Preparation for Outcomes-Based Accreditation

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Dhaka

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Organized by
Board of Accreditation for Engineering and Technical Education (**BAETE**)

Agenda

- Overview of OBE
- Overview of outcome-based accreditation system
- Accreditation criteria
- Preparing new program for accreditation
- Sharing of some common shortcomings
- Discussion on outcomes assessment
- General discussion

Part 1:
Overview of
Engineering Education Development
& Outcome-Based Education

Application of Engineering Principles

The Pyramids

The Great Wall of China

Development of Engineering Education

- Engineering and skills found in military – civil & mechanical
- Industrial revolution in late 1700s – steam engines and machine tools
- Engineering manpower produced through a system of skills-based apprenticeship without much formal classroom training

Development of Engineering Education

- 1800s – formal engineering education on disciplinary knowledge with grounding in mathematics and sciences
- 1900s – continued to be practice-oriented, with many experienced engineers engaged in teaching & sharing engineering practice
- Since late 1900s – expansion of scientific and engineering knowledge
  - Early specialization in narrow disciplines
  - Increase in teaching of engineering sciences

Concerns

- Faculty became more dominated by researchers who had little real industrial experience.
- Curricula were often packed with course modules proposed and taught by professors.
- Many of these courses were related to the professors' own areas of expertise and were offered without a critical evaluation of the requirements of an integrated curriculum.
- Graduates from engineering programs were often found lacking in competencies required in real-world engineering employment.

Objectives of Engineering Education

- Unending debates among the engineering community regarding the fundamental requirements of engineering education in a typical undergraduate program.
- Should be answered by examining the social, economical and technological environment under which the graduates will practise, not just for the present but also for the anticipated future scenario.
- Not realistic to have one-size-fit-all approach.
- In less developed countries, engineers will continue to engage in solving basic problems such as access to water, electricity and housing.
- The traditional practice-oriented and discipline-focused curriculum is still applicable.

“Educating the Engineer of 2020” - the National Engineering Academy (NEA), USA

- The steady integration of technology in our public infrastructures and lives will call for more involvement by engineers in the societal context, and demanding attributes in communication and people skills necessary for effective interaction with technical and public audiences
- A growing need for interdisciplinary and system-based approaches
- Producing engineers with core knowledge, capable of defining and solving complex problems, and are lifelong learners
- Attention to ethical issues in engineering
- Reinventing engineering education requires the interaction of engineers in industry and academe

Purpose of an Education Program

- The purpose of an education program is broadly articulated in the accreditation jargon as Program Educational Objectives (PEOs).
- PEOs are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.
- These objectives are periodically reviewed based on feedback of the program's various constituencies.
- For this purpose, there should be in place a process to identify and document relationships with constituencies (who are expected to include students) and their needs which have to be adequately addressed when reviewing the curriculum and processes.
- Published PEOs should be consistent with the mission of the educational institution and the stipulated student learning outcomes and the curriculum and teaching processes that lead to the attainment of these objectives.
- The objectives should be assessable and realistic within the context of the committed resources.

Traditional Education System

Good Students + Adequate Resources = Good Graduates

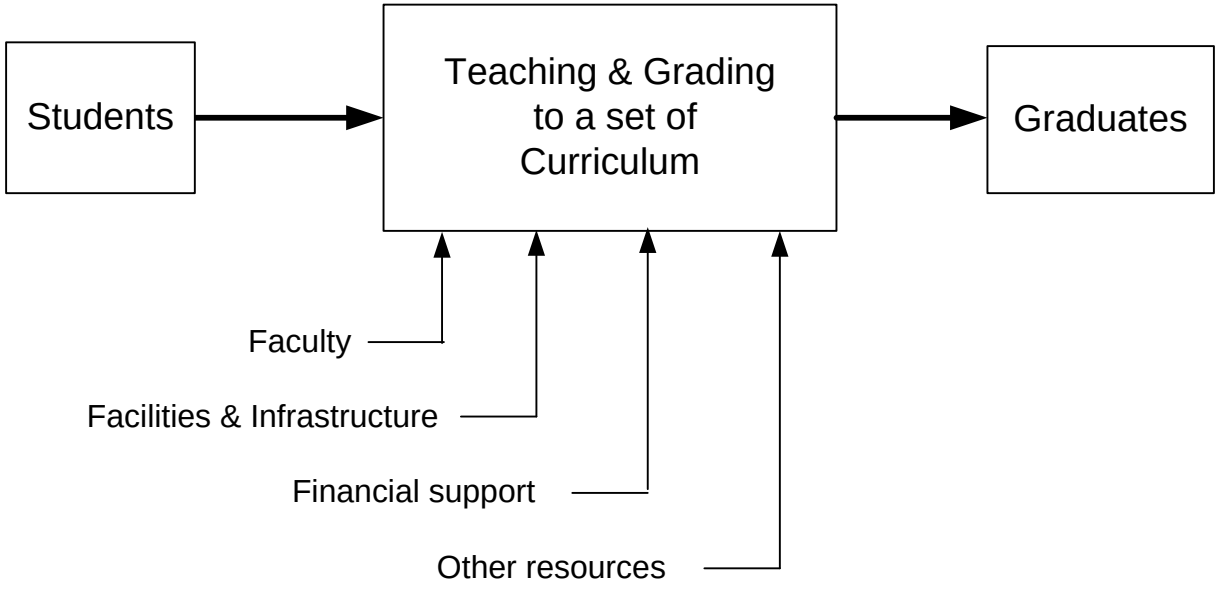


Figure 1 – Premise of traditional education system

Premise of traditional approach

- The premise that good raw materials (the students) plus good production system (institution resources) will automatically produce good products (the graduates).
- Evaluation of the quality of the graduates is based on comparative student grades and rankings.
- The curriculum is structured mainly based on the available expertise and preferences of the faculty. The system is content-based and teaching-centric.
- The emphasis is on the input and output of the education system. The important input parameters are the available resources, the number of qualified teachers and the student intake quality.
- The output quality is based on measuring the student's mastery of the defined body of disciplinary knowledge and their performance with the defined curriculum.
- The mastery is based on content acquisition and retention.

Development of Outcome-based Education

- OBE has been implemented since the 1980s with various forms at different levels of the education system, from nursery/primary schools to postgraduate schools
- Outcome-Based Education is well-defined by Wiiliam Spady [5], often called the father of OBE, as:
  - Defining, designing, building, focusing and organizing everything in an education system on the things of lasting significant that we ultimately want every learner to demonstrate successfully as the result of their learning experiences in that system.

Spady Definition of “Outcome”

- Outcome is “a culminating demonstration of learning”
- “Demonstration” meant that learners would actually DO something tangible, visible, and observable – e.g., describe, explain, design, construct, produce, negotiate, operate, etc. – with the concepts and content embodied in the typical curriculum
- Doing required skill and competence, not just knowledge and understanding
- Competence and its demonstration are equally important in an Outcome Statement

Part 2:
Outcomes-based Accreditation System

Outcome-based accreditation framework for engineering education

- Outcome-based accreditation framework has developed along general outcome-based education.
- ABET (Accreditation Board for Engineering and Technology) is a pioneer in engineering and technology accreditation.
- In 1996, ABET adopted the new set of standards called Engineering Criteria 2000 (EC2000) which shifted the basis for accreditation from inputs, such as what is taught, to outputs – what is learned.
- The criteria specified 11 learning outcomes and required programs to assesses and demonstrate their students' achievement in each of those areas.

Washington Accord

- Washington Accord, formed in 1989, is an international agreement among bodies responsible for accrediting engineering degree programs.
- It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering.
- To maintain quality consistency of accredited programs among its signatories, WA has introduced a set of graduate attributes to serve as benchmark standard for accreditation.

Program Learning Outcomes

- Accreditation criteria which require institutions to demonstrate the achievement of stipulated students learning outcomes which are common to all engineering disciplines, apart from discipline-specific criteria which are more content-based.
- The student learning outcomes are statements that describe what students are expected to know and be able to do by the time of graduation.
- The outcomes related to the skills, knowledge and behaviors that students acquire going through the program.

