

# ENGINEERING EDUCATION

## CURRICULUM:

### SCORECARD, PROSPECT AND POTENTIALS

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# FOCUS

*The purpose of this discussion is to provide a platform for the appraisal of Civil Engineering education with a view to having a clear understanding of the history, gaps, challenges, potentials and the possibilities therein, particularly at a time like this when the marketplace has become totally shrunk – One Job Market.*

## **BACKGROUND:**

Global engineering philosophies and models studied, prior to the development of the malaysian model, have shown their dynamic and farsighted approaches. However, total adoption may prove to be unfavorable for the progress and sustainability of the nation.

It has been the perception of many practitioners that **locally trained engineering graduates are strong technically but are lacking in non-technical or transferable skills, which are necessary for top management or leadership positions.**

Most engineering education models worldwide have placed importance to transferable skills apart from a continued emphasis on technical competency. Engineers are also having a very marginal role in the country's economic development and progress, which is substantiated by the unimpressive number of engineers in the top industrial leadership positions.

There is the need to have a greater emphasis in the knowledge of engineering science so that engineers are flexible and able to move across several engineering disciplines in a fast changing world.

Wholesome training of students are necessary in preparing engineers who are capable of performing useful functions in the industry, able to communicate effectively, manage or lead organization and having innovative thinking skills.

With rapidly expanding knowledge, globalization and the changing emphasis in scientific fields, engineers must be prepared for future challenges.

## DEFINITIONS

1. The term **ENGINEERING** itself has a much more recent etymology, deriving from the word engineer, which itself dates back to 1325, when an engineer (literally, one who operates an engine) originally referred to "a constructor of military engines."

In this context, now obsolete, an "engine" referred to a military machine, i. e., a mechanical contraption used in war (for example, a catapult).

The word "engine" itself is of even older origin, ultimately deriving from the Latin *ingenium* , meaning "innate quality, especially mental power, hence an engine is seen as a clever invention.

2. **EDUCATION** is the process of facilitating learning, or the acquisition of knowledge, skills, values, morals, beliefs, habits and personal development.

Educational methods include teaching, training, storytelling, discussion and directed research.

3. The **METHODOLOGY** of teaching is called **PEDAGOGY**.

4. **CURRICULUM** refers to the lessons and academic content taught in a school or in a specific course or program. In dictionaries, curriculum is often defined as the courses offered by a school, but it is rarely used in such a general form.

5. **SCORECARD** a report or indication of the status, condition, or success of something or someone.

6. **PROSPECT** is indicative of hope, possibilities, likelihood and expectations

7. **POTENTIALS** is the latent qualities or abilities that may be developed and lead to future success or usefulness.

## **CRITERIA FOR DURABLE ENGINEERING EDUCATION**

**FIVE CRITERIA ARE IDENTIFIED AS IMPORTANT IN THE INTERNATIONALLY ACCEPTED ENGINEERING EDUCATION MODEL AND THEY ARE:**

**SCIENTIFIC STRENGTH,** Which provides engineers who are innovative, able to work in research and development activities, and adaptable in different engineering fields.

**PROFESSIONAL COMPETENCIES,** Which provide engineers who are able to identify, formulate, and solve engineering problems, responsible professionally, and able to use techniques, skills, and modern engineering tools for engineering practice.

**MULTI-SKILLED,** Which provides engineers who are able to work in different engineering fields and function in multidisciplinary work/teams.

**WELL-RESPECTED AND POTENTIAL INDUSTRY LEADER,** Which provide engineers who are able to understand the impact of engineering solutions in a global/social context, knowledgeable of contemporary issues, able to communicate effectively and be involved in community or social projects.

**MORALLY AND ETHICALLY SOUND** Which provide engineers who understand ethical and moral responsibility.

## **6 SKILLS & COMPETENCIES REQUIRED**

Six skills and competencies are identified as highly necessary in preparing engineering students to satisfy the five criteria mentioned above and the table below also provides subjects associated with the six components. The model does not restrict nor impose a rigid barrier to the extent and content of a curriculum.

There is a freedom to emphasize on scientific or professional skills and competencies or balancing both components.

Appropriate emphasis on global and strategic skills, adequate exposure to industrial and practical skills and incorporating humanistic skills also allow completeness in the training. The model recommended that 30% of the curriculum be attributed to non-engineering subjects.

