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Strive for Excellence: Integration of Learning Taxonomy and Paradigm shift to Outcome Based Education

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Rationale:

Outcome Based Education (OBE) system's major focus is on development, delivery and assessment of student learning outcomes. Transformation from teacher centered to student centered learning environment and adaptive approaches to learning in an OBE system.

Objective:

This study was conducted for assessment of the transformation of OBE system, whether the improved course designing, integration of learning taxonomy and change in teaching & learning environment improves process control and student learning experience.

Methodology:

Secondary data of student learning experience, inspection of updated lesson plans, and assessment of process control performance indicators, results of accreditation and 3rd party audits are analyzed. Content analysis techniques are used to measure effectiveness of design activities and descriptive statistics for assessing the impact on student learning experience.

Results:

Significant results are identified after implementation of the DAAR model;

Improved industry involvement,

Public confidence that increases the student application ratio,
Alumni satisfaction index is improved,
Process based KPIs developed to assure learning achievement.
The DAAR model is also recognized by national accreditation body as well as international mentors and assessment team of Washington accord.

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Conclusion:

Educational processes are shifting towards a learning outcomes based approach in modern education model. Knowledge, skills and competences achieved by the learner play progressively significant role in the professional life that presents new lifelong challenges. A theoretical framework DAAR has thus been proposed for learning outcomes based system for academic institution. The proposed DAAR model captures the influence of learning outcomes in the learning designing and assessment process, which determines appropriate teaching and assessment methods.

1. Introduction:

The International Engineering Consortium (IEA) granted Pakistan Engineering Council (PEC) an interim signatory of the Washington Accord (WA) in 2010. Pakistan's engineering education system centered traditionally on the input based education system or teacher centered education system, thereby having no feedback for the student as well as teacher. This is a major obstacle to the continuous improvement of quality of learning. After recognizing shortcomings of the traditional education system, major transformation from traditional education system to Out Come Based Education system (OBE) was carried out which is result oriented and enhances learner's ability to progressively use acquired knowledge and is known as Learner centered learning approach.

Pakistan Engineering Council faced a major challenge to shift its program accreditation requirements from traditional education to an OBE-based education system. Another challenge is the development of new qualification manual and incorporation of OBE concepts and Continuous Quality Improvement (CQI) methods.

Accreditation or external assessment is a powerful tool for quality assurance that can be used to enhance mutual recognition of educational base and professional experience and to promote local quality assurance system (Dodridge, 2002, Szanto, 2005). It also helps educational institution to improve classroom and laboratory facilities and enhance institutional prestige in academic excellence. Stakeholders in the accreditation process include various elements such as: universities, employees, employers, students, professional agencies, etc.

Engineering accreditation board (EAB) of PEC introduced a new accreditation manual based on the OBE approaches (Manual of accreditation, 2014). Since 2014, all undergraduate engineering programs in Pakistan have been accredited under OBE approach which

put a very strong emphasis on development, assessment and evaluation of program educational objectives (PEOs) and program Learning outcomes (PLOs).

The research herein is how to design lesson plan to meet the program's outcomes. Engineering Courses provide students with the knowledge and opportunities to prepare them for industry and further their studies at the graduate level. This study focus on the methodology for creating learning objectives, contribution of outcomes of courses in specific programs' outcome, and assessment methods at all levels. This article focuses on the reasoning of curriculum and lesson plan reform. In particular, this study refers to Bloom's learning taxonomy, which provides structure for course organization and also provides the foundation for teachers to seek improvements. Also discusses the learning outcomes, assessment and learning styles and introduces classification of educational objectives. The learning outcomes of courses require specific teaching and assessment methodologies based on literature review. We will present an implementation model for OBE at an educational institution and some of the benefits measured by Institute of Space Technology (IST) Islamabad, Pakistan.