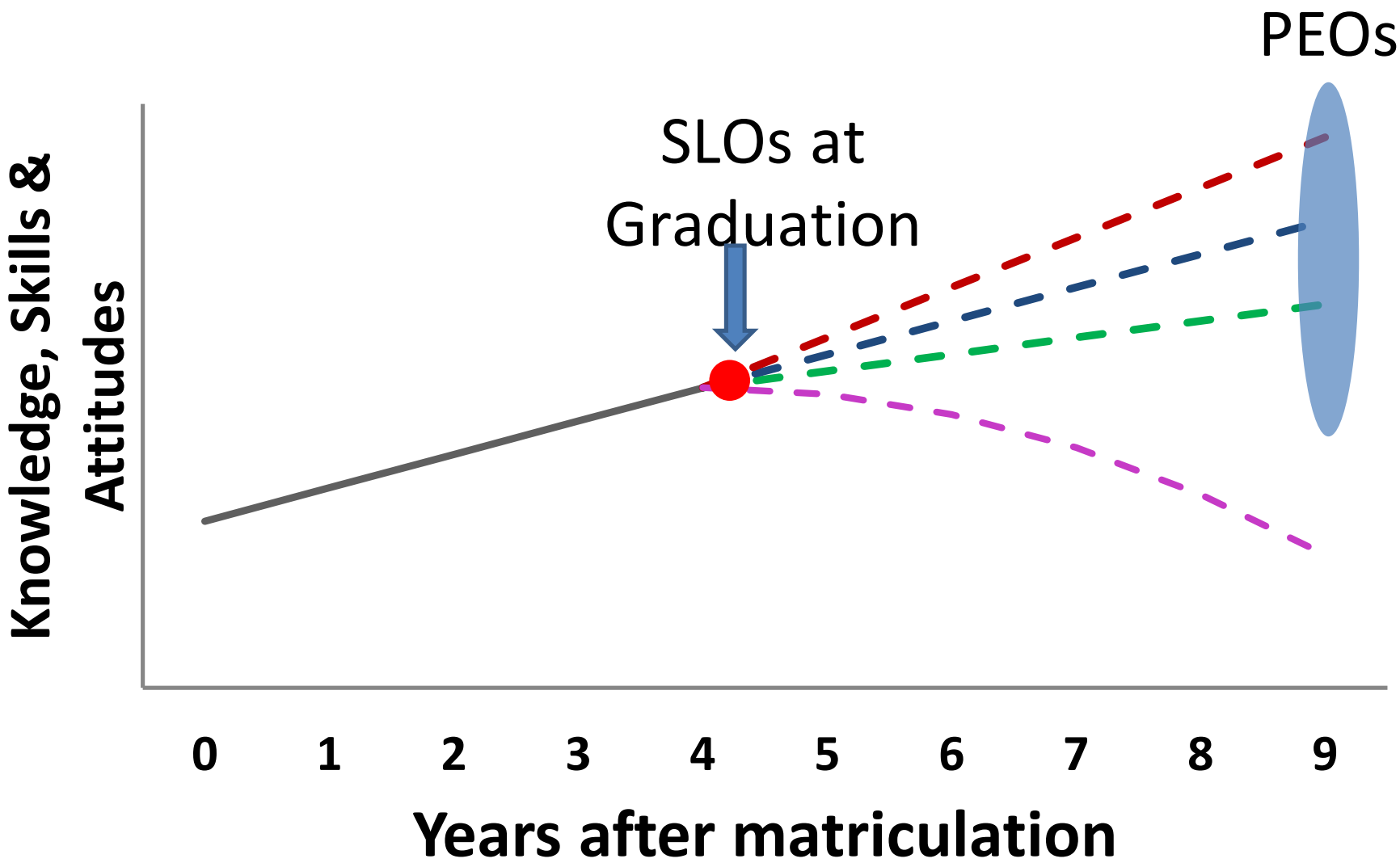
HEIs not told what to do or how to do

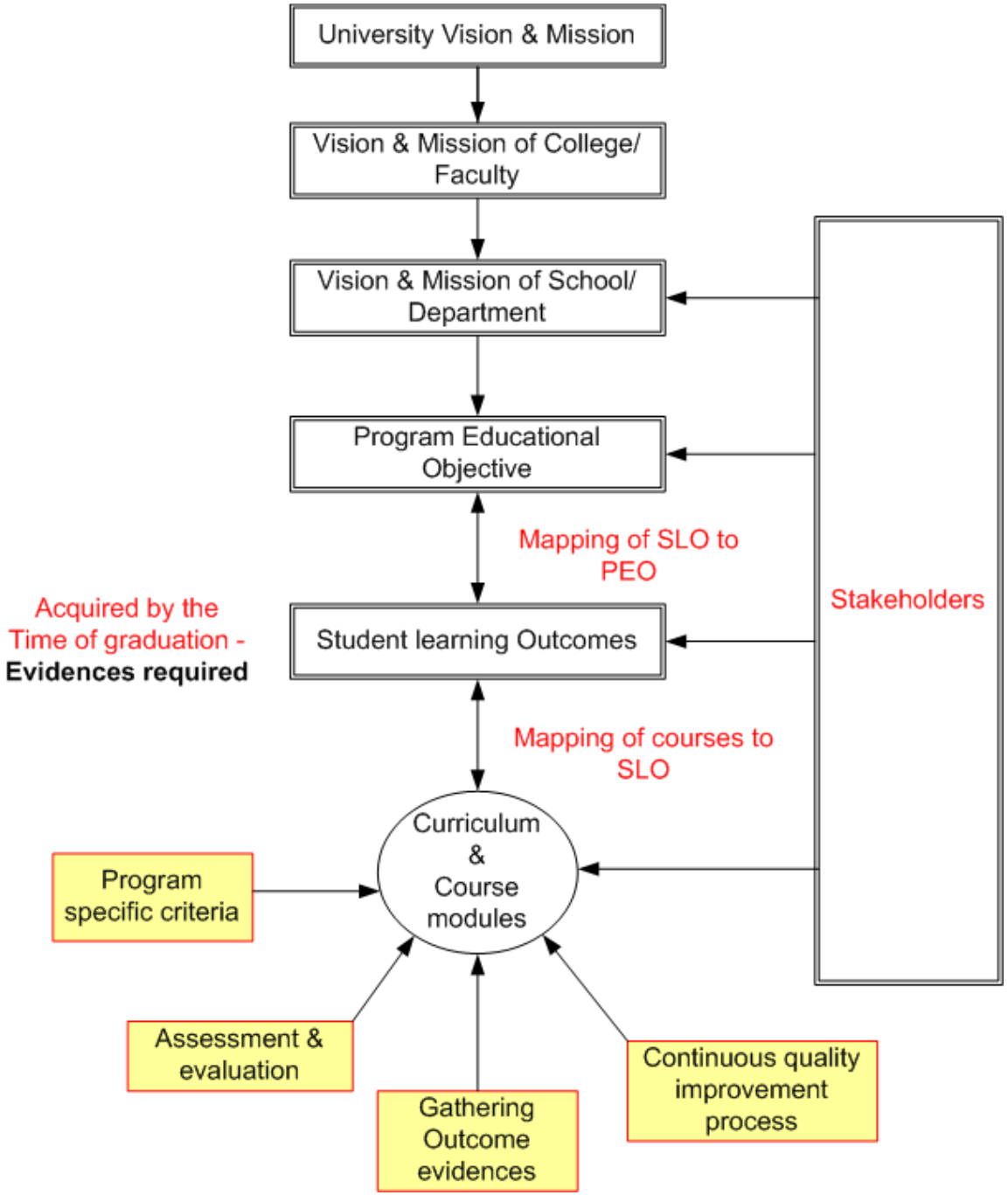
- The institutions are free to design and integrate their various education components and to deploy their resources for delivering the student learning experiences which culminates in the exit outcomes at the point of completing the program.
- With the outcomes in mind, the institutions must put in place an integrated pedagogy including appropriate assessment and feedbacks which enable continuous quality improvement process in helping students to achieve the learning outcomes.

FOCUS OF OUTCOMES-BASED ACCREDITATION

- Attainment of published Program Education Objectives
- Attainment of Program Learning Outcomes
- Continuous Quality Improvement system in place to sustain and improve PEO & PLO
- Resources and system available

A Simple Schematic




University Vision & Mission
Vision & Mission of College/ Faculty
Vision & Mission of School/ Department
Program Educational Objective
Mapping of SLO to PEO
Acquired by the Time of graduation - Evidences required
Student learning Outcomes
Stakeholders
Mapping of courses to SLO
Curriculum & Course modules
Program specific criteria
Assessment & evaluation
Gathering Outcome evidences
Continuous quality improvement process

Success of OBE?

- William Spady frankly admitted:
  - *"… "real" OBE is almost impossible for an education system to implement because it requires such profound levels of change – in paradigm thinking, in mission and purpose, in organizational and structural arrangements, in the very meaning teaching and curriculum, in the structuring and use of time, in resource allocations, in professional training, deployment, and support, and in the role of the entire system in its society's social fabric and economy – that the political, cultural, and economic leaders of a country cannot bring themselves to address the enormity of the task."*

Spady on OBE

"That is why, when asked where one can see "real" OBE in action in education, I say, "Nowhere. But …."

Spady

- Spady, William, Outcome Based Education: Critical Issues and Answers, Arlington, Va, American Association of School Administrators.
- Spady, William, It's Time to End the Decade of Confusion about OBE in South Africa, South African Journal for Science and Technology, https://edulibpretoria.files.wordpress.com/2008/08/spadyobeconfusionpaper.pdf

What is Accreditation?

- The process of external quality review used in higher education to scrutinize colleges, universities, and higher education programs for quality assurance and quality improvement.
- Success results in an accredited institution and/or program.

Two types of academic accreditation

- **Institutional accreditation** evaluates overall institutional quality, but does not focus on a given academic program.
- **Program Accreditation** evaluates an individual program of study, rather than an institution as a whole. This type of accreditation is granted to a specific program.

Objectives of accreditation (1)

- Recognition for professional registration;
- Prestige of program being accredited;
- International mobility of academic qualifications benchmarked to meet the standards of mutual or international agreements, including the Washington Accord;
- Grants, finance and other support for accredited program;

Objectives of accreditation (2)

- Transfer of credits between accredited programs
- To assist stakeholders as well as potential students and their parents, professional societies, and potential employers, in identifying specific engineering programs that meet the minimum criteria for accreditation;
- To provide feedback to the educational institutions for the improvement and development of educational programs.

Accreditation Function

- Accreditation is normally voluntary
- Accreditation involves:
  - an evaluation of engineering education programs offered by the institution, and
  - a judgment against stipulated criteria in accordance with the respective accreditation policy and criteria.
- An accredited engineering education program is judged as providing satisfactory preparation for graduates to enter the profession in the entry level of engineering practice.

Quality assurance

- Accreditation is not a ranking system.
- It is an assurance that a program or institution meets established quality standards.
- The role of accreditation is to provide periodic external review in support of the program's continuous improvement process.

OBA not OBE

- OBA does not require the institutions or the programs to fully embrace the outcome-based education (OBE).
- For accreditation purpose, the program shall provide evidences that the set of graduate attributes or student learning outcomes stipulated by the accreditation body are achieved by the students at the time of graduation.
- Education providers have freedom to design programs with different detailed structure, learning pathways and modes of delivery.
- Outcome-based assessment and evaluation systems must be put in place to verify the achievement of defined program education objectives and graduate attributes.

Outcomes of Significance

- The focus of accreditation is on “Outcomes of Significance”
- Spady articulated as something that “really mattered in the long run”, long after that particular segment of curriculum or time block was over – something that learners could ultimately “take out the door and apply” …. when they “exited” the system.
- That outcomes-of-significance is encapsulated in the set of WA graduate attributes which form the multi-lateral recognition of substantial equivalency of programs within the WA framework.

Perspectives on Program Accreditation

- Program Accreditation is a scheme of granting recognition to an education program by an independent body after a systematic and consistent process of evaluating the program in accordance with the stipulated accreditation policy and criteria, and making judgment that the program has satisfied the benchmark standard.
- To gain accreditation, first and foremost the program must satisfy the full set of accreditation criteria - to cross the bar.
- Continuous quality improvement (CQI) is a necessary criterion, but not the overriding component.

Misleading Interpretation

- It is misleading to interpret accreditation as:
  - *"Accreditation is for continuous improvement of delivery of education for producing human resource needed for national development."*

Proper Perspectives

- The narrow focus of accreditation based on continuous improvement has resulted in below-bar programs being granted accreditation just because the programs showed strong efforts in continuous improvement, even without meeting the rigors of the accreditation criteria.
- CQI may be a mitigating factor in marginal cases, but must not be taken as the predominant or even over-riding criterion.
- CQI is a process, not the outcomes which really matter in the long run – those outcomes students take with them at the exit point of the program.

Part 3:
BAETE’s Accreditation Criteria

All the Accreditation Activities are for the purpose of deciding whether the program has satisfied the 11 BAETE Accreditation Criteria

BAETE Accreditation Criteria

- 11 criteria in BAETE new Accreditation Manual
  1) **Organization and Governance**
  2) **Financial and Physical Resources**
  3) **Faculty**
  4) **Students**
  5) **Academic Facilities and Technical Support**
  6) **Curriculum and Teaching-Learning Processes**
  7) **Program Educational Objectives (PEO)**
  8) **Program Outcomes and Assessment**
  9) **Continuous Quality Improvement (CQI)**
  10) **Interactions with the Industry**
  11) **Program Specific Criteria**

Criterion 1

Organization and Governance 4.1

The major positions should be filled, and the statutory bodies/committees of the institution should be formed in accordance with the applicable rules and guidelines. These include positions such as Vice Chancellor, Pro-Vice Chancellor, Treasurer, Dean, Chairperson and bodies/committees such as Board of Trustees, Syndicate, Academic Council, Admission Committee, Finance Committee, Curriculum Committee and the Faculty Selection Committee. The appointees in the positions and the members of the committees should function effectively as per the roles defined in the relevant act/statute.

The institution should have published policies, including a mechanism for addressing grievances, regarding academic and the administrative matters involving students, faculty members and non-teaching employees. The policies should be put into practice.

Criterion 2

Financial and Physical Resources 4.2

The financial resources of the institution should be adequate to fulfill its mission and vision. Financial resources committed to the program should also be sufficient for the appropriate functioning of the program, including recruiting and retaining qualified faculty members, the procurement of necessary lab equipment, and equipment and tools to support teaching and learning.

The institution should have a process to plan the budget and allocate resources to the priority areas as per requirements. The campus infrastructure, such as the extent of the land and built-up area, extra- and co-curricular facilities, and support facilities, including maintenance support for infrastructure and facilities, should be adequate for the total number of students and employees of the institution.

The possibility of any risk from manmade or natural hazards should be properly assessed and addressed in the Safety Plan. All labs shall have their own plans to prevent and manage incidents and accidents. Fire detection and fire-fighting facilities should be adequate. An action plan is required to address safety issues when demanded by the situation. Adequate measures should be in place to make the campus safe for students, employees and visitors.

Criterion 3

4.3 Faculty

The department should have a sufficient number of full-time faculty members so that they are not overloaded with courses and so the program does not become overly dependent on part-time faculty members.

The faculty members should have adequate academic qualifications with specialization in areas closely related to the program(s) offered by the department. The proportion of senior faculty members and junior faculty members should be appropriate. Adequate interactions between students and faculty members both within and outside the classes are essential. The teacher-student ratio, class size and teaching load should not compromise opportunities for interactions.

The faculty members should be motivated to improve their pedagogy and assist the students in achieving the outcomes. They should be committed to the continuous quality improvement activities of the department. Faculty members should have the responsibility and the authority to design and update the curriculum, establish the course and program outcomes, and select and use the assessment tools appropriate for evaluating the performance of the students in the classes and the achievement of the outcomes.

Faculty members should be engaged in research, development and professional activities, such as consulting. They should also be involved in the activities of relevant professional societies. The results of these activities should benefit the students. The institution or the department should periodically arrange training for the faculty members on outcome-based education and assessment. All the faculty members should be adequately trained on how to establish course outcomes, conduct teaching-learning activities appropriate for the outcomes and assess the level of outcome achievement.

Criterion 4

4.4 Students

There should be a published policy for the admission and transfer of students into the program. The admission or transfer requirements should be appropriate for the selection of students with the potential to achieve the program's outcomes. The policy should be implemented in practice.

The academic performance of the students should be continuously monitored in terms of the achievement of the outcomes and feedback provided to the students. There should be provisions for remedial or corrective measures when necessary. Every student should be assigned an advisor. The advisor should counsel, guide and mentor the student on all academic and professional matters.

Opportunities should exist for students to participate in extra- and co-curricular activities as well as activities of relevant professional societies. The institution should ensure the participation of a significant number of students.

Criterion 5

Academic Facilities and Technical Support 4.5

The institution should have a well-stocked library. The books, journals and other resources available in the library should be adequate for the program and the faculty members. The number of classrooms available should be adequate to properly run the program. The classroom facilities and the environment should be conducive to learning.

The number of laboratories and equipment should be adequate for conducting different labs in the program. Every student should have the opportunity for hands-on activity in the laboratories.

Students and faculty members should have access to adequate computing and Internet facilities, including hardware, software tools and support.

Criterion 6

Curriculum and Teaching-Learning Processes 4.6

The curriculum should satisfy the requirements of the relevant program-specific criteria as described in Section 6.

The breadth and depth of the curriculum and the teaching-learning activities should be appropriate for the solution of complex engineering problems in the relevant discipline. The curriculum should contain an adequate number of courses on mathematics, physical science, humanities and non-engineering subjects. The teaching-learning processes and activities selected for each course should be effective and appropriate for achieving the outcomes. Student participation and learning should be enhanced. Hands-on activities in the lab should be an integral part of teaching and learning. The program should include adequate activities in the lab. There should be a final year design project or capstone project extending over a period of one year that represents a culminating demonstration of the program outcomes at the level of solving complex engineering problems.

Criterion 7

4.7 Program Educational Objectives

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. PEOs are assessable based on the attributes and accomplishments of graduates, preferably those who have worked for 3 to 5 years after graduation. Each engineering program should have published PEOs that should be clear, concise, assessable and realistic within the context of the available resources. The PEOs should be consistent with the vision and mission of the program-offering department. They should be supported by a curriculum and teaching-learning processes that lead to the attainment of these objectives. Justifications should be provided for how the curriculum and the outcomes contribute to the attainment of the PEOs. A process should be developed to assess the level of attainment of each of the PEOs to evaluate the effectiveness of the academic program. Adequate evidence and documentation should be provided to support the achievement of a PEO with the help of the assessment and evaluation process that has been developed. The tools should be indicated, and the way these tools are used should be explained. PEO assessment should lead to periodic review of the PEO. Feedback of the various program stakeholders, including employers, alumni, students and faculty, should be considered during the review.

