Electronics and Communication Engineering) to gather relevant information.
- ii. Process mapping
- iii. Analysing the students, parent, and alumni feedback
- iv. Analysing the results and outcomes
- v. Suggestions from Industry experts
- vi. Exit Survey of the passing out students

The deliverable of this exercise is to identify the relevant elements of the process establishment or process improvement. The main objective was to improve student performance by lowering the percentage of the slow learners and improve the campus placement percentage to 50% by creating skill oriented learning environment.

## **2.2. Measure the current situation**

In the journey of continuous improving, the departments started understanding the factors that affect the processes currently followed along with the learning outcomes and framed out an a continuous improvement approach to increase the likelihood of achieving the desired outcome. New practices were incorporated into the prime stakeholders' activities and the organisational structures of both the departments underwent changes to support continuous improvement efforts considering the following factors.

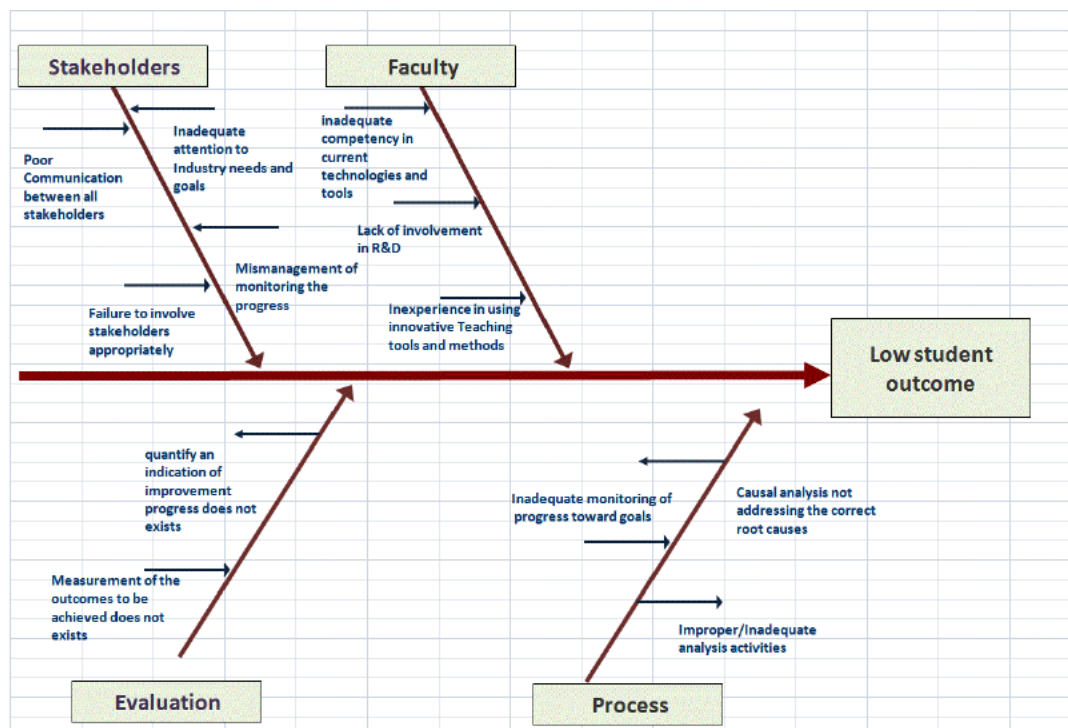
- i. Focus on continuous improvement as a main agenda of accreditation to NBA and NAAC
- ii. The improvement plan provides faculty training to be of high priority
- iii. Set specific goals to faculty in line with students' achievement and outcome
- iv. Practical and Research effective practices involving students
- v. Develop and implement action plans aligned to professional development

Identifying & measuring of the critical to quality characteristics should also flexibility to customize to meet the needs of their individual contexts monitor progress toward achieving the students' goals. The data is gathered and summarized to address the problems identified.

## **2.3. Analyse to identify root causes**

The fishbone diagram is a tool that determines the potential root causes of a problem. Here the problems may refer to ongoing efforts to improve operational practices and processes related to achievement gaps or student outcomes.

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**Figure 2** Fishbone Analysis

The fishbone analysis or the Ishikawa (Fig. 2) was carried about improving the focus on the student's outcomes and industry readiness, closing achievement gaps, and increasing the success rate (graduation rate). The continuous improvement needs the timely and accurate data to provide feedback and improve teaching and learning practice.

### 2.4. Improve

The departments established Programme Assessment Committee (PAC) in each department to analyse the data collected from feedback from the students, parents, and Alumni and also analysed the results and programme outcomes of the passed out batches. The departments also felt that conducting SWOT analysis involving faculty members would be the best approach for analysing the collected the data via observations, industry experts, surveys and industrial visits. Finally the PAC presented its findings and a proposed improvement action plan (Table 1) for the improvement was given by the Department Advisory Committee (DAB) for discussion and approval for the year current academic year (2018-19).

GOALS	ACTION PLAN	RESPONSIBLE PERSON		ANTICIPATED PERIOD OF COMPLETION
I	Action Plan for Increased Learning Outcomes of the Students			
A	Accreditation.			
	Obtain NBA accreditation for Computer Science and Engineering programme	Head of the Department	NBA Coordinator for CSE	2018
B	Encourage outstanding students to participate in exchange programs.			
	Provide outstanding students the skills required to get placements in campus recruitment as well as off-campus recruitment Motivate students to do certifications in emerging technologies	Head of the Department	Department Placement and Internship Coordinator	Ongoing
C	Offering a percentage of courses through blended learning systems.			