Table 1: Recommended Skills and Competencies

Skills & Competencies	Characteristics	Typical Subjects (Civil)
<b>Global &amp; Strategic</b>	These skills enable students to adapt easily within the borderless world that is experiencing rapid expanding knowledge.	<b>Languages, Strategic Planning, Information Technology, Multimedia, International Business</b>
<b>Industrial</b>	Skills that go beyond the scientific and professional and which are necessary in the advanced phase of the graduate's career.	<b>Environment, Management Finance, Economics, Engineers in Society, Communication Skills, Law, Occupational Safety, Human Resource Management, Innovation</b>
<b>Humanistic</b>	These skills help create a balanced engineer with high ethical and moral standards.	<b>Islamic Civilization, Asian Civilization, Nationhood, Islamic Studies, Moral Education,</b>
<b>Practical</b>	<b>These enable students to be directly involved with hands-on activities or real-life situations, thus providing the basis for integrating the intra and inter engineering and non-engineering knowledge</b>	<b>Final Year Project, Industrial Project, Practical Training, Engineering Design</b>
<b>Professional</b>	<b>Such skills cover technical competency aspects required to perform specific engineering tasks.</b>	<b>Professional Subjects in Civil Engineering e.g. Foundation Engineering, Water &amp; Waste Engineering, Highway Engineering, Concrete Structures, Public Health Engineering, Surveying</b>
<b>Scientific</b>	<b>They enable students to have a firm foundation in engineering science, thus enabling them to realign themselves with the changes in emphasis in the scientific field and to develop an interest in R&amp;D and design.</b>	<b>Engineering Sciences e.g. Engineering Mathematics, Engineering Materials, Fluid Mechanics, Engineering Statistics, Thermodynamics, Engineering Mechanics, Programming</b>

## ENGINEERING EVOLUTION

The concept of engineering has existed since ancient times as humans devised fundamental inventions such as the [pulley](#), [lever](#), and [wheel](#). Each of these inventions is consistent with the modern definition of engineering, exploiting basic mechanical principles to develop useful [tools](#) and objects.

Later, as the design of civilian structures such as bridges, roads and buildings matured as a technical discipline, the term [civil engineering](#) entered the lexicon as a way to distinguish between those specializing in the construction of such non-military projects and those involved in the older discipline of [military engineering](#).

The [pyramids](#) and [Pharos of Alexandria](#) in [ancient Egypt](#),  
[Acropolis](#) and [Parthenon](#) in [ancient Greece](#),  
[Aqueducts](#), [Via Appia](#) and [Colosseum](#) in the [Roman Empire](#), [Teotihuacán](#),

Civil and Military Engineers – The separation of the same product for military based uses and civilian uses.

# A STATEMENT OF THE PROBLEM

# **THE GAP**

## **GAPS IN ENGINEERING EDUCATION**

The Nigerian tertiary institutions are faced with enormous challenges in terms of general conduct of engineering education programs which has failed to equip students with the necessary skills to cope with the challenges of world of work, entrepreneurship, leadership and the modern day society.

**A SYSTEM THAT PRODUCES ACADEMICALLY BRILLIANT,  
DEMOTIVATED, UNFOCUSSED AND ALMOST HOPELESS ENGINEERS  
WHO DO NOT HAVE THE TRAINING NOR COURAGE TO BE  
CREATIVE.**

## **ENGINEERING EDUCATION IN NIGERIA**

The effectiveness of a program starts with effective and adequate curriculum design that will guide and equip the students with the skills needed in their respective areas of specialization. The curriculum of engineering education is described as obsolete and needs to be thoroughly reviewed from time to time by the body concerned in order to meet with the world standard and allow Nigerian graduate to compete globally.

The curriculum should be able to create space to accommodate certain aspects of engineering applications that are prevalent in our environment today. The high level of re-training of graduates of engineering education by the industries signals the evidence of the curriculum inadequacies.

Therefore, for engineering education to fully support economic growth, there should provisions for the change of tools that is used in solving the problem as the problem is equally changing from time to time. This implies that engineering education curriculum should be flexible in nature, appraised and modified in order to accommodate certain societal needs (kofoworola, 2003; onwuka, 2009).