Criterion 8

4.8 Program Outcomes and Assessment

Program Outcomes (POs) are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attitudes that students acquire while progressing through the program. The program must demonstrate that by the time of graduation, students have attained a certain set of knowledge, skills and behavioral traits to some acceptable minimum level. The BAETE specifically requires that students acquire the following graduate attributes.

Criterion 9

Continuous Quality Improvement 4.9

The program should have a continuous quality improvement mechanism. It should demonstrate an established system for periodically compiling the level of attainment in terms of PEO, including a mechanism to track and obtain feedback from graduates and their employers. The outcomes of these exercises should be evaluated, and the identified shortcomings and limitations should be used to refine and improve the program.

POs should be assessed on a regular cycle. Each teaching module should have clear quality requirements and facilitate the achievement of COs through teaching and evaluation methods. Students should provide feedback in every course on the appropriateness of COs, course content, delivery of content, assessment and the attainment of COs. The program should evaluate the curriculum and teaching quality on a regular basis while taking into account feedback from faculty members and students. The program should demonstrate that the results of this periodic evaluation are used for continuous improvement.

Criterion 10

4.10 Interactions with the Industry

A communication channel between the educational institution and the industry should be in place. The industry should be encouraged to provide feedback concerning the quality of the teaching-learning process. There must be industry participation in the development of the curriculum to ensure that it is relevant, regularly updated, and meets the needs of the industry, particularly in areas experiencing rapid changes. An engineering program should have an Industry Advisory Panel (IAP) and an Alumni Association (AA) for this purpose. The IAP or AA may meet at certain intervals with the department to provide feedback.

The program should provide students with the opportunity to obtain industrial experience through internships, industry visits or design projects conducted by practicing engineers and faculty members with industrial experience.

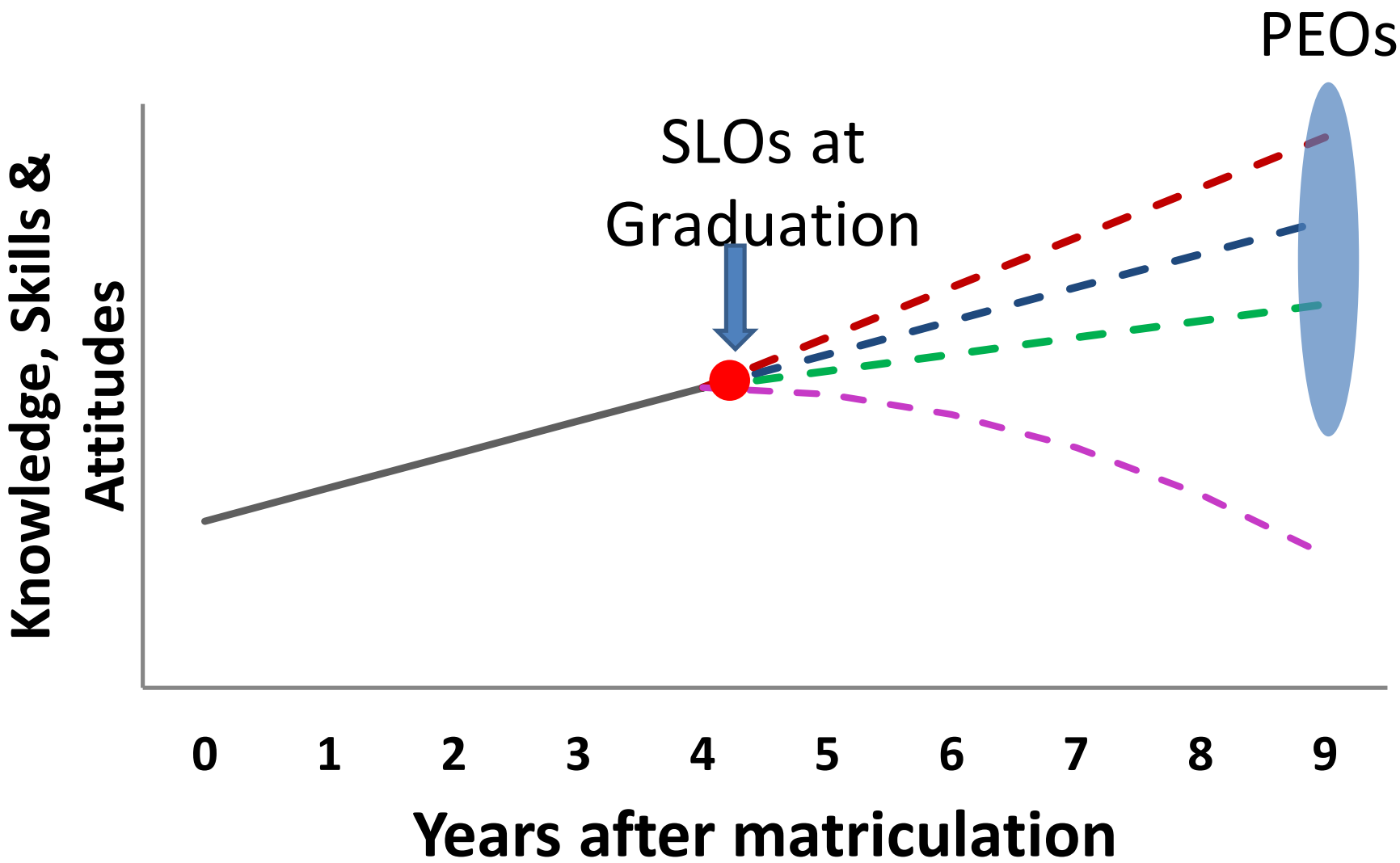
Criterion 11

Part 4:
A more in-depth understanding of PEO & SLO

Criterion #7- Program Educational Objectives (PEOs)

- Program educational objectives (PEO) are broad statements that describe what graduates are expected to achieve a few years after graduation, preferably those who have worked for 3 to 5 years after graduation.
- PEOs are assessable based on the attributes and accomplishments of graduates

A Simple Schematic



Criterion #7 – PEO

- published & assessable

- Each engineering program should have published PEOs that should be clear, concise, assessable and realistic within the context of the available resources.
  - *Published – public domains, info known & accessible to stakeholders*
  - *Importance of clear, concise, assessable and realistic*

Criterion #7 – PEO

- alignment

- The PEOs should be consistent with the vision and mission of the program-offering department.
  - Articulate the alignment of PEOs to vision and mission

Criterion #7 – PEO

- achievable

- They should be supported by a curriculum and teaching-learning processes that lead to the attainment of these objectives.
- Justifications should be provided for how the curriculum and the outcomes contribute to the attainment of the PEOs.
  - Mapping of POs and PEOs

Mapping of POs to PEOs – Evidence that PEOs are realistic and achievable through the support of POs

Mapping of POs to PEOs

	PEO1	PEO2	PEO3	PEO4
PO1	3	1		
PO2	2	2		
PO3				
PO4			3	
P05		3		2
PO6	2			
PO7			3	
PO8	3			3
PO9				
PO10		3	3	3
PO11	2			
PO12		2		2
1 – moderately support; 2- strongly support; 3 – very strongly support				

Criterion #7 – PEO

- assessment & evaluation

- A process should be developed to assess the level of attainment of each of the PEOs to evaluate the effectiveness of the academic program.
- Adequate evidence and documentation should be provided to support the achievement of a PEO with the help of the assessment and evaluation process that has been developed.
- The tools should be indicated, and the way these tools are used should be explained.

Criterion #7 – PEO

- assessment & evaluation

- Direct & indirect assessment
- Survey employers and alumni
- Focused group meeting with alumni
- Focused group meeting with employers
- Faculty assessment
- Student feedback

Criterion #7 – PEO

- review & CQI

- PEO assessment should lead to periodic review of the PEO.
- Feedback of the various program stakeholders, including employers, alumni, students and faculty, should be considered during the review.

- Formalized structure & process in place? Who execute & what periodic process?

Criterion 8

4.8 Program Outcomes and Assessment

Program Outcomes (POs) are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attitudes that students acquire while progressing through the program. The program must demonstrate that by the time of graduation, students have attained a certain set of knowledge, skills and behavioral traits to some acceptable minimum level. The BAETE specifically requires that students acquire the following graduate attributes.

Criterion 8 - Program Outcomes (POs)

- Program outcomes are the narrower statements that describe what students are expected to know and be able to do by the time of graduation.
- These relate to the knowledge, skills and attitude that the students acquire while progressing through the program.
- The program must demonstrate that by the time of graduation the students have attained a certain set of knowledge, skills and behavioral traits to some acceptable minimum level

BAETE's 12 PLOs are identical to WA GAs

INTERNATIONAL ENGINEERING ALLIANCE

Constituent Agreements

Washington Accord
Sydney Accord
Dublin Accord

International Professional Engineers Agreement
International Engineering Technologists Agreement
APEC Engineer Agreement

Graduate Attributes and Professional Competencies

Version 3: 21 June 2013

This document is available through the IEA website: http://www.ieagreements.org.

PO #1

- **Engineering Knowledge:**
  - An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO #2

- **Problem Analysis:**
  - An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO #3

- **Design/Development of Solutions:**
  - An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO #4

- **Investigation:**
  - An ability to conduct investigation of complex engineering problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO #5

- **Modern Tool Usage:**
  - An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PO #6

- **The Engineer and Society:**
  - An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PO #7

- **Environment and Sustainability:**
  - An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO #8

- **Ethics:**
  - Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO #9

- **Individual and Team Work:**
  - An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

PO #10

- **Communication:**
  - An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO #11

- **Project Management:** An ability to demonstrate management skills and apply engineering principles to one’s own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

PO #12

- **Lifelong Learning:**
  - Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broader context of technological change.

Complex problems

(A requirement of WA)

- *Involve wide-ranging or conflicting technical, engineering and other issues*
- *Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models*
- *Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach*
- *Involve infrequently encountered issues*
- *Are outside problems encompassed by standards and codes of practice for professional engineering*
- *Involve diverse groups of stakeholders with widely varying needs*
- *Have significant consequences in a range of contexts*
- *Are high level problems including many component parts or sub-problems*

Mapping of Courses to POs –

Evidence that the POs are well-supported to achieve the depth and breadth through the various courses

Contribution of each course

- Each undergraduate course in the programme contributes to a list of POs
- Usually, a course may contribute strongly to some POs and less strongly to other POs
- While a course may contribute to several POs, usually only a subset of its strong outcomes need to be used for PO assessment.

Course Learning Outcomes (COs)

- A learning outcome is what a student can do as a result of a learning experience.
- It describes a specific task that student is able to perform at a given level of competence under a certain situation.
- The three broad types of learning outcomes are:
  - Disciplinary knowledge and skills
  - Generic skills
  - Attitudes and values

Course Learning outcomes

- Course Learning Outcomes describe the complex performances a student should be capable of as a result of learning experiences within a course.
- These are determined by the course instructor (s)
- Mapping course learning outcomes to program outcomes and how overall learning experience meet the accreditation criteria

Mapping of Courses to SLOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C1	2	3	3				2					1
C2	3	2	1					2				
C3												
C3		3	3			2				3	1	
C5												
C6												
C7												
C8												
C9												
C10												
C11												
C12												
C13												
C14												
1 – moderately support; 2- strongly support; 3 – very strongly support												

Student Outcomes and Performance Indicators

Performance indicators are a means to focus on specific expectations of a program. They facilitate the curriculum delivery strategies, and assessment procedures. There is an important first step that must come before the development of performance indicators, and that is deciding on student outcomes. These are usually communicated to students in the program description, and are stated in terms that inform the students about the **general purpose** of the program and expectations of the faculty. The primary difference between student outcomes and performance indicators is that student outcomes are intended to provide general information about the focus of student learning and are broadly stated of the outcome, not measurable, while performance indicators are concrete measurable performances students must meet as indicators of achievement. Performance indicators are developed from program outcomes.

Sample student **outcomes**:

- Students will work effectively as a member of a team.
- Students can apply the principles of math and science to a technical problem.
- Students will have an appreciation for the need to be lifelong learners.
- Students will have effective communication skills.

Revised 04/21/10 G. Rogers

Performance indicators indicate what concrete actions the student should be able to perform as a result of participation in the program. Once program outcomes have been identified, the knowledge and skills necessary for the mastery of these outcomes should be listed. This will allow the desired behavior of the students to be described, and will eliminate ambiguity concerning demonstration of expected competencies. Performance indicators are made up of at least two main elements; action verb and content (referent). The expected behavior must be specified by name, using an observable action verb such as demonstrate, interpret, discriminate, or define.

Sample performance indicators:

- Students will know a professional code of ethics. (knowledge)
- Students will be able to describe the problem solving process. (comprehension)
- Students will solve research problems through the application of scientific methods. (application)

Cunningham, G. K. (1986). *Educational and psychological measurement*. New York: MacMillan Publishing.

McBeath, R. J., Ed. (1992). *Instructing and evaluating in higher education: A guidebook for planning learning outcomes.* Englewood Cliffs, NJ: Educational Technology Publications.