2. Outcome Based Education:

Outcome-based education is a new model to improve quality in education (Rajaee et al., 2013). It focuses on the teaching and learning expected based on the student's learning outcomes. To achieve the designed outcomes, assessment and performance methods have been introduced and implemented. Recently, two main types of education systems have been implemented, namely (i) problem-based learning and (ii) project-based learning. Problem-based learning is a student-centred approach towards learning. It encourages teachers to facilitate learners rather than disseminators of information (White, 2001). On the other hand, project-based learning is designed to involve students in an authenticated problems investigation and based on objective to educate learner (Blumenfeld et al., 1991). Traditional education systems have focused on pre-defined curricula and assessment systems. The outcome-based education system is relatively new and based on the outcomes framework, which focuses on the capability and competence of learners that are been utilized in the future (Spady et al., 1991). In this system, curricula, lesson plans, assessments, teaching strategies, and performance standards are developed and implemented to achieve the expected outcomes (Spady, 1994).

Outcome based education includes major concepts (i) program educational objectives (PEO's), (ii) program learning outcomes (PLO's),

(iii) stakeholders involvement in defining PEO's and PLO's, a well-developed curriculum to achieve desired program educational objectives and program learning outcomes, (iv) courses mapping to program educational objectives and program learning outcomes for contribution and development of continuous improvement process, (V) course learning outcomes (CLOs). Program educational objectives describe career and professional success that students attain after graduation (Manual of accreditation, 2014). Program learning outcomes are specified attributes that describe what student are expected to know and be able to do by the time of graduation. Those are classified in twelve major categories with specified profile of knowledge, skills and behavioural traits. Also required that curriculum encompasses the desired elements of knowledge.

For implementation of requirements at an engineering university proposed an implementation framework call DAAR - Design, Assess, Analyse, and Review (Waqas et al., 2014). They also propose the three design levels PEO, PLO, and CLO level along with input requirements and identification of major stakeholders of each level.

Design is the first level to define clear objectives for a program, relative required outcomes of the program, curriculum designing and course identification and alignment with curriculum, appropriate teaching methods as per nature and complexity of course level outcome. Here keeping in view variation and complexity of learning outcomes, a learning taxonomy is integrated at each level of designing.

Assessment is the second step which aims to define clear and measureable assessment methods and tools for each level of design activities, ensuring opportunities to achieve the target levels. Many direct and indirect assessment tools have been proposed in literature. Direct assessment tools include course assessment, student satisfaction survey, CGPA index for course, basic exams, senior design project, and program accreditation (Sekhar et al., 2008). Senior exit survey is an indirect program outcomes assessment tool (Othmanet al., 2011). Teacher evaluation is a tool that can be used for the evaluation of teacher performance (Chalmers and Gardiner, 2015) by student feedback which helps to improve teaching skills. Rubrics is another indirect assessment tool that can be used for student's skills and course assessment (Almarshoud, 2011).

Analysis is the third level to implementing an evaluation system for student learning improvement. Appropriate analysis techniques are introduced for getting meaningful results from assessment data.

Review is forth level of model contain the activities of revision of procedure, design, implementation methods, infrastructural facilities and work environment, curriculum or lesson plan, objectives/outcomes and their level of complexity, threshold values of the targets, etc.

3. Taxonomy of Educational Objectives and Levels of Thinking

The learning taxonomy of educational objectives is a program that classifies educational goals and recent standards. It provides an organizational structure that enhances communication by providing commonly understood meanings for the purposes of categorizing in taxonomy's learning category. Based on this exam, teachers can decide where and how to improve curriculum planning and teaching delivery. Several taxonomies were developed to be used in higher education presented some of them as follows;

- Bloom's Taxonomy
- SOLO Taxonomy
- EER Taxonomy
- Fink's Taxonomy

Webb (1997) developed a process and criteria for systematically analysing the alignment between standards and standardized assessments. Since then the process and criteria have demonstrated application to reviewing curricular alignment as well. Webb describes his DOK levels as "nominative" rather than as a taxonomy. Depth of knowledge is identified in four levels; 1) recall, 2) skill/concept, 3) strategic thinking, and 4) extended thinking (Hess, K., 2006, 2013).