**If all Engineering awarding institutions in Nigeria were to be holistically audited in terms of equipment, many graduates will have their certificates rejected or recalled.**

Atsumbe and saba (2008) postulated that students undergoing engineering education in Nigeria should be exposed to the current edge technology machines during their programs for them to be able to develop emotional stability and self confidence

Facilities for the teaching of engineering education in Nigeria the dilapidation of laboratories and equipment in the Nigerian tertiary institutions has been a major concern to all stakeholders in engineering education. Most of the tertiary institutions laboratories and equipment were the old ones provided since the inception of the institutions for decades and hence they are completely obsolete for the current training of our graduates. The quantity of the facilities is grossly inadequate, and for those institutions that have laboratories are facing an acute shortage of supplies of consumables and equipment (owolabi & rafiu, 2010).

Since great importance is attached to the development of creativity of students by engineering education, then there is a great significance attached to practical education in which for this reason, conducting engineering education in conjunction with industries is also of great importance for the training of engineering students.

Universities in developing world play a very important role towards economy and the industry in a number of ways as assessed by the American national academy of engineering.

Collaboration between academia and industry is a vital instrument for development, which came through different ways such as faculties, hiring of students by the industries, graduates; exchange of researchers temporarily; consultancies;

Academic and industry, engineers and scientist joint research, grants and contracts offered by the industries to academia, conferences, seminars, publications etc.

In some cases, the stake holders of industries are made advisory board in a number of universities and is increasingly seeing as an effort in promoting science and technology, but such arrangements between universities and industries are completely absent in the nigerian education system (onwuka, 2009).

# WHAT IS THE SCORECARD?

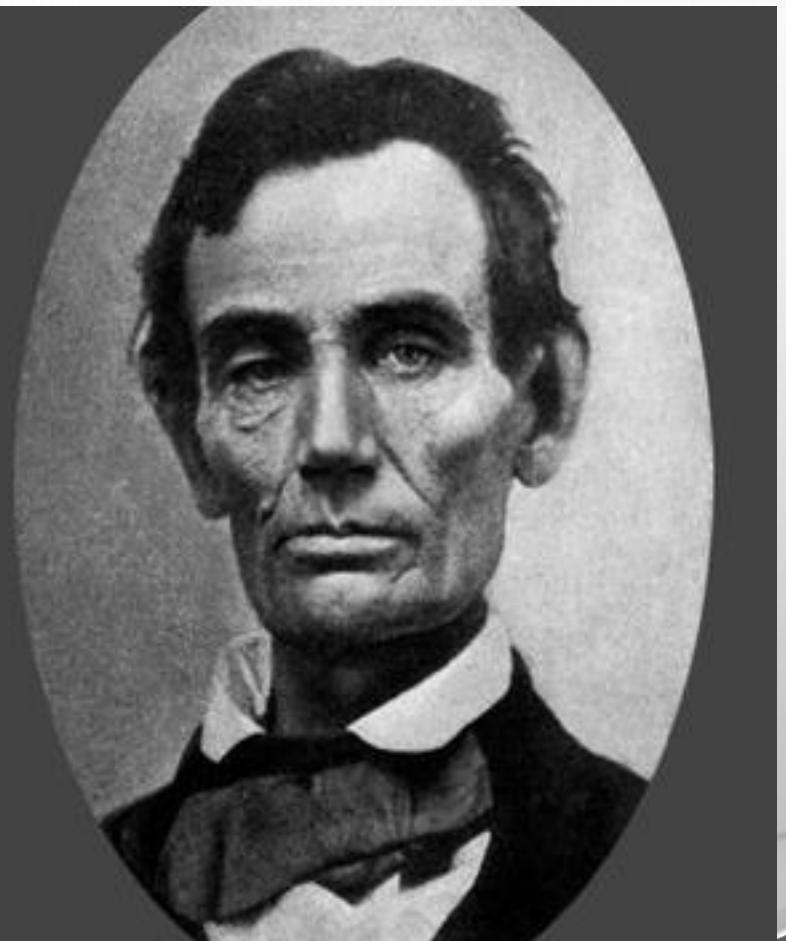
1. HIGHLY INTELLIGENT POPULATION
2. HARD WORKING AND VERY RESILIENT STUDENTS
3. POOR GOVERNANCE STRUCTURE
4. STAGNANT SYSTEM (DEGRADING INFRASTRUCTURE)
5. CHAOTIC SYSTEM
6. UNDER FUNDED SYSTEM
7. SOCIETAL INDISCIPLINE & POOR FAMILY STRUCTURE
8. LACK OF RESPONSIBILITY AND CONTROL
9. POLITICIZING EDUCATION
10. RESTIVE COMMUNITY – STRIKES AND STUDENTS PROTESTS

PROSPECTS

THE POWER OF PLANNING.....