Mapping of Courses to Performance Indicators of SLOs

	PO1			PO2			PO3			PO3		
	PI1-1	PI1-2	PI1-3	PI2-1	PI2-2	PI2-3	PI3-1	PI3-2	PI3-3	PI4-1	PI4-2	PI4-3
C1		2	3		1		2	3				
C2	3		1	2		2				3	3	1
C3												
C4												
C5												
C6												
C7												
C8												
C9												
C10												
C11												
C12												
C13												
1 – moderately support; 2- strongly support; 3 – very strongly support												

Evidence beyond mapping exercise

- Program Accreditation Committee undertake the task of mapping subjects/courses to each outcomes
- Faculty teaching a particular subject is not aware of the outcomes contribution from his subject, and has not conducted proper outcomes assessment
- Just a mapping exercise – not acceptable

Assessment

Evidence that Faculty has the ability and are conducting outcomes assessment

Evidences of Outcomes Assessment

- Not merely mapping of courses to outcomes
- Evidence of outcomes assessment at course level
- Evidence that faculty has training in conducting outcomes assessment
- Going beyond subject/course marks & grading being used as justification that overall outcomes are contributed by the subject(s)

Module Profile

- Well-prepared module profile needed
- Well- articulated module learning outcomes
- Learning activities to acquire MLOs
- Assessment beyond marks-based tests and exams
- Reflection and continuous improvement
- Committed to what are written

Program Outcomes

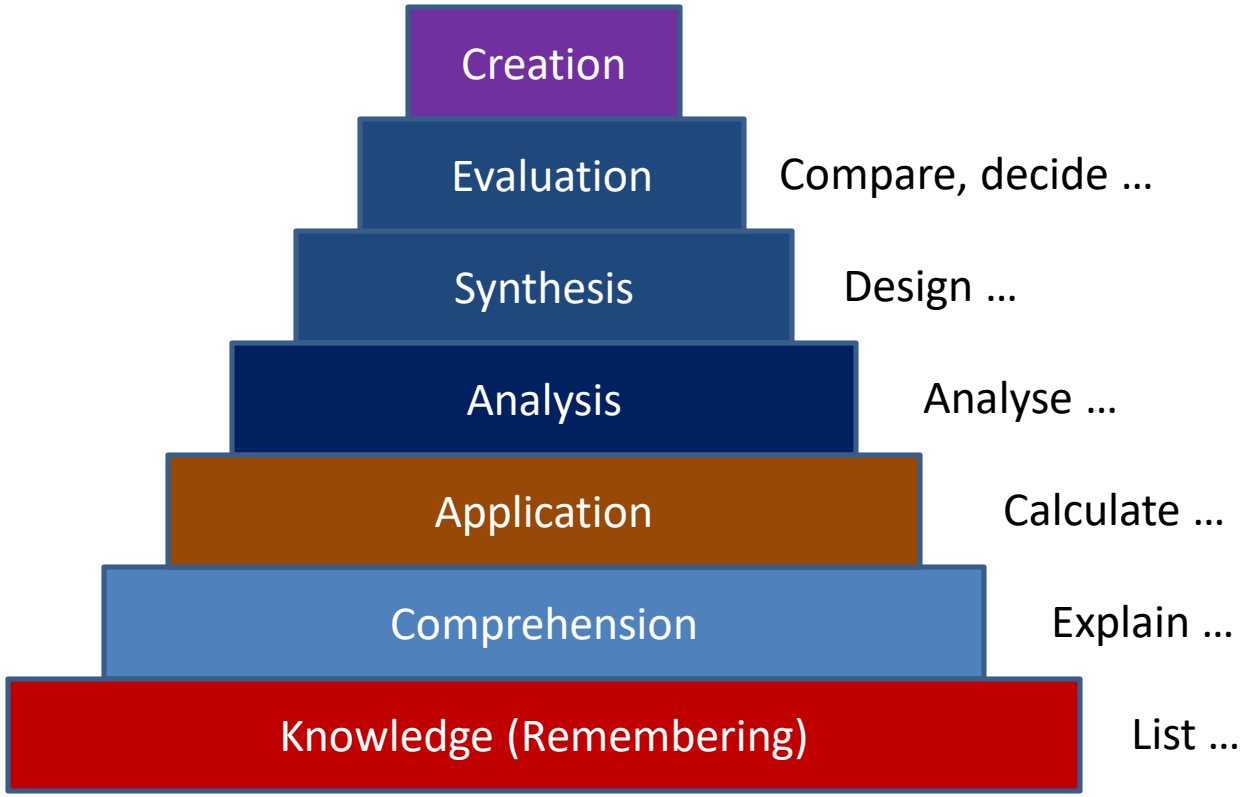
- Illustrations of how
  - course outcomes
  - modes of delivery of the courses
  - assessment tools
  - laboratory
  - project course work

  are used to assess the impact of course delivery/course content, and are contributing towards the attainment of the POs
- Attainment of POs assessed by direct and indirect methods

Evidence of Faculty actively involved in outcomes assessment

- Do faculty members know the requirements of outcome-based accreditation?
- Are they trained in outcomes assessment?
- Evidence of faculty conducting outcomes assessment at their courses
- Reflection and continuous improvement at course level

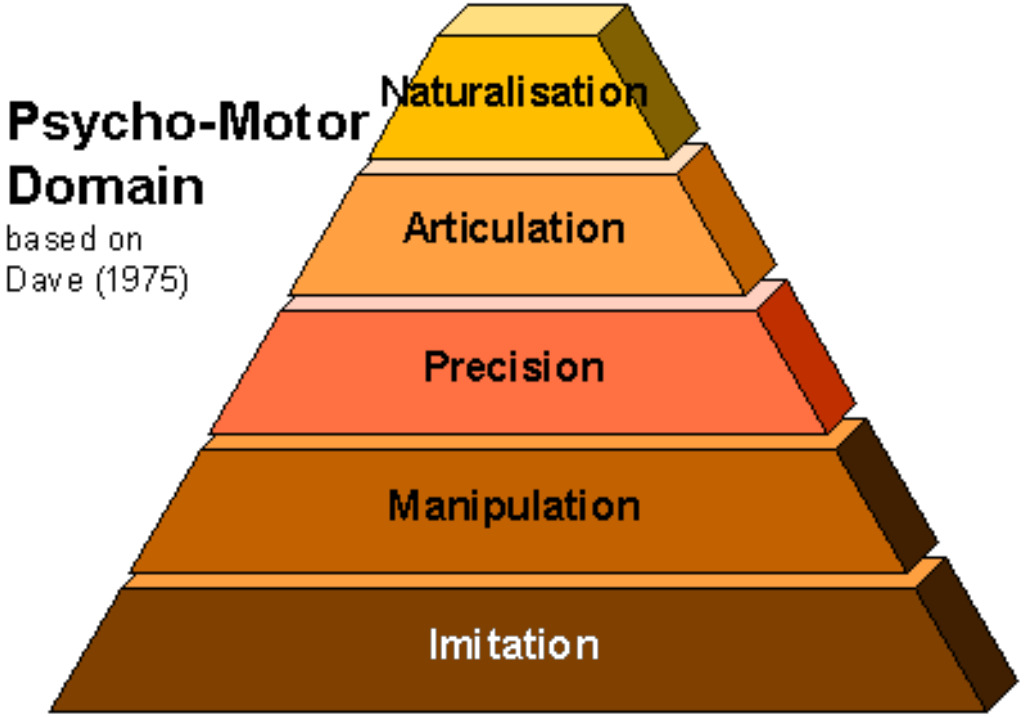
Bloom's Taxonomy – Cognitive Domain
(modified by Anderson & Krathwohl)



Abilities

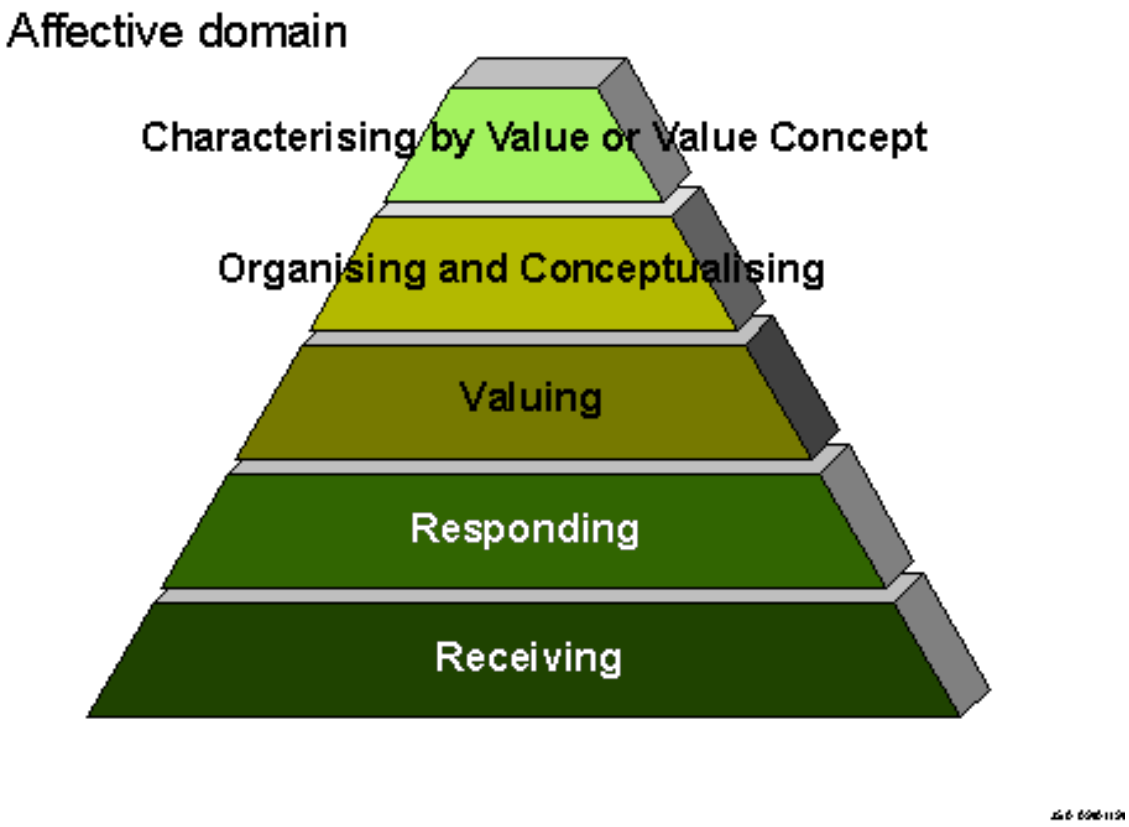
- Knowledge (gathering & recall)
- Comprehending information
- Application (making use of knowledge)
- Analysis (taking apart)
- Synthesis (putting together)
- Evaluation (judging the outcome)
- Creation

Psychomotor Domain



http://www.learningandteaching.info/learning/bloomtax.htm

Affective Domain



http://www.learningandteaching.info/learning/bloomtax.htm

Activities	Action Verbs that provides evidence
Knowing	define, describe, identify, label, name, outline, reproduce, recall, select, state, present, be aware of, extract, organise, recount, write, recognise, measure, underline, repeat, relate, know, match.
Comprehension	interpret, translate, estimate, justify, comprehend, convert, clarity, defend, distinguish, estimate, explain, extend, generalise, exemplify, give examples of, infer, paraphrase, predict, rewrite, summarise, discuss, perform, report, present, restate, identify, illustrate, indicate, find, select, understand, represent, name, formulate, judge, contrast, translate, classify, express, compare.
Application of knowledge (understanding)	apply, solve, construct, demonstrate, change, compute, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, use, give examples, exemplify, draw (up), select, explain how, find, choose, assess, practice, operate, illustrate, verify.
Analysis	recognise, distinguish between, evaluate, analyse, break down, differentiate, identify, illustrate how, infer, outline, point out, relate, select, separate, divide/subdivide, compare, contrast, justify, resolve, devote, examine, conclude, criticise, question, diagnose, identify, categorise, point out, elucidate.
Synthesis	propose, present, structure, integrate, formulate, teach, develop, combine, compile, compose, create, devise, design, explain, generate, modify, organise, plan, rearrange, reconstruct, relate, reorganise, revise, write, summarise, tell, account for, restate, report, alter, argue, order, select, manage, generalise, precise, derive, conclude, build up, engender, synthesise, put together, suggest, enlarge.
Evaluation	Judge, appraise, assess, conclude, compare, contrast, describe how, criticise, discriminate, justify, defend, evaluate, rate, determine, criticise, choose, value, question.

Ability/ competency	Level	Definition
Knowledge	1	the remembering of previously learned material; it may involve the recall of a wide range of material from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information.
Comprehension	2	the ability to grasp the meaning of material; may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects); this goes one step beyond the simple remembering of material, and represent the lowest level of understanding
Application	3	the ability to use learned material in new, concrete situations; may include the application of rules, methods, concepts, principles, laws, and theories; requires a higher level of understanding than those under comprehension.
Analysis	4	the ability to break down material into its component parts so that its organizational structure may be understood; may include the identification of parts, analysis of the relationship between parts, and recognition of the organizational principles involved; represents a higher level than comprehension and application because it requires an understanding of both the content and the structural form of the material.
Synthesis	5	the ability to put parts together to form a new whole; may involve the production of a unique communication, a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information); stresses creative behaviors, with major emphasis on the formulation of new patterns or structure
Evaluation	6	the ability to judge the value of material for a given purpose, based on definite criteria; contains elements of all the other categories, plus conscious value judgments based on clearly defined criteria.
Creation	7	

Rubric

- A rubric is a set of criteria for assessing student work or performance. Rubrics are particularly suited to learning outcomes that are complex or not easily quantifiable, for which there are no clear “right” or “wrong” answers, or which are not evaluated with standardized tests or surveys. Assessment of writing, oral communication, critical thinking, or information literacy often requires rubrics.

