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Review Article

Adaptation of Outcome-Based Education System in Pakistan for Engineering Disciplines and its Critical Evaluation

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Abstract: Pakistan has become a part of the Washington Accord in 2017 and started making reforms in its education sector. Outcome-Based Education (OBE) has been emphasized by Pakistan Engineering Council (PEC) for the accreditation of all engineering degree programs. This paper presents some basic literature on the existing educational models in the world and the Outcome Based Education-OBE structure that has been implemented in Pakistan yet. Pakistan has successfully designed the Program Education Objectives (PEOs) and Program Learning Objectives (PLOs) for the academic sector. PEOs are the mission/vision statements that define the career and professional goals which the program is preparing students to achieve. PLOs are the quantifiable statements that define the knowledge and skills expertise of the students upon graduation ceremony. A survey has been conducted by employers to assess the skill level of fresh graduates against 12 PLOs of the OBE system in Pakistan. Of these, the PLOs related to four measurable statements namely: (i) Problem Analysis, (ii) Design of Solutions, (iii) Investigation, and (iv) Environment & Sustainability are found underperformance as surveyed from the industry sector following the performance of freshly graduated students. The survey also includes the Key Performance Indicator (KPI) evaluation of faculty members both from the department heads and the students too. This result shows underperformance of 15 % of the teaching faculty as per prescribed grading ranges. However, the OBE faces some difficulties as well and unfortunately, there are not so many graduates who entered into the industry after learning from OBE. It will, therefore, take some time to deliver the results of OBE implementation in Pakistan. Furthermore, some other education reforms from around the globe have been presented in this paper and some suggestions have been provided.

Keywords: Outcome Based Education, Pakistan's Educational Reforms, Program Education Objectives, Program Learning Objectives.

1. INTRODUCTION TO EDUCATIONAL MODELS

Education is typically a dimension that deals with the method of teaching and learning environment in schools. It is a continuous process of facilitating, learning, acquisition of knowledge, wisdom, skills, morals, belief, habits, and personality grooming. On the whole, education plays a vital role in the development and polishing of a society and a community. It is believed that economic growth is directly related to the education infrastructure in a positive direction [1].

UNICEF is providing facilities for learning and skill development in 147 countries across the globe with the objective of quality, learning skills, equality to all, and emergency and fragile context [2]. In different parts of the world, countries have adopted and developed techniques for learning and teaching environments, and day by day these systems have been in a continuous process of making reforms in their design. Globally, there are seven (7) models designed for education and academic institutions. These models include Science Technology Engineering Mathematics (STEM), Project Based Learning, Inquiry Based Learning, Interdisciplinary Collaborative Learning, Neuroscience, Place-Based Education, and Multiage Learning models [3]. The Model STEM uses four basic and strong tools of life altogether by creating a meta-discipline. It encourages

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students in a curriculum that is driven by problem-solving, discovery, and exploratory learning and thus developing a thought-provoking habit [4]. The Project-Based Learning model of education provides students with small tasks in a well-designed process of problem solutions, inquiry, and clear objectives. The projects are usually assigned to the students in several groups for their learning [5]. The Inquiry-Based Learning model of education is a learning process involving the interest, curiosity, and perspective of students. The Interdisciplinary Collaborative Learning model is an education model that uses some recreational environment by uniting all the academic disciplines of medicine, science, arts, and humanities. It involves some common subjects between the two groups. The Neuroscience is an education model that typically involves the use of one's intellectual capacity by some research methodology. It is also commonly termed as mind and brain educational technique [6]. The Place-Based Education model offers interaction of local community and surrounding environment with the learner and this typically involves excursions and field visits. Multiage learning is a system where students are not separated by their grades and it uses some flexible groups where students can be taught together without distinguishing by their grades. These multi-age groups are created on the basis of pedagogical choices of school or learning program [7].

