

Engineering Education In The Philippines

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Abstract: Education is the process of acquiring the body of knowledge and skills that people are expected to have. A good education develops a critical thinking, encourages intellectual curiosity, which lead to lifelong learning. Quality education today is measured by effectiveness, efficiency, sustainability and relevance. Relevance in education means addressing the needs of the students and the society and preparing the graduates to be globally competitive. The main purpose of this paper is to present the current educational system in the Philippines particularly the engineering education. The Philippine educational system consists of K to12 program and tertiary level. The K to 12 Program covers Kindergarten and 12 years of basic education to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship. The last two years of this program is the senior high school where the students can choose from learning areas of core curriculum or specific tracks: Academic; Technical-Vocational-Livelihood; Sports and Arts; and Design. Academic tracks include Accountancy, Business and Management (ABM), Humanities and Social Sciences (HUMSS), Science, Technology, Engineering and Mathematics (STEM) and General Academic Strand (GAS). The students in STEM strand will continue pursuing their studies to engineering education in the tertiary level. The Commission on Higher Education (CHED) is the governing body of higher education institutions (HEIs) in the Philippines. CHED memorandum order (CMO) No. 37 Series of 2012, gives the policies, standards and guidelines in the establishment of an outcomes-based education (OBE) system in HEIs offering engineering programs. It aims to transform engineering education into an outcomes-based system to meet the equivalent global quality standards. OBE focuses on what is essential for all students to be able to do successfully at the end of their learning experiences. HEIs are now on the process of implementation of OBE. Information about OBE are disseminated to all stakeholders, curriculum and course specifications are revised, capacity building through seminars and trainings are conducted, improvement of facilities, assessment and evaluation, and continuous quality improvement are conducted for its implementation.

Keywords: continuous quality improvement, educational system, engineering education, K to 12, outcomes-based education.

1. Introduction

Education in its general sense is an act or experience that has a formative effect on the mind, character, or physical ability of an individual. In its technical sense, it is the process by which society deliberately transmits its accumulated knowledge, skills and values from one generation to another. In the Philippines, the education system aims to provide general education to individuals, help them participate in the basic functions of society, train the nation's manpower skills, develop the professionals, respond to the changing needs of the society. In the country, the governing bodies responsible for education and manpower skills development are the Department of Education (DepEd), Technical Education and Skill Development Authority (TESDA) and Commission of Higher Education (CHED). The enhanced basic education, the K to 12 is implemented by DepEd. The K to 12 Program covers Kindergarten and 12 years of basic education (six years of primary education, six years of secondary education (four years in Junior High School and two years in Senior High School). There are three specific tracks the students can choose from: Academic; Technical-Vocational-Livelihood; and Sports and Arts. The Academic track includes three strands: Business, Accountancy, Management (BAM); Humanities, Education, Social Sciences (HESS); and Science, Technology, Engineering, Mathematics (STEM). The students who will take the STEM strand will continue pursuing their studies to engineering education in the tertiary level. Engineering education is a foundation for the development of the society. There are challenges in engineering education: knowledge, innovation and collaborative knowledge construction. In Philippines, there are several engineering programs offered in different HEIs, both public and private. Engineering education follows OBE system and HEIs started to subject their programs to accreditation such as Philippine Technological Council - Accrediting and Certification Board for Engineering and

Technology-Engineering Accreditation Commission (PTC-ACBET-EAC), Accreditation Board for Engineering and Technology (ABET), Accrediting Agency of Chartered Colleges and Universities in the Philippines (AACUP) for public and the Philippine Association of Colleges and Universities Commission on Accreditation (PACUCOA) for private HEIs. The curriculum in all engineering programs are designed according to the CHED minimum requirements.

2. The Philippine Educational System

The education system in the Philippines is closely related to American system. It includes elementary or primary education, high school or secondary education and the college or tertiary education. Previously, basic education which consists of the primary and secondary level is only for ten years; six years in primary and four years in secondary. It was only in academic year 2016-2017 that K to 12 program was implemented. Two years was added to the secondary level: junior high school and senior high school. This section presents the laws about education, the different governing bodies and the K to 12 program.

Laws About Education

The 1987 Philippine Constitution states that "state shall protect and promote the right of all citizens to quality education at all levels and shall take appropriate steps to make such education accessible to all"[1]. The national government supports the public elementary and secondary education. Public elementary education is mandated by the 1987 Constitution. Republic Act 6655 known as the "Free Secondary Education Act" mandates the secondary education [2]. Republic Act No. 232 otherwise known as the "Education Act of 1982" is an act which calls for the establishment of national schools and the conversion from elementary to national secondary schools or from secondary to national secondary or tertiary schools. This act specifies

the objectives of formal and non-formal education in the country. Private education, on the other hand, is under Republic Act No. 6728. This act sets the minimum curricular requirements and common physical facilities for all private schools. The Department of Education through Republic Act 9155, otherwise known as the Governance of Basic Education Act of 2001 establishes the mandate of DepEd [3]. The Commission on Higher Education (CHED) which is responsible for the formulation and implementation of policies and programs for higher education was created under Republic Act No. 7722 [4]. Republic Act No. 7796 enacts the establishment of the Technical Education and Skills Development Authority (TESDA) [5].