Figure 2: Example of Rubrics (Accessed from Rogers, 2010)

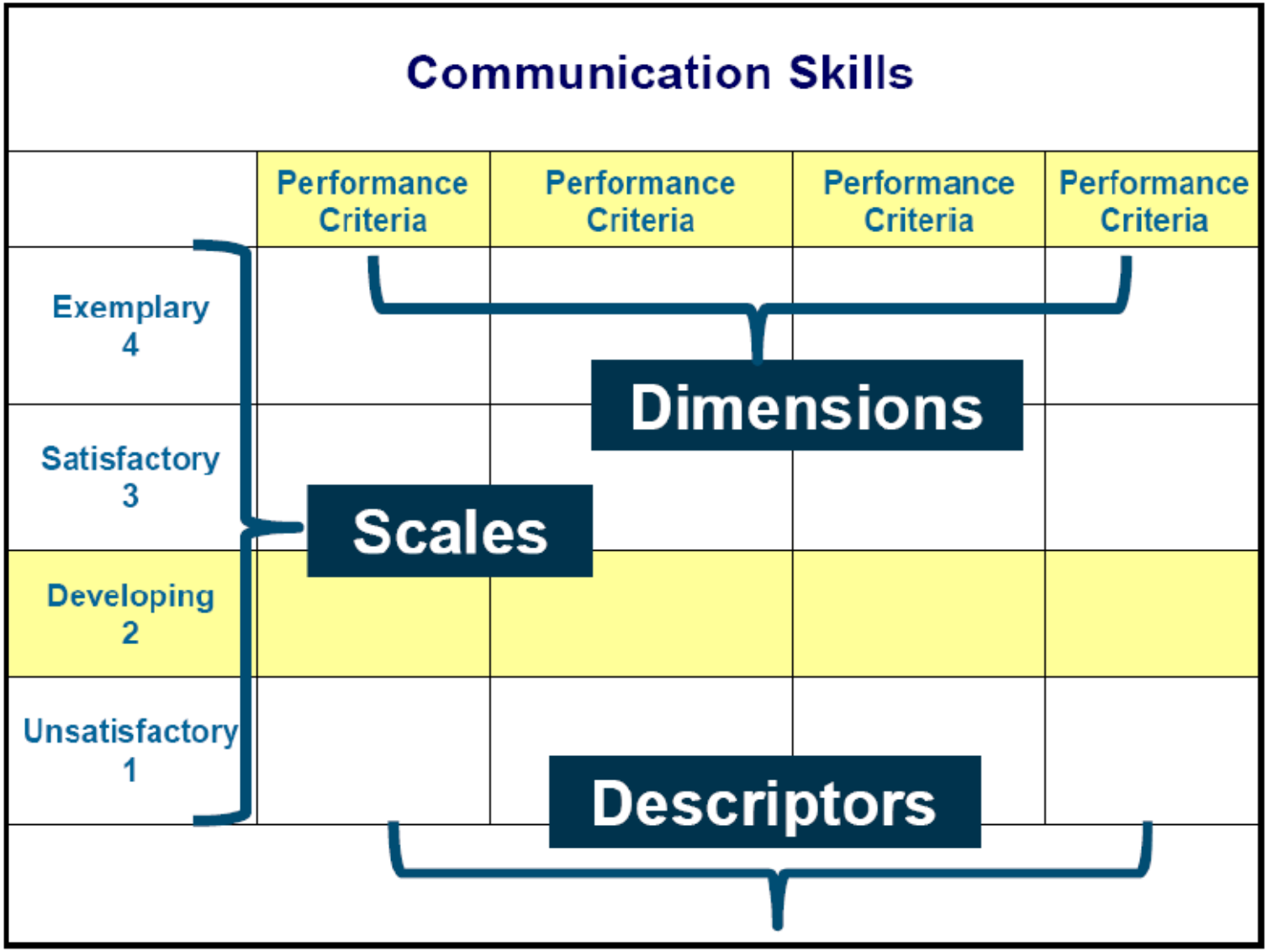


Figure 2: Example of Analytic Rubrics (Accessed from Rogers, 2010)

Work Effectively in Teams				
	Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
Research & Gather Information	Does not collect any information that relates to the topic.	Collects very little information--some relates to the topic.	Collects some basic information--most relates to the topic.	Collects a great deal of information--all relates to the topic.
Fulfill Team Role's Duties	Does not perform any duties of assigned team role.	Performs very little duties.	Performs nearly all duties.	Performs all duties of assigned team role.
Share in work of team	Always relies on others to do the work.	Rarely does the assigned work--often needs reminding.	Usually does the assigned work--rarely needs reminding.	Always does the assigned work without having to be reminded.
Listen to Other Teammates	Is always talking--never allows anyone else to speak.	Usually doing most of the talking--rarely allows others to speak.	Listens, but sometimes talks too much.	Listens and speaks a fair amount.

POs & Assessment Domains

	PO	Assessment Domain	Evidence?
1	Engineering Knowledge	Cognitive	
2	Problem Analysis	Cognitive	
3	Design/Development of Solutions	Cognitive, Affective	
4	Investigation	Cognitive, Psychomotor	
5	Modern Tool Usage	Psychomotor, Cognitive	
6	Engineer & Society	Affective	
7	Environment & Sustainability	Affective, Cognitive	
8	Ethics	Affective	
9	Individual & Team Work	Psychomotor, Affective	
10	Communication	Psychomotor, Affective	
11	Project Management & Finance	Cognitive, Psychomotor	
12	Life-long Learning	Affective, Psychomotor	

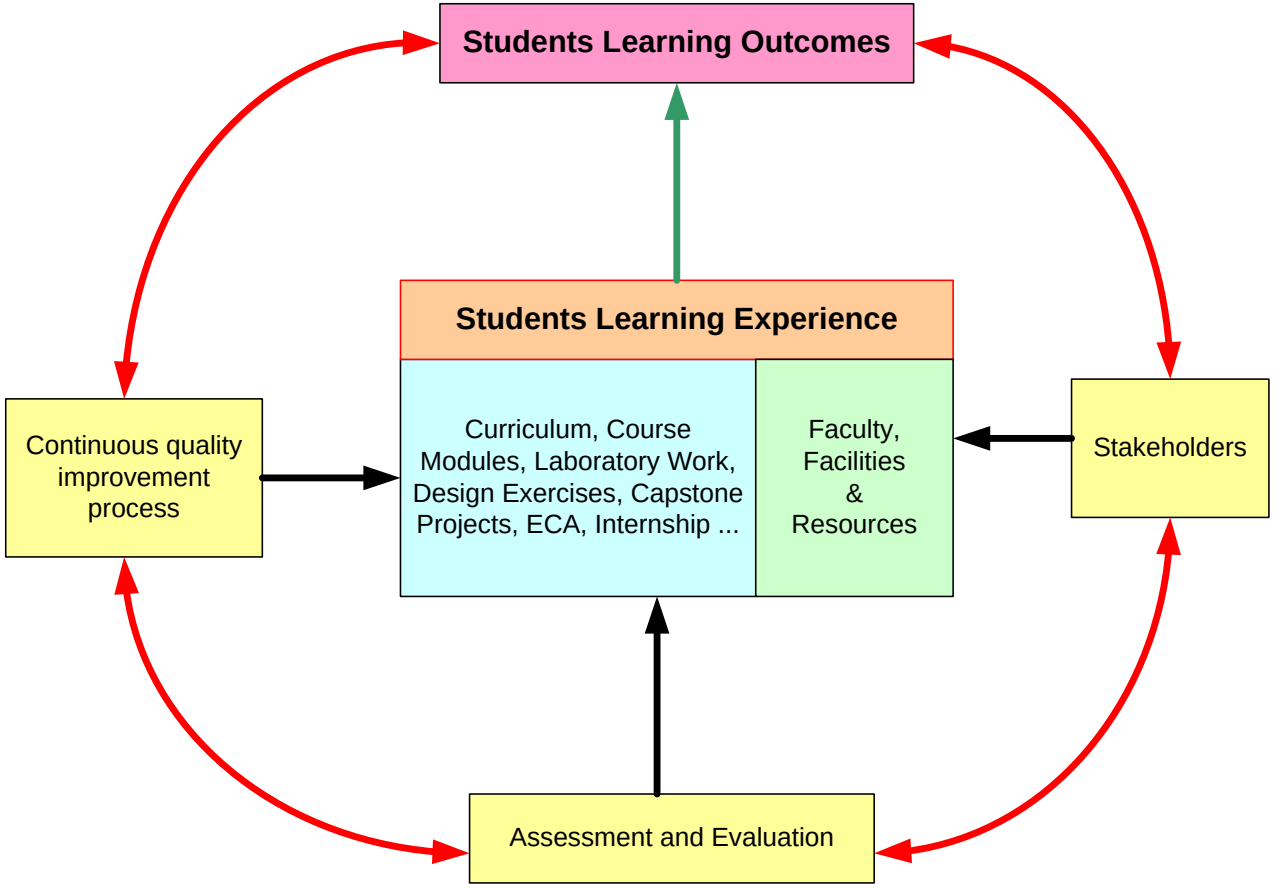
Avoid Obsession with Assessment

- Assessment involves:
  - Cognitive domain (thinking, knowledge)
  - Psychomotor domain (doing, skills)
  - Affective domain (feeling & attitude)
- Is the assessment efforts sustainable?

Evidence of Using PO Evaluation for CQI

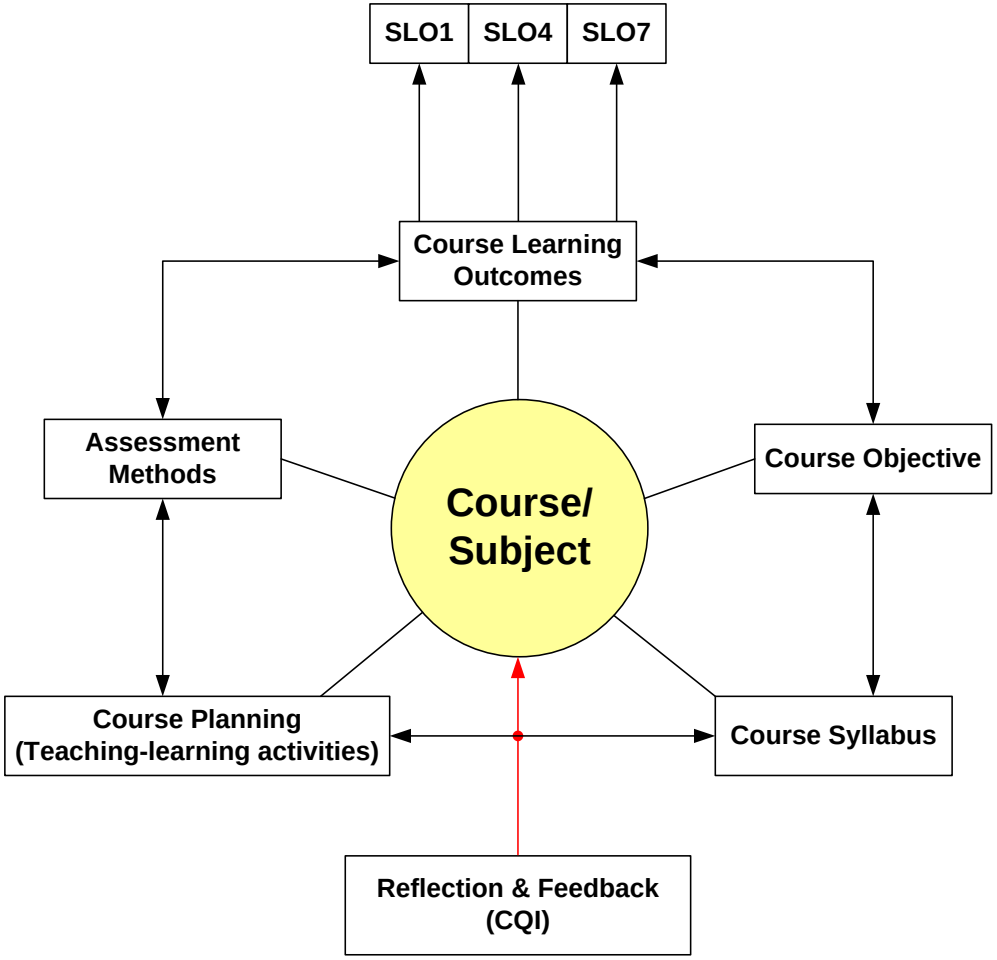
Program Outcomes

- Results of assessment of each PO shall be indicated as they play a vital role in implementing the Continuous Improvement process of the programme
- How the results of assessment of the POs are used to improve the programme in terms of
  - curriculum
  - course delivery
  - assessment methods
  - processes of revising/redefining the SLOs


Students Learning Outcomes
Students Learning Experience
Curriculum, Course Modules, Laboratory Work, Design Exercises, Capstone Projects, ECA, Internship ...
Faculty, Facilities & Resources
Continuous quality improvement process
Stakeholders
Assessment and Evaluation

Learning outcomes of a subject/course may support several SLOs.

Evidence of course assessment to be documented.



Criterion 6

Curriculum and Teaching-Learning Processes 4.6

The curriculum should satisfy the requirements of the relevant program-specific criteria as described in Section 6.

The breadth and depth of the curriculum and the teaching-learning activities should be appropriate for the solution of complex engineering problems in the relevant discipline. The curriculum should contain an adequate number of courses on mathematics, physical science, humanities and non-engineering subjects. The teaching-learning processes and activities selected for each course should be effective and appropriate for achieving the outcomes. Student participation and learning should be enhanced. Hands-on activities in the lab should be an integral part of teaching and learning. The program should include adequate activities in the lab. There should be a final year design project or capstone project extending over a period of one year that represents a culminating demonstration of the program outcomes at the level of solving complex engineering problems.

Program Curriculum

- Programme curriculum that leads to the attainment of the PEOs and the POs must be designed
- Flow diagram that shows the prerequisites for the courses shall also be provided
- Each program should cover general and specialized professional content of adequate breadth and depth
- Appropriate components in the Sciences and Humanities.