2. OUTCOME-BASED EDUCATION (OBE)

In 1989, an international proposal has been suggested for undergraduate studies of professional engineering degrees and this is termed as Washington Accord [8]. This agreement has to be signed between the regulating body and the academia of countries. It resulted in the proposal of different reforms in education and among these, the Outcome-Based Education (OBE) is one. The OBE system offers an educational reform that works on a very clear concept of what students are supposed to know and are potentially able to do [9]. It is often termed as Performance Based Education in some parts of USA where the student's learning outcome constitutes the whole academic environment including teaching method and materials, grading and assessment techniques, and recreational activities.

The Education Commission of the USA traces this reform back to the 1930s with a study involving 300 colleges and 30 high schools. The participant institutes have redesigned their academic model following the need and interests of their students and their graduates have been found more successful compared to the traditional academies [9]. It was the first time that learning and teaching are linked directly and teaching effectiveness had been associated with the learning outcome of students. The outcome must be a measurable unit and should have some deliverable activity. The assessment criteria may vary in different institutes but it must reflect an outcome of the student's strengths or weaknesses. It can be achieved by making a rubric within a subject or maybe in terms of levels like beginner, basic, expert, etc. [10]. Asim *et al.* [11] have identified some factors influencing the design of the infrastructure of OBE in developing countries including Pakistan. He found Learning objectives, Assessment methods, Learning styles, English language competency, and Employer graduate requirements as the primary factors to be considered in OBE. Katawazai [12] has researched the implementation of OBE in Afghanistan and pointed out the difficulties there. He claimed that content-based curriculum, policies of teaching, learning, and assessment, lack of facilities, and teachers' workload are the key hindrances in adopting the OBE system in Afghanistan.

3. OTHER EDUCATIONAL REFORMS IN THE WORLD

Several countries including Australia, Malaysia, South Africa, and the majority of the European Union had adopted OBE in the past but soon removed this theory from their education infrastructure and worked on alternative reforms. The reasons for detracting from OBE are lack of evidence of its success, overburden for staff and students, dissatisfaction with the testing and assessment approach, and to some extent the admission requirements for the degree program. Thus, instead of OBE, some other reforms in the education infrastructure were made and the two most famous models namely, Competency-Based Education (CBE) and Work Based Learning (WBL) were used. These two theories are found as successful as OBE and are discussed as follows:

3.1 Competency-Based Education (CBE)

Competency-based education (CBE) is a student-centered education theory that focuses on the learning outcomes considering the interest and needs of the learner [13]. It involves the process of self-learning plans in parallel to the scheduled classes to bring out the mastery of a student's competencies. A competency can be defined as a package of knowledge, attitude, and skills and this is somewhat similar to vocational training. The basic attribute is to understand how a learner can learn the skill and performance, and much more important is to identify a competency for a student and work on its fine-tuning [14]. CBE provides students the chance to use their past experiences, skills, and knowledge to complete a course, get a degree, and/or participate in training to fulfill their goals [13].

3.2 Work-Based Learning (WBL)

Work-based learning is an educational reform that provides a student with real-life work experience from the industries. European Union in the majority is working on the WBL system and has made it mandatory to gain professional experience parallel with studies in the form of work student, internships, and part-time experiences. WBL deliberately combines theory with practice and acknowledges the intersection of clear explicit and tacit forms of knowing [15]. It has a benefit of a strong liaison between academia and industry [16], the generation of a more practical skilled pool of future employees, student awareness of career opportunities, and a reduction in pre-service training time and cost. However, it needs careful consideration and planning when imposing WBL as it consumes time to identify the key courses to be taught in degree programs.

4. OBE STRUCTURE IN PAKISTAN

Among all of the above-discussed educational reforms, Pakistan has started implementing OBE in its tertiary education system as per the policy of the Higher Education Commission (HEC). In many graduate programs including management, social and applied sciences it has opted for many years ago but engineering education was a bit lazy in this context. Pakistan Engineering Council (PEC), a statutory body to regulate the engineering profession including the mandatory education structure signed the Washington Accord in 2017 and thus instructed the HEC and affiliated institutions to make educational reforms under OBE [17]. This has been observed when Iqra National University in Peshawar started to propose a structure for Faculty Course Assessment Reports-FCAR for the assessment and monitoring of students' performance in the Department of Electrical Engineering and it was the first step toward OBE [18]. FCAR technique is a comprehensive document to assess the impact of OBE [19]. Faiz *et al.* [20] did similar research for a different institute. Manzoor *et al*. [21] discussed the transformation of the education infrastructure of Pakistan from content-based to Outcome-based technology and critically discussed the impact in terms of the success and failure of the system. This analysis was carried out typically for engineering graduate programs under the regulations implemented by PEC.