4. Bloom's taxonomy

Bloom's taxonomy has been widely accepted for engineering education with a universal agreement that engineering graduates should be competent at analysis, synthesis and creativity (Williamson, and Koretsky, 2007, Bloom et. al. 1956). There are more than one type of learning which are clustered in three domains; cognitive, affective and psychomotor. Bloom developed taxonomy (hierarchy) of cognitive learning skills which allows educators to evaluate learning of students systematically (Barrett, 2009). The categories were ordered from simple to complex and from concrete to abstract (Krathwohl, D. R., 2002., Goel and Sharda, 2004). Instructors categorize the learning objectives they have constructed into either lower or higher cognitive domains, according to Bloom's taxonomy. Based on the cognitive level, they create a teaching and an assessment plan consisting of three methods to assess

each learning objective. Methods of teaching and assessment are specifically matched to the cognitive level of the learning objective. Collection of performance evidence becomes increasingly more difficult as increasingly higher-level thinking is required (Williamson, and Koretsky, 2007). Bloom's action verbs introduced by Anderson in 2001 can be used to connect all areas of the curriculum and to accommodate measurement and assessment.

The students also experience much higher learning when engaged in such processes. Conception of creativity includes an interrelated set of intellectual skills of creative thinking, critical thinking, and innovative problem solving; personal characteristics of versatility, tolerance for ambiguity, willingness to take risks, open-mindedness, confidence, curiosity, and values of discipline, perseverance, and responsibility. Engineering students report more effective learning when they are engaged in higher order cognitive activities through active learning. Even in the opinion of professional engineers, faculty should engage students in higher level cognitive activities like analyse, design, develop, implement and so on (Goel and Sharda, 2004).

5. Development of Program Objective

Department approached development of the programme educational objectives through an iteration process consists of design, assessment tools, analysis methods and improvement mechanism. It started with a brainstorming session which identified major stakeholders of the programme and institutional vision and departmental mission. Their concepts and requirements were interpreted based upon the relevant documents and role play as stakeholders (Besterfield et. al, 2003). Objectives must also be in line with the vision and mission of the institution. Department also kept in view of the other stakeholders which were parents and general public, alumni, and students. Also provides the explanation of the keywords used in programme objectives and contribution in bloom's learning dimensions as well as measurable elements in order to avoid different interpretations in future.