	Ensure that students learn through online interactive resources	Head of the Department	Department Training Coordinator	Ongoing
	Ensure vibrant teaching-learning process, mostly learner-centric are used viz. Learning by Doing, Course Based Projects, Field visit / Guest lecture, Certificate courses, Project Based Learning through the establishment of Advanced Technology Group (ATG) among the faculty.	Head of the Department	Faculty	Ongoing
	Conduct Training Needs Analysis (TNA) at beginning of the academic year to ensure that the faculty attends the training in the relevant areas of their subject knowledge and research areas.	Head of the Department	Faculty	
D	Continue to mandate the use of English as the instructional language.			
	Ensure that the instruction by the faculty in the classroom is in English language.	Head of the Department	Faculty	Ongoing
II	Action Plan for Finishing School and for improving the Performance of Academically Weak Students			
	Conducting of remedial classes & expert sessions	Head of the Department	Faculty	Ongoing
III	Action Plan for Enhancement of research and consultancy activities			
A	Identify areas of research.			
	Periodically, identify and justify new areas of priority for research	Head of the Department	Professors and Associate Professors	Ongoing
	Conduct workshops and seminars to orient the faculty in core areas of research and research methodologies. Form Special Interest Groups (SIGs) to discuss and share research ideas and do collaborative work	Head of the Department	Professors and Associate Professors	August 2018
	Develop a collaborative program for applied research with regional and national governmental and private sectors.	Head of the Department	Professors and Associate Professors	2018
	Continue to motivate students to participate in competitive research projects	Head of the Department	All Faculty Members	ongoing
	Encourage participation in CSI, Institution of Engineers (India), and IEEE chapters.	Head of the Department	Respective Coordinators	Ongoing
B	Encourage faculty members to compete for national and international grants.			
	Motivate faculty members to apply for various grants both national and international. Initiate collaborative contracts with various agencies for research and training.	Head of the Department		Ongoing
C	Encourage faculty and students to participate in both national and international conferences, workshops, and exhibitions.			
	Provide financial support and reward to faculty and student who present a paper at a national and international scientific conferences and workshops. Provide motivational rewards to faculty and students who participate at national and international activities.	Management and Principal	Head of the Department	Ongoing
D	Enabling faculty to take up Consultancy work			

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	Establishing Facilities for getting consultancy work from industry	Head of the Department		Ongoing
E	Professional certification			
	Continue to promote APSSDC.	Head of the Department	SPOC	Ongoing
	Work with Cisco to establish Cisco academy.	Head of the Department		September 2018
F	Establishment of Incubation Centers			
	Establishment of Multimedia and Creativity Lab. Establishment of Business Intelligence Lab.	Head of the Department		2018
V	Action Plan for Increasing Extra-Curricular Activities.			
	Establishment of a student scientific, social and cultural clubs. Continue to promote effective student participation in various technical activities. Encourage participation of students in social and cultural activities.	Head of the Department	Event Coordinator	Ongoing
VI	Action Plan for Improving Employability of the Students			
	Guidance/counseling facilities for outstanding students be made proactive and training/placement activities strengthened to benefit them in a bigger way Provide training by Professional Trainers	Head of the Department	TPO	Ongoing
VII	Action Plan for Improving interaction with industry (Industry-Institute-Interaction)			
	Conducting workshops and sessions by industry experts Establishing Facilities for getting consultancy work from industry Student Internship in industry	HoD	I-I-I coordinator	
VII	Action Plan for ICT Infrastructure to be strengthened and upgraded to avoid its obsolescence			
	Laboratories to be equipped with the ICT facilities like Internet, Projector, Audio Visual facilities	HoD	System Administrator	Ongoing

**Table 1** Action Plan to implement Continuous Improvement Process to derive Learning Outcomes

Learning is a participative driven approach involving both students and faculty to achieve the following outcomes: collaborative working environment, problem/project based learning, strengthening the competencies, focuses on Industry-Institute-Interaction, educational equity and career oriented learning. As the industries need skilled workforce, the departments recognized that there is a need for the students to adopt technical knowledge and skills which must be mastered in the college itself. This requires a concrete foundation of academic, as well as additional skill oriented education beyond the curriculum. The institution established IQAC and put in place an academic quality management framework to implement and encourage a culture of continuous self-improvement through self-reflection of processes and best practices of various programmes. The departments in order to examine the possibilities for improvement in teaching and learning process initiated a learner-centric environment to be followed at the department level with the following practices:

- i. Department action plan and targets
- ii. Conducting departmental meetings of various committees established

- iii. Record of content delivery through lectures, practical etc.
- iv. Result analysis semester/annual of courses in relation to set targets.
- v. The CO, PO and PSO attainments computed are the quality indicators
- vi. Results and interpretation of indirect assessment
- vii. Identifying curricular gaps and strategy to bridge the gaps
- viii. Significant activities such as research and services, co- curricular and extracurricular activities to support program outcome
- ix. Corrective action envisaged and
- x. Recommendations of Department Advisory Board

## 2.5. Control

The control phase ensures that the future improvements and the goals of the proposed action plan can be consistently maintained and controlled. The specific skills students need to learn can be measured by going beyond the summative assessments to evidence-based formative assessments. By doing this, students' learning trends can be assessed by implementing new strategies or mechanism to improve the efficiency of the faculty to assess whether the professional learning needs are being met.

## 3. CONCLUSION

DMAIC is a continuous improvement model can be used as an iterative process for ongoing quality improvement. DMAIC methodology implemented in OBE will help to improve the performance of both the faculty and students. This study provided an opportunity to identify root causes that affected the educational outcomes and improve the processes that deliver the best possible learning outcomes.

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