Pakistan has defined the infrastructure for OBE based on nine different criteria as shown in Table 1. Among all the nine criteria, three have gained much importance in Pakistan namely; Class Learning Objectives (CLOs), Program Learning Objectives (PLOs), and Program Educational Objectives (PEOs) [22]. PEOs are the broad statements or mission statements of the Academic Department explaining the goals and milestones which the students are achieving through a specific program. CLOs and PLOs are measurable statements from a course or activity which describe the expertise level of the students upon the completion of a degree

Table 1. Criteria for OBE Implementation in Pakistan

Criteria	Measurable statement
Criterion 1	Program Educational Objectives (PEOs)
Criterion 2	Program Learning Outcomes (PLOs)
Criterion 3	Curriculum and Learning Process/ Course Learning Outcomes (CLOs)
Criterion 4	Students
Criterion 5	Faculty and Support Staff
Criterion 6	Facilities and Infrastructure
Criterion 7	Institutional Support & Financial Resources
Criterion 8	Continuous Quality Improvement (CQI)
Criterion 9	Industrial Linkage

program. The basic difference between CLOs and PLOs is that the CLO relates to a specific course or degree program while a PLO is associated with the whole Department. PEC has defined 6 CLOs and 12 PLOs to maintain the quality of education in engineering degree programs. The details of these CLOs and PLOs are presented in Table 2 and Table 3 respectively. Keeping in mind that the CLOs and PLOs combined result in achieving the PEOs of an organization and each PLO is to be evaluated through a CLO and CLO can be evaluated by any direct and/or indirect assessment [23]. Mahmood [24] has explained very well about the infrastructure and grading system as a part of OBE and described the minimum threshold for passing criteria and the respective assessments for CLOs and PLOs. DHA Suffa University has set a well-defined framework for an OBE structure to be implemented in Pakistan [25]. This framework is shown in Figure 1.

The two direct stakeholders of the OBE system are Students and Faculty staff. Students have the benefits of clarity, flexibility, and involvement in tasks and employment opportunities and they are expected to demonstrate what they know and must accept the responsibility for what they don't know in preparation for continue achieving and reach high performance finally students have to fulfill all the PLOs to obtain their respective degrees. The faculty members are required to satisfy a

Table 2. List of all possible CLOs in OBE Pakistan

Class learning objective (CLO)	Measurable statement
CLO 1	Knowledge
CLO 2	Comprehension
CLO 3	Application
CLO 4	Analysis
CLO 5	Synthesis
CLO 6	Evaluation

Table 3. List of PLOs in OBE Pakistan

Program learning objective (PLO)	Measurable statement
PLO 1	Engineering Knowledge
PLO 2	Problem Analysis
PLO 3	Design of Solutions
PLO 4	Investigation
PLO 5	Modern Tool Usage
PLO 6	The Engineer & Society
PLO 7	Environment & Sustainability
PLO 8	Ethics
PLO 9	Individual & Teamwork
PLO 10	Communication
PLO 11	Project Management
PLO 12	Lifelong Learning