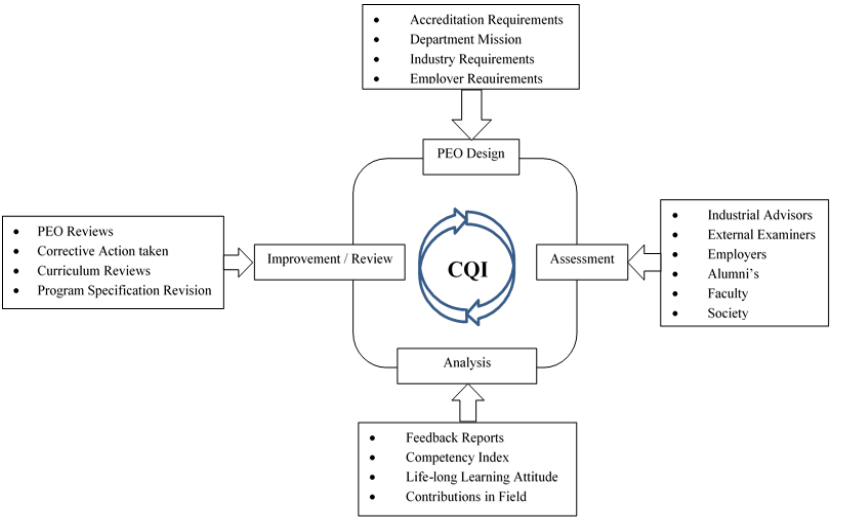

Figure 1: Process of PEO development and improvement

6. Development of Program Learning Outcomes

Results of course study illustrate the acquisition of students' capabilities, and department must ensure that they achieve the desired outcomes upon graduation. There may be a debate on which basis to develop the results. As engineering graduate attributes were available in accreditation manual and the move by PEC to become a Washington Accord signatory. Each programme learning outcome must not be too many in numbers and verity of capabilities, as it would create difficulty in mapping PLOs to course learning outcomes, hence their assessment and achievement becomes difficult. All PLOs should address the scope of PEOs and address the level of difficulty derived based on bloom's learning taxonomy if using top down approach of development. Also ensure to define an iterative process that consists design activities, assessment tools, analysis methods and improvement mechanism.

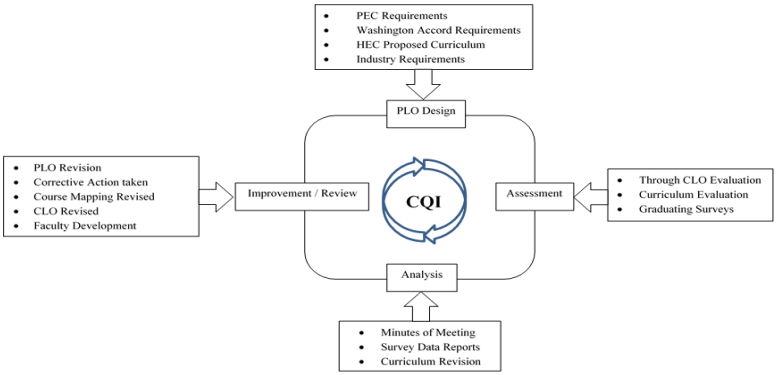

Figure 2: Process of PLO development and improvement

7. Development of Lesson Plan and Course Learning Outcomes

Describing of the each module with course learning outcome enforces the faculty member to think creatively on conduct of each course learning outcome. The key performance indicators as to how and at what level of learning outcome is to be assessed. They also indicated by the appropriate teaching methods and assessment tools for each learning outcome within the range of topics and the appropriate hours for the students to grasp required level of competence. After having able to define CLOs for one course and its contribution towards PLOs, it is also required to identify weight of CLO contribution according to level of learning complexity as per identified by bloom's taxonomy.

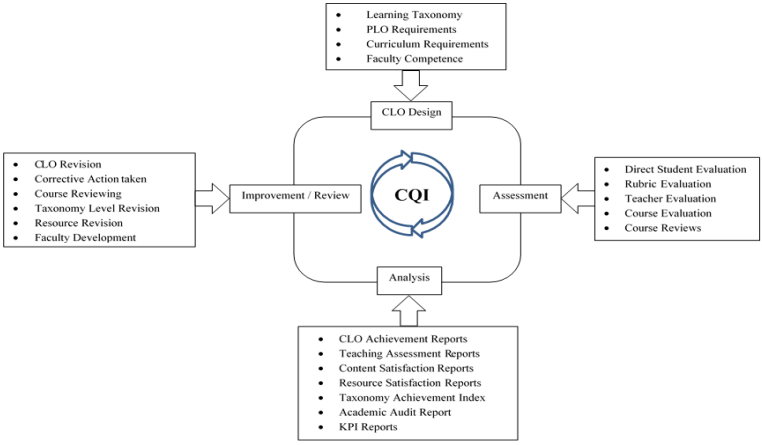

Figure 3: Process of CLO development and improvement

When writing learning outcomes, it is recommended that to focus on student behaviour and use simple, specific action verbs to describe what students are expected to demonstrate. Learning Outcomes can be divided into three main sections:

- An action verb;
- A learning statement;
- Acceptable performance standard.

Key performance Indicators for obtaining CLO, we need to show that students have necessary depth of knowledge, skills and attitude. Project reports, exam answers, class presentations, class observations, communication skills and drawings are all examples of evidences department can provide. It is therefore required that modern teaching methods should be integrated in teaching and learning system to provide the most appropriate learning mechanism.