If I had 8 hours to  
chop down a tree I  
would spend 6 hours  
sharpening my axe.

Abraham Lincoln



# POTENTIALS

## THE WAY FORWARD.....

1. EDUCATION ADVOCACY
2. INCREASED FUNDING
3. SYSTEMIC IMPROVEMENT
4. STRUCTURAL CHANGES – S.T.E.M. EDUCATION
5. OUTCOME BASED ENGINEERING EDUCATION

# **OUTCOME BASED ENGINEERING EDUCATION**

## **ENGINEERING EDUCATION MODEL**

GLOBAL ENGINEERING PHILOSOPHIES AND MODELS STUDIED, HAVE SHOWN THEIR DYNAMIC AND FARSIGHTED APPROACHES. HOWEVER, TOTAL ADOPTION MAY PROVE TO BE UNFAVORABLE FOR THE PROGRESS AND SUSTAINABILITY OF THE NATION.

IT HAS BEEN THE PERCEPTION OF MANY PRACTITIONERS THAT LOCALLY TRAINED ENGINEERING GRADUATES ARE STRONG TECHNICALLY BUT ARE LACKING IN NON-TECHNICAL OR TRANSFERABLE SKILLS, WHICH ARE NECESSARY FOR TOP MANAGEMENT OR LEADERSHIP POSITIONS. MOST ENGINEERING EDUCATION MODELS WORLDWIDE HAVE PLACED IMPORTANCE TO TRANSFERABLE SKILLS APART FROM A CONTINUED EMPHASIS ON TECHNICAL COMPETENCY. ENGINEERS ARE ALSO HAVING A MARGINAL ROLE IN THE COUNTRY'S

ECONOMIC DEVELOPMENT AND PROGRESS, WHICH IS SUBSTANTIATED BY THE UNIMPRESSIVE NUMBER OF ENGINEERS IN THE TOP INDUSTRIAL LEADERSHIP POSITIONS.

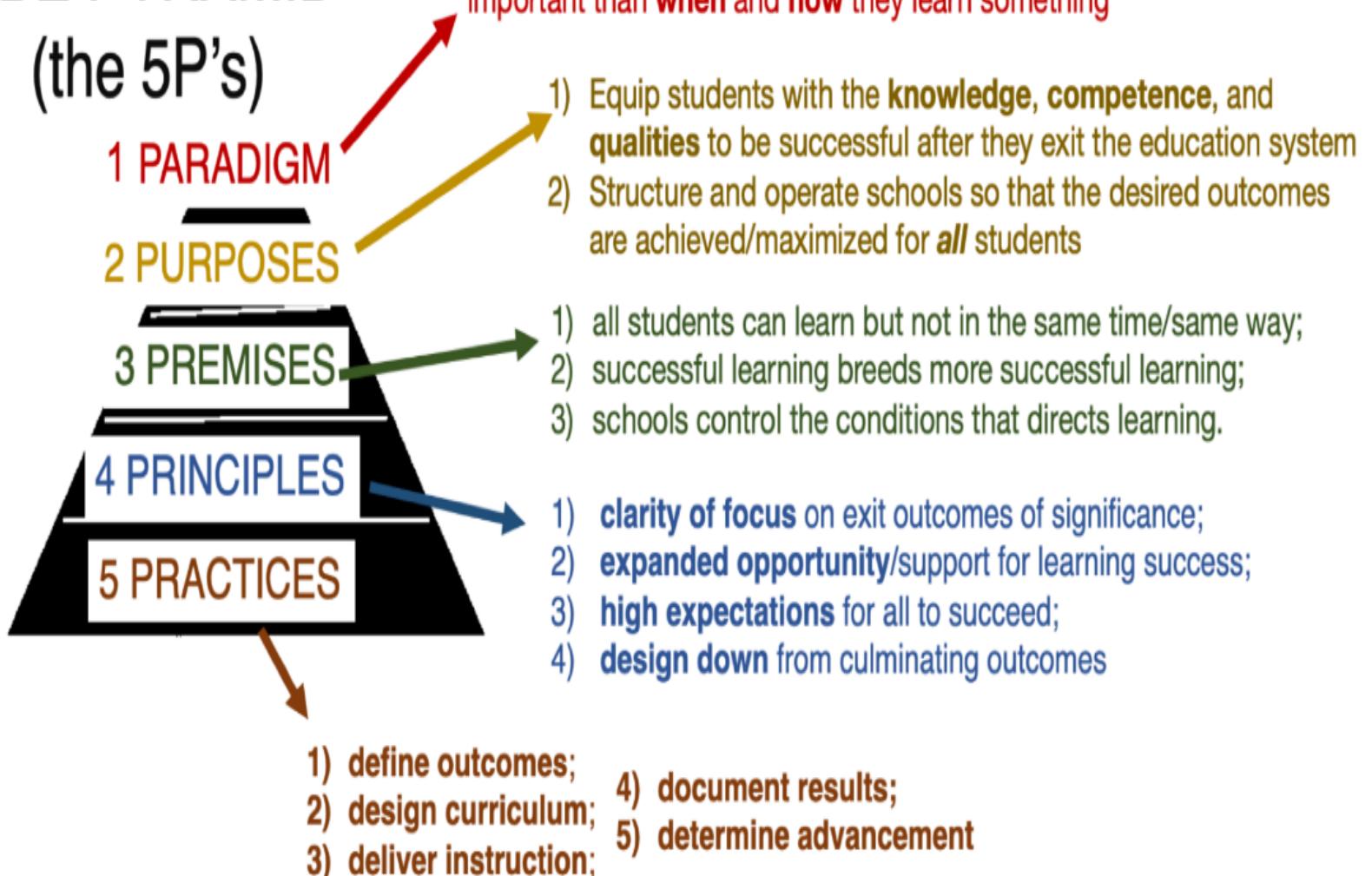
## WHAT IS OUTCOME-BASED EDUCATION?