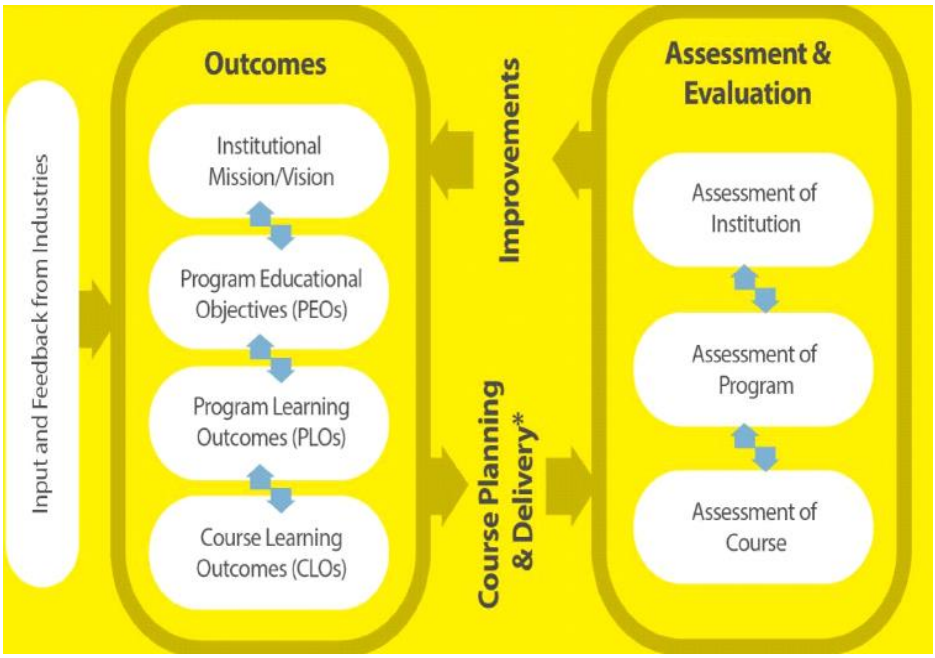

Fig 1. A typical framework for OBE in Pakistan [25]

Key Performance Indicator (KPI) evaluation for each semester. KPIs are the targets and goals defined to strengthen the Institution's ability to evaluate how well a department is going to support the students in achieving the skills, knowledge, and personal grooming. PEC has associated these KPIs with the faculty members to bring strength to the Department's ability to design a specific program in a better way. The KPIs include factors such as their regularity, punctuality, lecture delivery and knowledge, research projects and publications, conferences and seminars, and arranging site visits. The KPI ranges for the faculty members are shown in Table 4 [26].

In a small survey, students were questioned about the OBE system w.r.t. its policies, probable advantages and outcomes, and shockingly, the majority of these students were even unaware of what the OBE is. The feedback from the industry, however, seems satisfied with the implementation of OBE. Figure 2 shows the satisfaction level of employers with the performance of freshly graduated students for each PLO. The PLOs with 50 % satisfaction can be termed as successfully implemented but it shows many of the dimensions to be handled carefully in the future.

To assess the successful impact of OBE, the KPI evaluation has been made for the faculty members of different engineering disciplines from various institutes. The KPI evaluation has been made through the Department Head as well as directly from the students to analyze the more realistic and true response. A random survey has been made by Department to get the results of KPI reports confidentially and the results are presented graphically. Similarly, a group of 1000 students was questioned randomly to evaluate the KPI scores of their teaching staff, and the results are summarized graphically. The results of both surveys are shown in Figures 3 and 4 respectively.

Table 4. KPI range for faculty members [26]

KPI range	Performance level
Below 50	Under Performance
50-60	Satisfactory Performance
60-70	Good Performance
70-80	Very Good Performance
80-90	Excellent Performance
Above 90	Outstanding Performance

4.1 Advantages and Disadvantages of OBE

Compared to the traditional teacher-centered education system, OBE has provided students more importance w.r.t their fundamental rights. The PLOs have made education multifacet and the KPI evaluation has activated the working strength of the faculty members. On the other hand, it has become much more difficult to monitor the circumstances and results of OBE at such a big national level. Moreover, OBE constituted a more busy workload for faculty members and make it a bit difficult for students as well since they have to satisfy all the CLOs and PLOs to obtain their degrees. [26]

According to the PEC accreditation manual 2014, the OBE needs to be implemented in engineering degree programs in the future. In 2017, PEC became a full signatory member of the Washington Accord [27]. Therefore, since 2017, educational reforms have been made in engineering degree programs in Pakistan and engineering graduates have been introduced to the learning concept of OBE. Since, this is a newly adopted technique of learning in engineering subjects and not so many of the batches have graduated with the OBE concept therefore, it will take a few more years to assess the impact of OBE in the professional industry. Dewani et. al (2022) evaluated the impact of OBE implementation using the comparison of