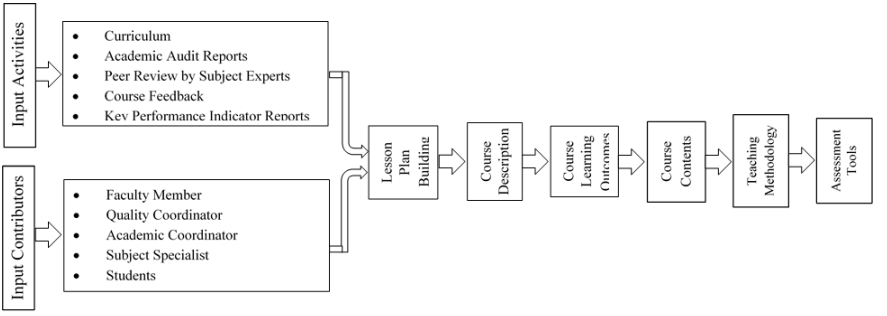

Figure 4: Lesson Plan development process

DAAR model emphasise that each level in OBE must have improvement mechanism. So lesson plan should consider the requirements of associated stakeholders, analysis of associated matrices, results of learning achievement indexes, contribution in PLOs along with other same streamed courses.

8. CQI Mechanism and Identified Results

A portion of a Total Quality Management (TQM) is called 'Contentious Quality Improvement' (CQI). TQM at institute of space technology (IST) focuses on improvements in all areas of the organization while CQI focused and designed for an individual activity or a process. Timeframe of CQI process is much shorter than the TQM. For successful CQI mechanism development and implementation, IST focuses on the

accuracy of recorded data, appropriate analysis techniques, meaningful identification from results and the strong decision making process.

The concept of CQI at course level is based on Key Performance Indicators (KPIs) analysis of learning achieved by students, course self-evaluation by faculty, and students' perception feedback index about achieved level of learning. Based on respective data an academic audit report created to reflect the learning comparison, trend of improvement, grey areas and potential root causes. This report then presented at departmental board of study (DBS) for discussion and decision making. Sometime decision is made at DBS if the clear root causes are identified by analysis and often designate a quality improvement team (QIT) for further investigation and recommend appropriate decision. This approach improve the process of lesson plan revision, helps faculty to improve teaching or assessment skills, made conscious the students to focus on certain capability rather grades, gauge CLOs' contribution towards achievement of PLOs.

Progress of PLO achievement is measured through the contribution of CLOs of linked courses. Their progress reports are presented at DBS for discussion and decision making. It also depends on the year of study of the student and level of course associated with PLO. Curriculum evaluation and review reports, incorporation of industry evaluations, changes from accreditation body can also be considered for improvement of PLOs. Based on recommended changes the process of change implementation is activated. Third level is of PEOs' improvement, the assessment of PEOs is done after the three to five years of graduation. Analysis of Alumni, employer and respective faculty based on the revised trends of respective field development and changing requirements of the industry. The feedback results in terms of career competency, Life log learning attitude and contributions in respective field of study by the graduates is discussed in DBS and recommendations are implemented through change procedure. Based on such recommendations Program specifications, Curriculum or program design may be revised.

	Conventional Education	**OBE based Education**
Inputs	Teacher, students, curriculum, Labs, classrooms	Teacher, Mentors, Learners, Curriculum, Labs, Classrooms, Course Outlines, Course Descriptions
Processes	Teaching (Transfer of Information)	Teaching and Learning

Outputs	Grades of students	Grades of students, Achievement of CLOs, PLOs and PEOs
Planning	Program Structure	Program Structure, Lesson Plans, PEOs, PLOs, CLOs, Teaching and Assessment Methods
Assessments	Exams, Tests, Quizzes, Assignments	Exams, Tests, Quizzes, Assignments, Project, Case Studies, Rubrics, Lab Viva
Quality Assurance	Teacher Evaluation	Teacher Evaluation, Course Evaluation, Learning Environment Evaluation, Student Capability, Industry and Alumni feedbacks, CQI Structure

Table 1: Comparison of Convectional and OBE system

After the implementation of DAAR model and its integration with conventional education system, program design is improved in terms of learning level identification, engagement of external stakeholders improved, link of courses in a curriculum, level of complexity of course contribution in the program, scientific and modern teaching methodologies introduced, new assessment methods implemented and most importantly utilization of assessment and tracking of improvement in the system are validated.