OUTCOME-BASED EDUCATION (OBE) IS CONSIDERED THE BRAINCHILD OF THE SOCIOLOGIST WILLIAM SPADY.

IN THE OBE PARADIGM, THE INSTRUCTIONAL AND ASSESSMENT/EVALUATION PRACTICES ARE EXPLICITLY DESIGNED FOR ENSURING THE ATTAINMENT OF PREDEFINED LEARNING OUTCOMES THAT ARE ALIGNED TO BROADER, LONG-TERM EDUCATIONAL OBJECTIVES. OBE IS NOW THE UNDERLYING PARADIGM FOLLOWED BY GLOBAL ACCREDITATION EFFORTS SUCH AS THE WASHINGTON ACCORD (RATIFIED IN 1989), WHICH IS AN AGREEMENT TO ACCEPT UNDERGRADUATE ENGINEERING DEGREES THAT WERE OBTAINED USING OUTCOME-BASED EDUCATION (OBE) AND ACCREDITATION (OBA) METHODS.

THE SCALE OF THE SHIFT TO OBE CAN BE GAUGED FROM THE FACT THAT SOME EDUCATIONAL EXPERTS ARE NOW CALLING IT AS ONE OF THE TOP FIVE MAJOR CHANGES IN ENGINEERING EDUCATION IN THE LAST 100 YEARS.

# OBE PYRAMID (the 5P's)



## OBE Terminologies

Some common terminologies are used in relation with OBE (Table III).

The learning outcomes at the level of the course are typically called Course Learning Outcomes (CLOs) but at some places these are referred to as Intended Learning Outcomes (ILOs) [as per AHEP, UK] and Subject Learning Outcomes (SLOs) [e.g., at places in Malaysia and Hong Kong].

Table III: Important terms (and their synonyms) used in global OBE accreditation

Term	Also Called	Explanation
Course Learning Outcomes	ILO	<b>What students should be able to know, do, and value by the end of a course.</b>
Graduate Attributes	PLO, SLO, SO	<b>Statements that describe what students are expected to know and be able to do by the time of graduation</b>
Intended Learning Outcomes	CLO	<b>What students should be able to know, do, and value by the end of a course (Sometimes used to refer to desired outcomes at the end of course units).</b>
Program Educational Objectives		<b>Broad statements that describe what graduates are expected to attain within a few years of graduation.</b>
Program Learning Outcomes	SO/SLO	<b>Statements that describe what students are expected to know and be able to do by the time of graduation.</b>
Student Outcomes	SLO	<b>Statements that describe what students are expected to know and be able to do by the time of graduation.</b>
Student Learning Outcomes	SO	<b>Statements that describe what students are expected to know and be able to do by the time of graduation.</b>

**THANK YOU FOR YOUR ATTENTION**