Fig 2. Performance of fresh graduates with respect to PLOs

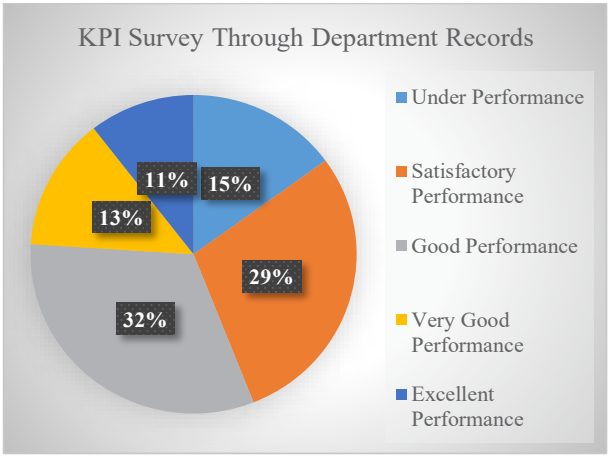

Fig 3. KPI evaluation of faculty members through daepartment records

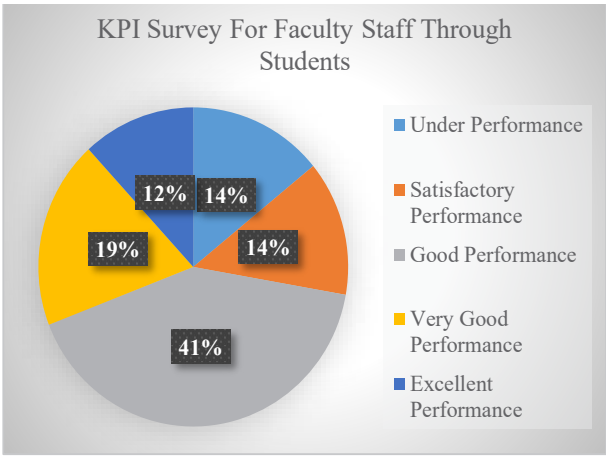

Fig 4. KPI evaluation of faculty members through students

students taught with and without the OBE system [28]. They found OBE more efficient in terms of student learning, grades, and skill competencies.

5. CONCLUSION AND RECOMMENDATIONS

Pakistan started implementing OBE in 2017 for all of the engineering degree programs under the PEC guidelines and successfully designed the PLOs and PEOs for the institutions. Unfortunately, till date, it has not been implemented completely and it will take a considerable time to get results of this educational reform. However, it has made the faculty member to be more academic since they have to present their KPIs at the end of each semester. At the current stage, OBE has kept the academic staff so busy in making policies and regulations that their workload becomes too high and this is resulting in their performance. Some Institutions involved their faculty members in the administrative work of OBE implementation and this has badly affected their academic performance. In addition, PLOs 2, 3, 4 & 7 need to be monitored with more focus as their satisfaction level has been obtained less than 50 % from the employers.

The following suggestions are highly recommended to make the education sector more strengthened:

1. The assessment of students' grades can be made in terms of excellency class rather than numeric scaling. That is *satisfactory, Fair, Good, Very Good, and Outstanding grades*. This will maintain a confidence level in a student as no one is aware of their performance and marking in exams and ultimately, it can help in their learning and communication in their tasks and completing degrees.
2. As the KPI has been implemented for the faculty members, it is suggested to announce their allowances, bonus, and increments based on the KPIs of each semester. It will make the faculty work with full pace of academic strength to participate in the competition.
3. About 15 percent of academic staff has been found under-performance and that might be because of the implementation of new system. Hence, PEC and HEC should conduct seminars and training workshops to keep the academia updated and efficient.
4. Apart from OBE, other models of education such as WBL & CBE must also be considered parallel. Especially, WBL has a more practical influence on the education of future employees.

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7. CONFLICT OF INTEREST

The authors declare no conflict of interest.

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