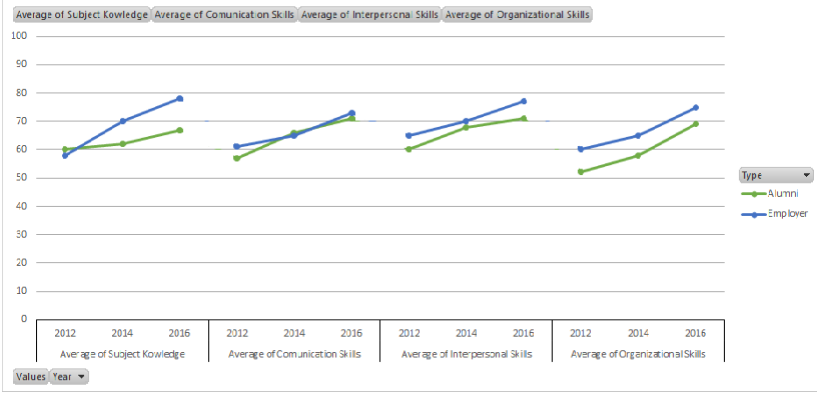

Figure 5: Employer and Alumni satisfaction above target Index of 2012 to 2016

Industry engagement is improved in terms of involvement in curriculum and lesson plan reviews, increased project sponsorship, increased employer satisfaction about the skills and competence of graduates. Alumni satisfaction in targeted areas of expertise and defined

dimensions of learning competencies. Employer satisfaction increases the acceptability of our program as well as improves employment opportunities for our graduates. This increases the public confidence and it is observed that application ratio against available seats for admission in new sessions has increased.

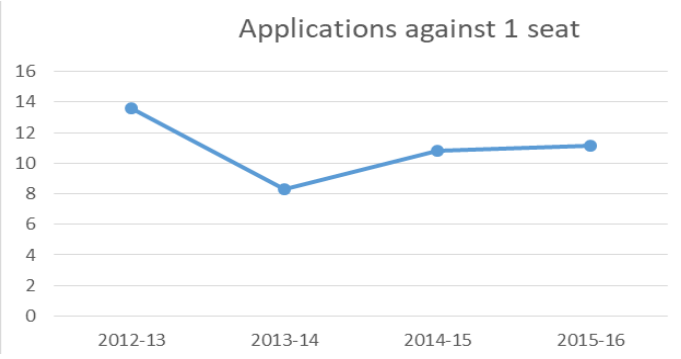

Figure 6: Admission Application ratio of 2012 to 2016

9. Conclusion

Educational processes at HEIs are shifting towards an outcomes based approach. Competence in terms of knowledge, skills and attitude should be achieved by the learner at the time of graduation. Also it has very important role as professional life introduces new lifelong formative challenges. Learning assessment cannot be oblivious to this paradigm shift, either aiming at formative purposes in active learning or as a mechanism for accrediting the attainment of knowledge, skills and attitude.

In this paper, the effectiveness measurement of DAAR framework for learning outcomes based assessment. The proposed model captures the influence of learning outcomes in the learning assessment process, which determines appropriate assessment methods and resources to be used. Assessment plays a key role in acknowledging that a learner has attained the intended knowledge, skills and attitude. This model is contextualised in the broader framework of outcome based learning, based on the unit of learning as the means by which the learners achieves such intended outcomes. Illustrative results of scenarios in terms of alumni and employer satisfaction, public confidence increases student application against available seats, and most importantly KPIs developed for monitoring of process of learning that clarify the practical use of the model and helps the system to improve called CQI process.

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