Program Curriculum

- The relevance of curriculum components including core engineering courses to the POs
- How the core engineering subjects in the curriculum lend the learning experience with the complex engineering problems
- Programme must satisfy Programme Specific Criteria
- Continuous Improvement process in curriculum refinement
- Evidence of assessment, evaluation and review methods – attainment of COs

2.1.3. State the components of the curriculum (5)

Program curriculum grouping based on course components

Course Component	**Curriculum Content (% of total number of credits of the program)**	**Total number of contact hours**	**Total number of credits**
Basic Sciences			
Engineering Sciences			
Humanities and Social Sciences			
Program Core			
Program Electives			
Open Electives			
Project(s)			
Internships/Seminars			
Any other (Please specify)			
Total number of Credits			

Table 3.1: Curriculum and teaching processes to achieve Student Learning Outcomes, and evaluation method/criteria

Module title	Category#	Evaluation method & criteria	Student Learning Outcomes*							
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	--
		• •								
		• •								
		• •								
		• •								
		• •								
		• •								

Category is to indicate whether module is Core, Electives, Faculty Requirements, Major Requirements, University Requirements, Unrestricted Elective, etc

Table 3.2: Curriculum/Course Time Allocation and Content

(A) Course Time Allocation by semester

Semester n Year n:

Course Title	Total Number of Contact Hours					No of MCs or AUs [2]
	Lec [3]	Tut/Con [4]	Lab [5]	Proj [6]	Total Hrs	
Total						

Evidences for achievement at Complex Engineering level

Complex problems

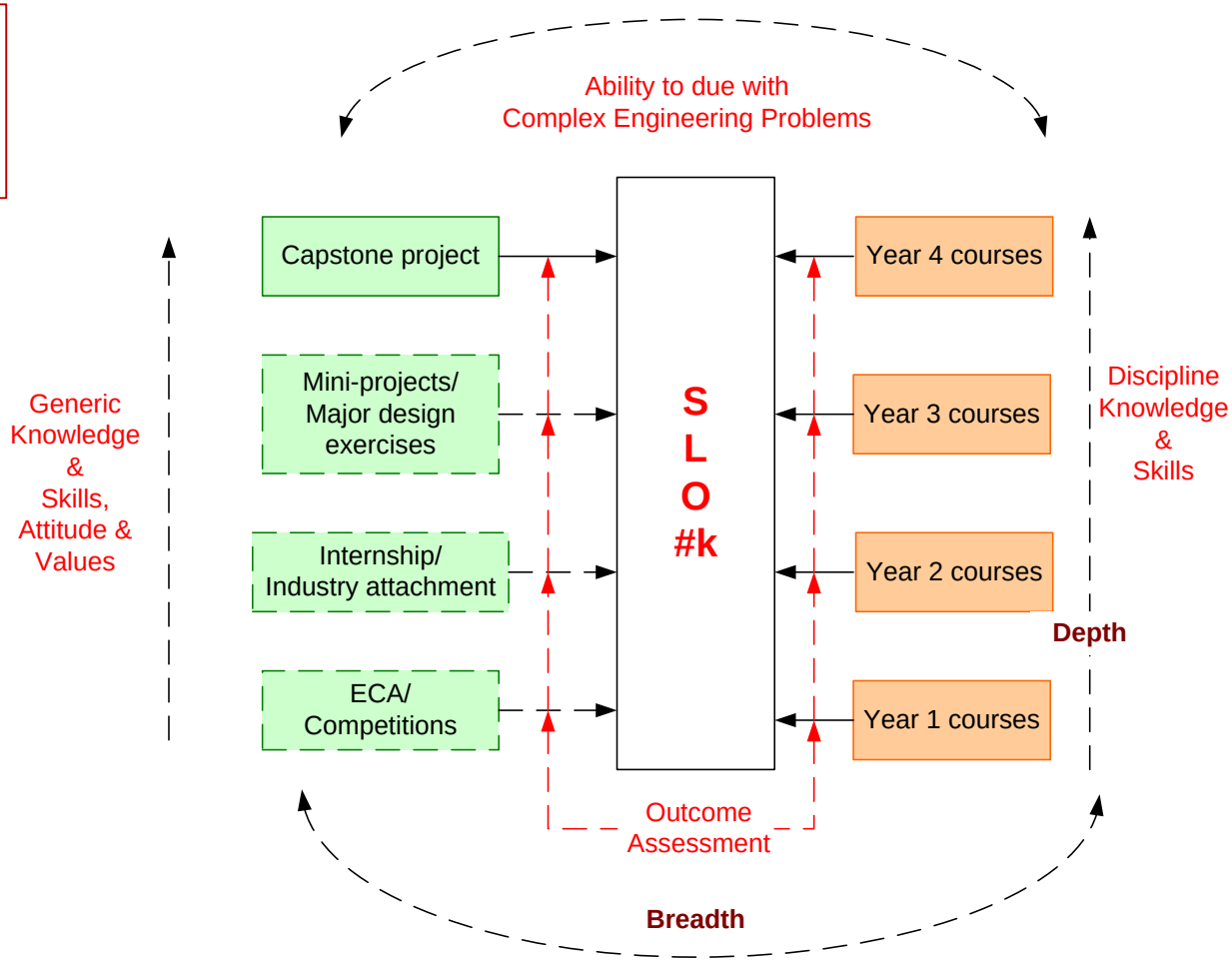
(A requirement of WA)

- *Involve wide-ranging or conflicting technical, engineering and other issues*
- *Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models*
- *Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach*
- *Involve infrequently encountered issues*
- *Are outside problems encompassed by standards and codes of practice for professional engineering*
- *Involve diverse groups of stakeholders with widely varying needs*
- *Have significant consequences in a range of contexts*
- *Are high level problems including many component parts or sub-problems*

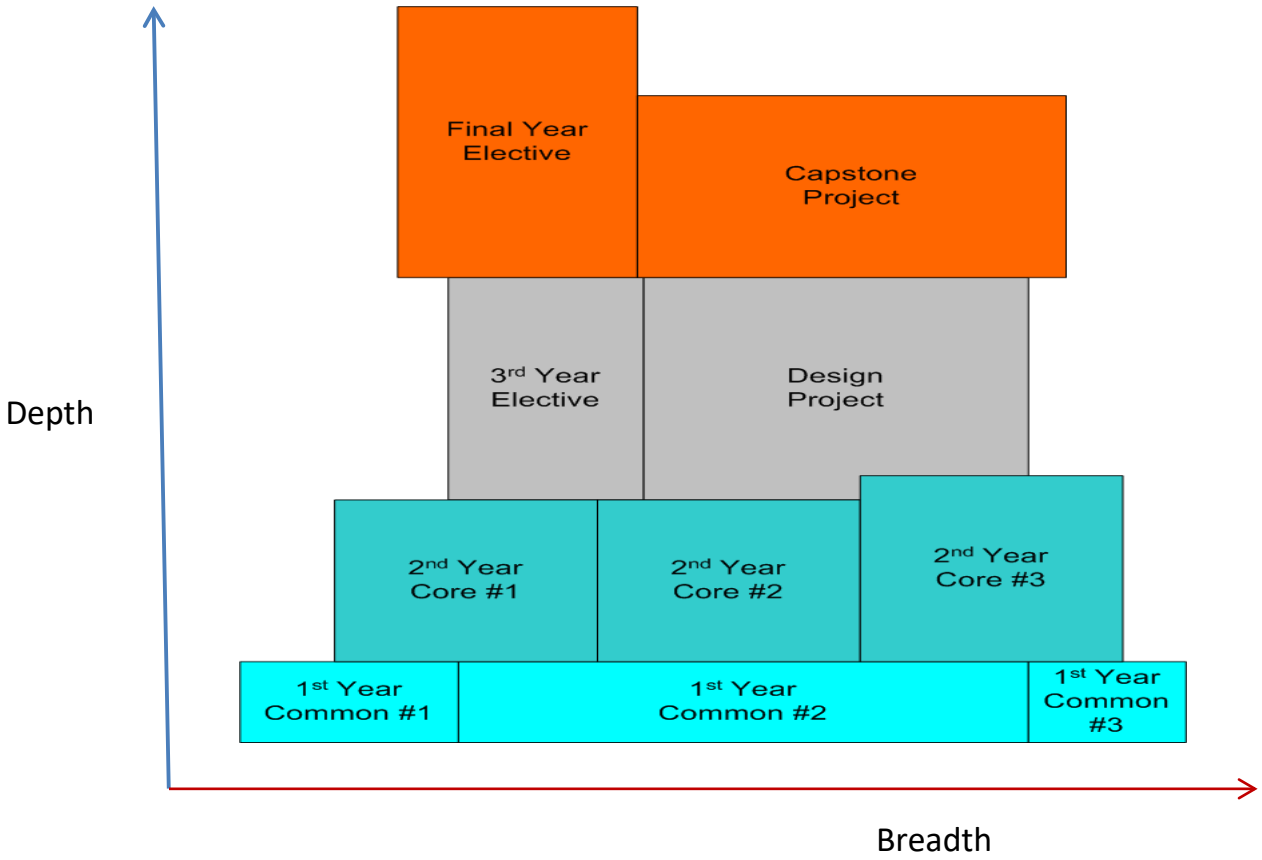
Evaluation of POs

- Attainment of each POs must be carefully evaluated in terms of depth and breadth stipulated – going through evidences provided
- Application to Complex Engineering Problems

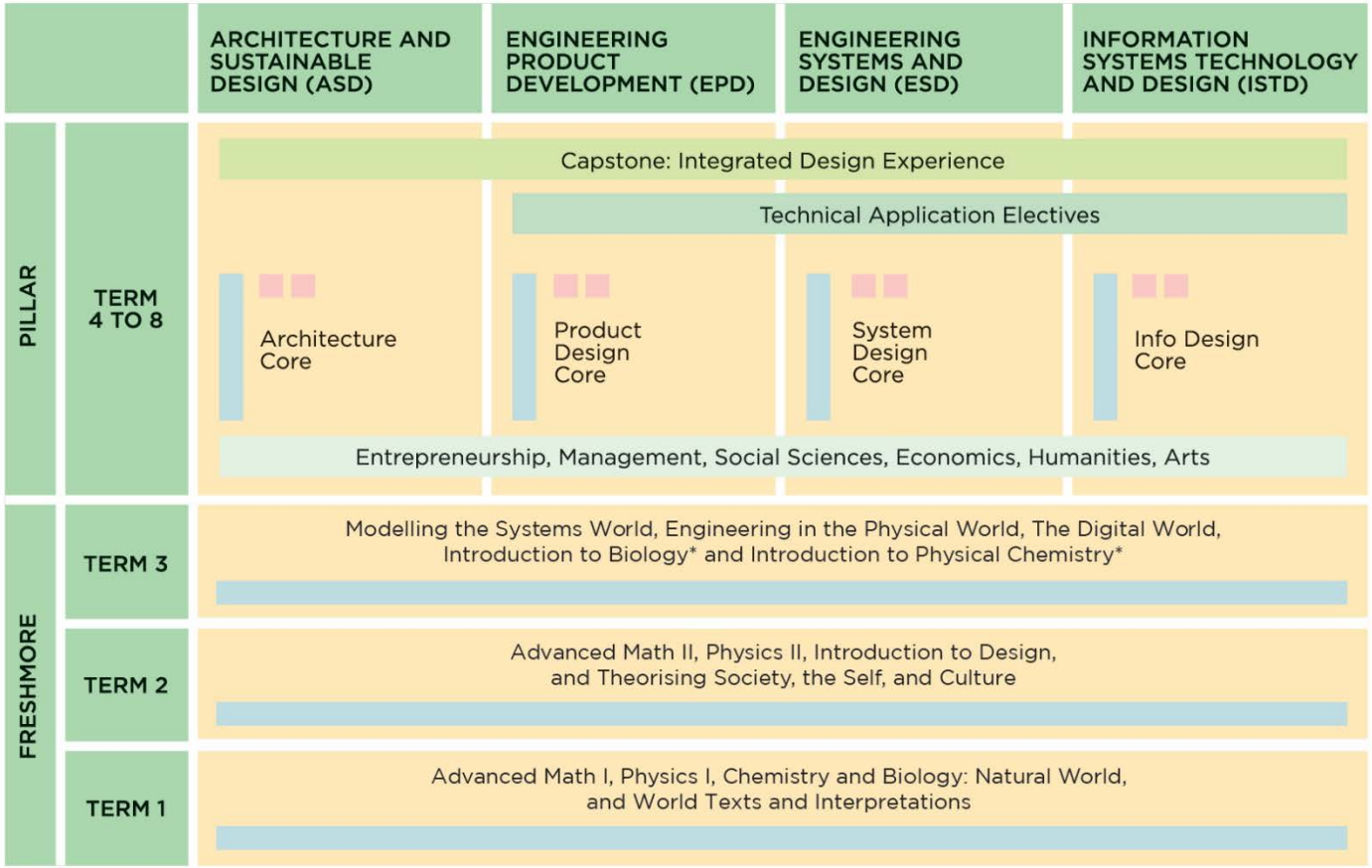
The achievement of each SLO, both breadth and depth, should be assessed and evaluated.



PO # 3


Final Year Elective
Capstone Project
3rd Year Elective
Design Project
2nd Year Core #1
2nd Year Core #2
2nd Year Core #3
1st Year Common #1
1st Year Common #2
1st Year Common #3
Depth
Breadth

Unique Academic Structure at Singapore University of Technology and Design
http://www.sutd.edu.sg/Education/



Evidences from various Teaching-Learning Activities

- Internship program
- Laboratory work
- Design projects
- Final year project
- Co-curricular activities to hone personal skills
- Assessment of learning outcomes
- Student feedback

PO Folder

- For accreditation evaluation, good to prepare a folder for each outcomes
- Contains relevant subjects and assessment details which support achievement of the PO
- Includes other student learning activities and assessment details
- Samples of student work

Part 5

Preparing New Program for Accreditation

Step 1 – Decide to go for accreditation

- Top management of HEI involved
- Initiated by Program Director, HoD
- Support of President, VC, Provost, Dean

Step 2 – Establish a Program Accreditation Committee

- Program Director
- Representatives of senior and junior faculty members whose contribution in accreditation should be recognized
- Desirable attributes for selecting committee members
  - Hardworking
  - Willing to learn new things
  - Not calculating

Step 3 – Understand BAETE accreditation requirements

- Program accreditation committee studies thoroughly BAETE requirements for accreditation
  - Manual of Accreditation
  - Accreditation Policy
  - Accreditation Process
  - Criteria for Accreditation
- Consult BAETE for clarification and further information

Step 4 – Examine details of accreditation criteria

- Program Accreditation Committee studies the detailed requirements of each criteria
- Conduct gap analysis of requirements and current state, and what need to be done to close the gaps

Step 5 – Confirm to go for accreditation or just drop the idea

- Based on evaluation of gap analysis of step 4, a decision is made to prepare the program for accreditation
- Top management of HEI involved

Step 6 – Establish strategy and roadmap

- Program Accreditation Committee established strategy and roadmap for the program to be accredited
- Resources and commitments from top management

Step 7 – Sharing of strategy and roadmap with stakeholders

- Explain the reasons to go for accreditation
- Sell the importance and benefits of accreditation to the stakeholders
- Buy-in from faculty members – whom will be actively involved
- Explain the resources and help which will be provided

Step 8 – Project Execution and Management

- Establish timeline for achieving each milestone
- Assign capable people in charge of each activities
- Bring in all stakeholders early
- Regular sharing and checking on progress

Step 9 – Training & Training

- Provide overview of accreditation to all faculty, management and supporting staff
- Conduct seminar on requirements of outcome-based accreditation, and the requirements of BAETE accreditation criteria
- Conduct workshop on assessment of PLOs
- Establish tools, assessment methodologies, templates to assist outcomes assessment

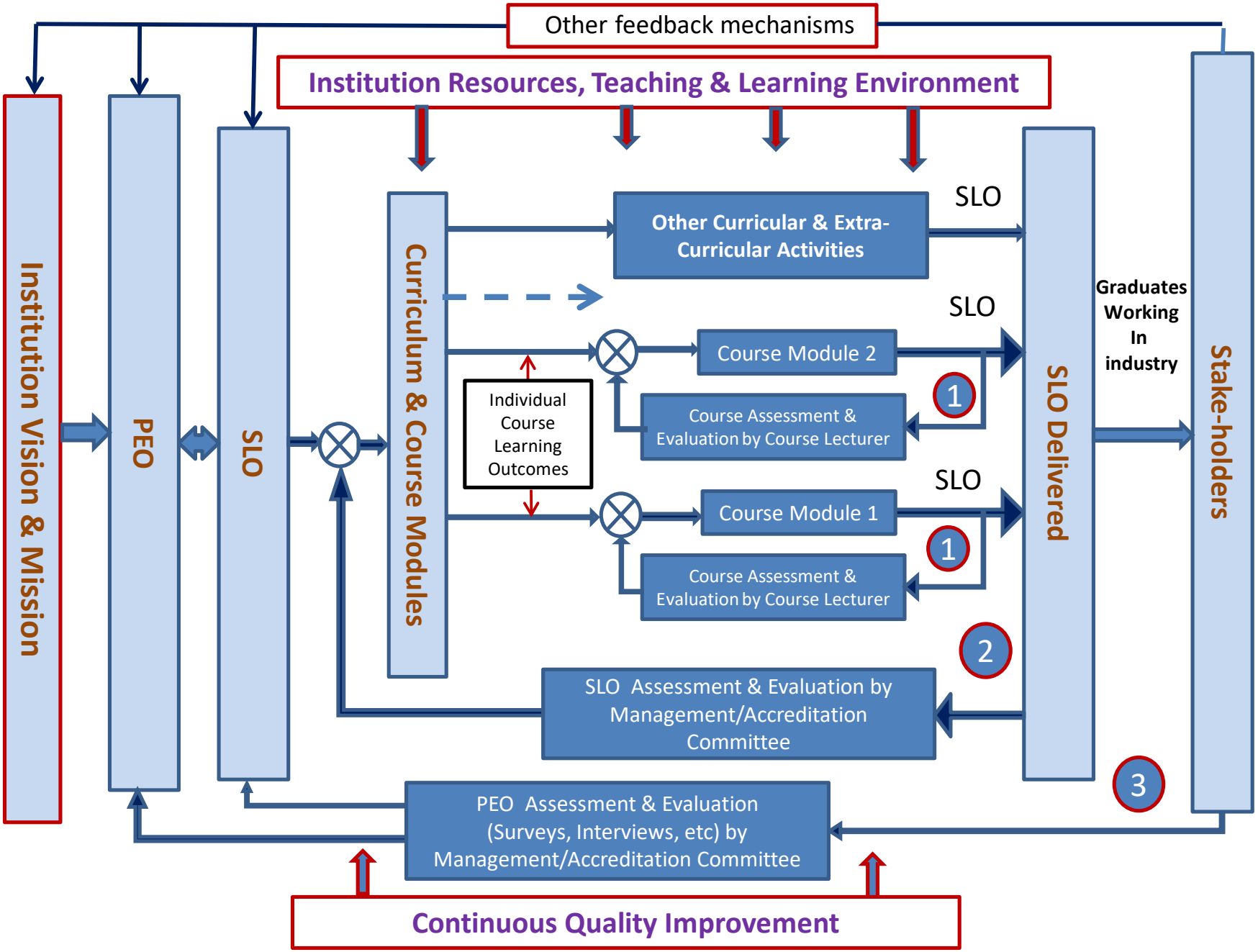
Step 10 – Active Participation of Stakeholders

- Establish Program Advisory Committee with participation of diverse stakeholders, particularly from the industry and professionals
- Involve stakeholders in framing the Program Education Objectives
- Involve stakeholders in examining the curriculum and student learning activities

Step 11 – Continuous Quality Improvement

- Establish & implement the close-loop CQI process
- Adopt period review with stakeholders
- Take necessary remedial actions
- Overcoming barriers and objections

Continuous Quality Improvement Process in Outcome-based Accreditation



Step 12 – PEO and PLO Evaluation

- Assessment and evaluation of achievement of PEO
  - Employers survey
  - Alumni feedbacks
  - Other means
- Assessment and evaluation of attainment of PLOs
  - Compilation of folders for each outcomes
  - Outcomes assessment at course level

Step 13 – Preparation of Self-Assessment Report

- This is a live document which is updated periodically
- Advantageous to prepare SAR early, well before applying to BAETE for accreditation visit
- The exercise is valuable to identify gaps which need to be addressed.

Step 14 – Apply to BEATE for Accreditation

- Apply to BAETE when self-evaluation indicates that the program is ready for accreditation
- Decision to apply for BAETE accreditation should be agreed upon and shared with all faculty and management at program/departmental meeting

Step 15 – Prepare for Accreditation Visit

- Establish timelines/schedule with BAETE
  - Constraints of availability of institution's top management
- Prepare and submit the SAR
- Get ready documents for on-site examination by visiting team
  - Folders with evidences of outcomes
  - Others as mentioned in Accreditation Manual or requested by visiting team

Step 16 – Logistics for Accreditation Visit

- Take time and efforts to finalize the logistics
- Get those involved all well-prepared
- Realistic schedule and timing
- Presentations should not repeat what are already included in SAR
- Minimize time for facilities inspection
- Meetings with stakeholders – arranged for focused groups

Part 6

Sharing of Some Common Shortcomings

1. Poorly prepared SAR

- Not preparing ahead – last-minute chasing of information
- Not following the BAETE template, resulting in many missing information
- Errors and inconsistencies – lack of review and proofreading
- Inadequate information required
- Poor 1st impression

2. Lack of understanding of OBA

- Program director and faculty did not have fundamental appreciation of the requirements of outcome-based accreditation
- No knowledge of terms used, e.g. PEO, PLO (SLO)
- Mix up of PEO and PLO in SAR
- Faculty not conducting outcomes assessment

Key features of OBA

- OBA focuses **more** on:
  - Learning, as against teaching
  - Students
  - Outcomes, not inputs or capacity

- OBA incorporates **continuous improvement**
  - to systematically analyze its systems for variance
  - make decisions based on facts
  - consciously define the organization's customers – both internal and external
  - actively seek input from customers

Outcomes-based system

- The emphasis is on measured “outcomes” rather than "inputs”
- Outcomes include a range of skills and knowledge
- Outcomes are measurable, observable
- Outcomes (skills and knowledge) are specified, but not inputs
- Identifying appropriate and measurable outcomes is difficult, and often controversial

Outcomes

- Stipulate knowledge, skills, attitudes & behaviors on completion of program
- Well documented
- Defined by measurable performance indicators
- Both direct & indirect assessment tools to measure each outcome

Writing Intended Learning Outcomes

- Intended learning outcomes need to be written at both programme and course levels.
- Both of them need two essential elements:
  - A statement of what content are the students expected to be able to do at the end of learning experience;
  - The levels of understanding or performance in those content areas.

Definition of terms used

- Programme Educational Objectives
  - Programme educational objectives are broad statements that describe the **career and professional accomplishments** that the programme is **preparing graduates to achieve** (within 3 to 5 years after graduation)
- Student Learning Outcomes
  - Student learning outcomes are narrower statements that describe **what students are expected to know and be able to do by the time of graduation**. These relate to the skills, knowledge, and behaviours that students acquire in their matriculation through the programme

3. Lack of understanding of PEO

- PEO written in the form of PLO
  - e.g. students will be able to do ….

Alignment with Mission

- University mission?
- Faculty (school) mission & departmental mission statement?
- Alignment with mission of institution?
- Published and known to stake-holders?

Programme Education Objectives (PEO)

- Broad statements that describe what graduates are expected to attain within a few years after graduation
- Align with university's & engineering school's mission
- Well defined & documented & publicized
- Stakeholders' participation, including faculty
- Manageable number of objectives
- Define outcomes
- Measurable
- Feedback mechanism for improvement

Programme Educational Objective (PEO)

- PEO consistent with mission?
- Alignment with mission of institution?
- Published and known to stake-holders?
- Based on needs of constituencies?
- Curriculum and processes that lead to attainment of PEO?
- Common mistakes in setting PEO
  - Too broad and not specific to program
  - Too narrow and similar to SLO
  - Not known to stake-holders

B.Eng. (Electrical Engineering)

The educational objectives of the B.Eng. (Electrical Engineering) programme are to graduate students who have the following attributes 5 years after their graduation,

1. **Technical skills :**
   are technically competent to solve complex problems in electrical engineering and can adapt effectively in a fast changing environment
2. **Critical thinking :**
   are able to critically think, analyse and make decisions that give due consideration to global issues in business, ethics, society and the environment
3. **Leadership, team building :**
   are able to communicate effectively, act with integrity, and have the inter-personal skills needed to engage in, lead, and nurture diverse teams
4. **Attitude :**
   are committed to lifelong learning, resourceful and embrace global challenges and opportunities to make a positive impact in society.

Achievement of PEO

- Are assessment and evaluation processes in place to determine attainment of PEO?
- Is there a continuous improvement mechanism in place?
- Evidence and documentation is important.

Assessment of Programme Educational Objectives

- What graduates are expected to attain within a few years after graduation
- Ingredients to look out for:
  - Objectives are current and relevant
  - Methods and frequency to monitor if they are appropriate (usually every 2 to 3 yrs)
  - Constituents involved is appropriate
  - Student learning outcomes will enable its attainment
  - Effective assessment processes in place to evaluate achievement
  - Assessment method depends on factors like size of cohorts
  - Methods can include data from advisory boards, recruiters, employers, graduate surveys

4. PLOs not well matched

- PLOs are not “perfect” match to those stipulated by the accreditation body
- Difficult to evaluate the shortfalls in breadth and depth of outcomes achievement
- My suggestion
  - Adopt all 12 BAETE PLOs without changes
  - Add additional PLOs if you want (but bear in mind the additional work in assessment, and the curriculum support)

5. Lack of Outcomes Assessment

- Only mapping of courses to outcomes
- No outcomes assessment at course level
- Faculty not trained and are not conducting outcomes assessment
- Subject/course marks & grading used as justification that overall outcomes are contributed by the subject(s)

6. Mapping exercise

- Program Accreditation Committee undertake the task of mapping subjects/courses to each outcomes
- Faculty teaching a particular subject is not aware of the outcomes contribution from his subject, and has not conducted proper outcomes assessment
- Just a mapping exercise – not acceptable

7. Faculty not fully involved in outcomes assessment

- Most faculty members do not understand outcome-based accreditation
- They are not trained in outcomes assessment
- They don’t know how to conduct proper outcomes assessment
- Student learning activities not guided by outcomes
- They rely on marks and grades to justify course outcomes attainment

8. Obsession with Assessment

- Assessment involves:
  - Cognitive domain (thinking, knowledge)
  - Psychomotor domain (doing, skills)
  - Affective domain (feeling & attitude)
- Is the assessment efforts sustainable?

9. Wrong Justification of Outcomes Attainment

- Wrong interpretation of the Bloom's Taxonomy
- Entry level courses are used to map achievement of outcomes at mastery level simply because some assessment exercises include activities of
  - Write
  - Evaluate
  - Design, etc
- Note that Complex Engineering Problems should be used for assessment at masterly level

10. Curriculum not adequate to support all the 12 outcomes

- Curriculum not adequately structured to achieve all the 12 PLOs
- Common curriculum deficiencies
  - The engineer and society
  - Environment and sustainability
  - Ethics
  - Finance and project management

Curriculum

- Does the curriculum satisfy the program specific criteria of the particular engineering discipline?
- Are performance indicators established to measure the outcomes of the courses with respect to the program outcomes of NBA criteria)?
- Major design experience?
- Prerequisites
- Course syllabi
- Cores and electives

11. Industry stakeholder not adequately involved

- No Program Advisory Committee (PAC) with industry members
- Industry not involved in setting PEO and curriculum review
- PAC not active – meeting once in many years
- No proper minutes of PAC meeting for deliberation of academic matters (PEO, PLO, student learning activities)

Interaction between institution & industry

- Involvement of industry stake-holders to ensure relevance of curriculum
- Opportunity for students to acquire industrial experience via internships and design projects by professional engineers and faculty members with industrial experience
- Communication channel with industry, e.g. industry advisory board

12. Health and Safety Issues

- Health & safety issues affect attainment of full accreditation
- Many of the H&S issues could have easily been addressed
- Common H&S issues
  - General on-campus safety
  - Laboratory safety
  - Electrical safety
  - Chemical safety
  - Others

13. Inadequate evidences to demonstrate compliance with criteria

- Not enough work done to gather evidences to demonstrate compliance with criteria
- Best practices
  - Course folders
  - Folders for each outcomes
  - Samples of student portfolio

Saving Samples of Student Works

- Each course is required to save samples of student homework solutions, laboratory reports, project or design reports, and exam solutions, typically from poor to good quality.
- At the end of each quarter, the lecturers of all undergraduate courses must compile a binder containing in addition to the solutions, the corresponding homework questions, exam questions, lab description, and project description.

14. Poor Execution of logistics during on-campus visit

- Lack of planning and experience
- Lack of commitments and support
- Not knowing what the visiting team will focus on

What the PEV looks for?

- PEVs are sent to evaluate programs, certifying that they satisfy the criteria
- They look for evidences that the required criteria are met
- They identify deficiencies, weaknesses, concerns
- They are not advisers and should not give solutions to problems identified

Major focus

1) Outcome of the education provided;
2) Quality assurance processes, including internal review;
3) Assessment procedures;
4) Activities and work of the students;
5) Entry standards and selection procedure for admission of students;
6) Motivation and enthusiasm of faculty;
7) Qualifications and activities of faculty;
8) Facilities;
9) Industry participation.

Part 7

Interactive Workshop 1 – Providing Evidences to Demonstrate PEO Attainment

Workshop Format

- Participants split into work teams, each comprising 5 members
- Members of a team should come from different institutions

Work Activities on PEO

- Each team member identifies a program from his/her institution and list the program's PEO
- Each team member shares the process for setting and reviewing the PEO, and how to provide evidences to evaluate the attainment of the PEO
- All members work as a team to comment, and to identify best practices and shortcomings
- The team summarizes key findings, best practices, shortcomings, and challenges to be presented to all at the workshop.

Interactive Workshop 2 – Providing Evidences to Demonstrate POs Attainment

Workshop Format

- Participants split into work teams, each comprising 5 members
- Members of a team should come from different institutions

Work Activities on POs

- Each team shall be assigned 2 POs to work on
- Members work together as a team on how best to provide evidences to demonstrate the achievement of the 2 POs – covering the depth and breadth required
- Considerations may include
  - Pedagogy, teaching-learning activities
  - Performance indicators for each PO
  - Required subjects, learning activities to attain PO
  - Direct and indirect assessment
- All members work as a team to comment, and to identify best practices and shortcomings
- The team summarizes key findings, best practices, shortcomings, and challenges to be presented to all at the workshop.

Part 8

References on Outcomes Assessment

Definition of terms used

- Assessment
  - Assessment is one or more processes that **identify, collect, and prepare data** to evaluate the achievement of programme educational objectives and student learning outcomes
- Evaluation
  - Evaluation is one or more processes for **interpreting the data and evidence accumulated** through assessment practices. Evaluation **determines the extent** to which programme educational objectives or student learning **outcomes are being achieved**, and results in **decisions and actions to improve** the programme

Assessment
&
Demonstration of Achievement

Breadth
Depth
Where gained
Learning Process
Assessment Methods

Reference: **Designing Better Engineering Education Through Assessment**
by JE Spurlin, SA Rajala & JP Lavelle
Stylus Publishing LLC, 2008

We Have To

1) Demonstrate that students have achieved the specified learning outcomes at appropriate level by the time of graduation, and
2) Provide evidence that our program has contributed to our students' ability to achieve the POs

Assessment of PO – Where?

- Course work & curricular activities
  - Classes chosen, major
- Classroom experience
  - Pedagogy, facilities, faculty & student interaction,
- Out-of-class experience
  - Co-curricular, internships, support services

1. Engineering Knowledge

- Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering* problems.

Assessment of PO (1)

- “Apply” - Level 3 BT
- Demonstrate breadth and depth of education and type of knowledge, both theoretical and practical
- Show students can employ general principles, theories, concepts, and/or formulas from mathematics, science, and engineering in the solution of problems in their field of engineering.
- For a particular complex engineering problem, students should demonstrate that they can
  - Define and describe the pertinent principle, theory, concept, and/or formula,
  - Explain why it is appropriate to the problem, and
  - Demonstrate how it has been applied in the solution of the problem.
  - Best demonstrated via capstone project or design work

Assessment of PO (1)

- Show evidence that students required to take modules in mathematic and science
- Respond positively, after students have been on the job, in applying knowledge of mathematics, science, and engineering to the particular engineering problems they encountered at work;
- Achieve a positive rating from their employers regarding their ability to apply general principles of mathematics, science, and engineering to particular engineering situations.

2. Problem Analysis

- Identify, formulate, research literature and analyse *complex* engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

Assessment of PO (2)

- Identify – level 2 BT
- Formulate – level 3 BT
- Research – level 3 BT
- Analyse, Solve – level 4 BT
- reaching substantiated conclusions – level 6 BT
- Demonstrate complexity of analysis
- Show that students can identify engineering problems. Problem identification entails two procedures:
  - Ability to <u>recognize</u> an engineering problem. An engineering problem is an opportunity for change in which engineering solutions can be applied to improve on existing or anticipated conditions and
  - Ability to <u>define</u> an engineering problem. Defining a problem means describing, in concrete and specific terms, the existing or anticipated condition that creates the opportunity for change and the goal state(s) that provides the direction and end-point for change

Assessment of PO (2)

- Show that they have taken assignment and project work and have the ability to research through relevant literature review
- Show that they can represent a problem in a form that makes finding solutions more efficient and effective.
- Show that they can analyze problems, that is, isolate and describe the important components of a problem; what is given (design specifications, availability of materials, performance requirements, testing standards, etc); what is known from previous experience relevant to the problem; and what the unknown are;

Assessment of PO (2)

- Show that they can apply engineering principles and mathematics to find the unknowns and arrive at appropriate solutions to the problem;
- Show that they are able to reach substantiated conclusions based on an analysis of various relevant factors
- Respond positively, after they have been on the job, to the training and guidance they received in solving engineering problems;
- Achieve a positive rating from their employers regarding their ability to solve engineering problems.

3. Design / Development of Solutions

- Design solutions for *complex* engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

Assessment of PO (3)

- Level 5 of BT
- Demonstrate breadth and uniqueness of engineering problems, i.e. extent to which problems are original and to which solutions have previously been identified or codified
- Show, via capstone project or design assignments, that students can engage productively and creatively in the process of design.
  - Establishing the goal of the design project, the outcome that must be attained
  - Defining the project
  - Take account of public health and safety, cultural, societal, and environmental considerations
  - Brainstorming for alternative possibilities
  - Choosing the best of the possible solutions
  - Creating a prototype or model that embodies or represents the chosen solution
  - Testing the prototype or model against the criteria for the project, and
  - Choosing and justifying to an appropriate audience the final system, component, or process

Assessment of PO (3)

- Provide evidence that curriculum covers public health and safety, cultural, societal, and environmental issues
- Respond positively, after they have been on the job, to the training and guidance in design process they received at university
- Achieve a positive rating from their employers regarding their ability to engage productively and creatively in the process of design

Assessment of PO

- Assessment is big subject and probably the major challenge of the teaching faculty
- Are assessment methods adequate to provide evidence of achievement of PO?
- Each learning outcome may be measured or evaluated in terms of performance indicators
- Is there a system in place to ensure that each student will acquire the stated PO before graduation? (bearing in mind the various core and optional subjects available, and overseas attachment)

Sustainable Program Assessment Processes

- Direct and indirect methods of assessment to be applied to measure a wide variety of different student abilities
- Consider best fit between program needs, satisfactory validity and affordability (time, money and effort)
- Need to use multiple methods to maximise validity and reduce bias of any approach – triangulation.

Assessment

- Assessment is one or more processes that identify, collect, and prepare data to evaluate the attainment of student learning outcomes and program educational objectives.
- Effective assessment uses relevant direct, indirect, quantitative and qualitative measures as appropriate to the objective or outcome being measured.
- Appropriate sampling method may be used as part of an assessment process.

Steps for assessment design

1) Define results to be measured
2) Identify data required and sources
3) Review existing assessment method
4) Define additional methods and measures
5) Implement & evaluate

Assessment Methods

(Gloria Rogers)

- Locally developed examinations
- Oral exam
- Written surveys and questionnaires
- Commercial, norm-referenced, standardized exams
- Exit and other interview
- Focus groups
- External examiner
- Portfolios
- Simulations
- Performance appraisals
- …

Examples of Assessment Methods in EC UK

- Exams
- Class tests
- Project reports
- Presentations
- Lab reports
- Design studies
- Vivas/orals
- Posters

Assessment tools and methods

- **Formative assessment**
  The collection of information about student learning during the progression of a course or program in order to improve students learning. Example: reading the first lab reports of a class to assess whether some or all students in the group need a lesson on how to make them succinct and informative.

Assessment tools and methods

- **Summative assessment**

  The gathering of information at the conclusion of a course, program, or undergraduate career to improve learning or to meet accountability demands. When used for improvement, impacts the next cohort of students taking the course or program. Examples: examining student final exams in a course to see if certain specific areas of the curriculum were understood less well than others; analyzing senior projects for the ability to integrate across disciplines.

Evaluation

- Evaluation is one or more processes for interpreting the data and evidence accumulated through assessment processes.
- Evaluation determines the extent to which student outcomes and program educational objectives are being attained.
- Evaluation results in decisions and actions regarding program improvement.

Two Assessment Mechanisms

- The End-of-Course Instructor Survey and
- The Instructor Evaluation of Students' Performance on an BAETE*-related Problem
  - It is the main mechanism used to obtain instructor feedback on whether the students in the course achieved some of the desired course outcomes.

Adapted from: UCLA Electrical Engineering Department's "Guide for instructors and teaching Assistants of undergraduate courses

Student Survey

- End-of-Course Student Surveys.
- The Student Surveys collect student input on course material, course organization, and instruction.
- Besides asking students questions about the quality of a course and its instruction, the surveys also assess, for each course, the main topics that students are expected to have been exposed to during the course.

Adapted from: UCLA Electrical Engineering Department's "Guide for instructors and teaching Assistants of undergraduate courses

Student Survey

- Students are asked to rate, on a scale from Poor to Excellent, whether they feel they have had an opportunity to learn the Specific Course Outcomes well.
- The student input is then summarized and tracked in:
  1. Individual reports on Course Performance for each course offering.
  2. Yearly reports on Course Performance during an academic year.
  3. Quarterly reports on Department Performance.
  4. Yearly reports on Department Performance.

Adapted from: UCLA Electrical Engineering Department's "Guide for instructors and teaching Assistants of undergraduate courses

Other student feedback mechanisms

- Student feedback may be collected through two additional mechanisms:
  - *Exit surveys administered to graduating seniors.*
  - *Student Advisory Committee.*

Saving Samples of Student Works

- Each course is required to save samples of student homework solutions, laboratory reports, project or design reports, and exam solutions, typically from poor to good quality.
- At the end of each quarter, the lecturers of all undergraduate courses must compile a binder containing in addition to the solutions, the corresponding homework questions, exam questions, lab description, and project description.

Student Learning Outcomes

- Student learning outcomes to be stated and documented - in the form of graduate attributes
- Provide mapping of program PLO with BAETE's PLO, if different
- Relationship of PLO to PEO

Assessment of PLO

- Assessment is big subject and probably the major challenge of the teaching faculty
- Are assessment methods adequate to provide evidence of achievement of PLO?
- Each learning outcome may be measured or evaluated in terms of performance indicators
- Is there a system in place to ensure that each student will acquire the stated PLO before graduation? (bearing in mind the various core and optional subjects available, and overseas attachment)

Program Outcomes & Teaching-Learning Processes

- Each program should cover general and specialized professional content
- Adequate breadth and depth, and
- Appropriate components in Science and Humanities
- Evaluation of teaching-learning processes
- Modes of teaching-learning: lecture, tutorial, seminar, projects, internship, peer-group discussion, ..

Q&A

Thank you