Governing Bodies of Education

There are three governing bodies in the Philippine education system which are responsible for education and development of manpower. These are the Department of Education (DepEd) for basic education, Commission on Higher Education (CHED) for tertiary and graduate education, and Technical Education and Skills Development Authority (TESDA) for technical-vocational and middle-level education. DepEd formulates, implements, and coordinates policies, plans, programs and projects in the areas of formal and non-formal basic education. It supervises all elementary and secondary education institutions, including alternative learning systems, both public and private; and provides for the establishment and maintenance of a complete, adequate, and integrated system of basic education relevant to the goals of national development [3]. The Commission on Higher Education (CHED) is the key leader of the Philippine Higher Education System effectively working in partnership with other major higher education stakeholders in building the country's human capital and innovation capacity towards the development of a Filipino Nation as a responsible member of the international community. It was created on May 18, 1994 through the passage of Republic Act No. 7722, or the Higher Education Act of 1994. CHED, an attached agency to the Office of the President for administrative purposes, is headed by a chairman and four commissioners, each having a term of office of four years. The Commission En Banc acts as a collegial body in formulating plans, policies and strategies relating to higher education and the operation of CHED. Given the national government's commitment to transformational leadership that puts education as the central strategy for investing in the Filipino people, reducing poverty, and building national competitiveness and pursuant to Republic Act 7722, CHED shall promote relevant and quality higher education (i.e. higher education institutions and programs are at par with international standards and graduates and professionals are highly competent and recognized in the international arena); Ensure that quality higher education is accessible to all who seek it particularly those who may not be able to afford it; Guarantee and protect academic freedom for continuing intellectual growth, advancement of learning and research, development of responsible and effective leadership, education of high level professionals, and enrichment of historical and cultural heritages; and Commit to moral ascendancy that eradicates corrupt practices, institutionalizes transparency and accountability and encourages participatory governance in the Commission and the sub-sector [4]. The Technical Education and Skills Development Authority (TESDA) was established through the enactment of Republic Act No.

7796 otherwise known as the "Technical Education and Skills Development Act of 1994", which was signed into law by President Fidel V. Ramos on August 25, 1994. This Act aims to encourage the full participation of and mobilize the industry, labor, local government units and technical-vocational institutions in the skills development of the country's human resources. TESDA is mandated to Integrate, coordinate and monitor skills development programs; Restructure efforts to promote and develop middle-level manpower; Approve skills standards and tests; Develop an accreditation system for institutions involved in middle-level manpower development; Fund programs and projects for technical education and skills development; and Assist trainers training programs. The agency is expected to Devolve training functions to local governments; Reform the apprenticeship program; Involve industry/employers in skills training; Formulate a skills development plan; Develop and administer training incentives; Organize skills competitions; and Manage skills development funds. Overall, TESDA formulates manpower and skills plans, sets appropriate skills standards and tests, coordinates and monitors manpower policies and programs, and provides policy directions and guidelines for resource allocation for the TVET institutions in both the private and public sectors. Today, TESDA has evolved into an organization that is responsive, effective and efficient in delivering myriad services to its clients. To accomplish its multi-pronged mission, the TESDA Board has been formulating strategies and programs geared towards yielding the highest impact on manpower development in various areas, industry sectors and institutions [5].

K to12 Program

The current educational reform programs that are basic to achieve comparable quality with ASEAN countries and the rest of the world are the K to 12 program, establishment of the Philippine Qualifications Framework (PQF) and higher education reforms for quality and efficiency. The K to 12 Program is an education system under the Department of Education that aims to enhance learners' basic skills, produce more competent citizens, and prepare graduates for lifelong learning and employment. "K" stands for Kindergarten and "12" refers to the succeeding 12 years of basic education : six years of elementary education, four years of Junior High School, and two years of Senior High School (SHS). Specifically, it aims to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship. The program accelerates mutual recognition of Filipino graduates and professionals in other countries. The six key characteristics of the K to 12 program that will yield fine learners with 21st century skills are the following: 1) Strengthening Early Childhood Education (Universal Kindergarten); 2) Making the Curriculum Relevant to Learners (Contextualization and Enhancements); 3) Building Proficiency (Mother Tongue-Based Multilingual Education); 4) Ensuring Integrated and Seamless Learning (Spiral Progression); 5) Gearing Up for the Future; and 6) Nurturing the Holistically Developed Filipino (College and Livelihood Readiness, 21st Century Skills [3]. The Philippine Qualifications Framework (PQF) is a national policy that describes the levels of educational qualifications and sets the standards for qualification outcomes which is based on the ASEAN Qualifications Reference Framework (AQRf).

Higher education reforms for quality and efficiency includes HE curriculum alignment with K to 12, OBE, amalgamation, typology based quality assurance, regular quality assurance and incentives, rationalized resource allocation for state HEIs, SUC road map, and management capacity buildings for SUCs [6]. Research shows completion rates of children who go through standards-based kindergarten programs are higher than those who do not. Early childhood learning can now be accessed by children of age 5 through the required pre-school program where they can learn letters, numbers, shapes and colors through the use of their mother tongue in forms of dances, songs, and games. Studies show if the students can relate to their lessons they can grasp them well. Thus, different activities, examples, songs, stories, poems and pictures are included in the new program. Issues such as climate change, disaster prevention and information and communication technology (ICT) are also added. With these, the students are expected to gain in-depth knowledge, skills, values and attitudes through relevancy, consistency and continuity across every subject and every grade level. According to the experts, the children learn lessons better and become more active in class if they are taught in their mother tongue and in building learners' skills, ethnic uniqueness, culture and values must be kept. Thus, learning tools and studying from kindergarten to grade 3 utilizes child's main language. Basic concepts are first learned by the students followed by the complex ones in the succeeding grades. This progression allows them to learn and match their cognitive skills. They strengthen retention and improve mastery as they revisit and share the topics, lessons and skills learned. The K to 12 program aims to guarantee preparedness of the students to college and brace technical vocation education and training. This helps the students in choosing the career path based on their own interests, talent and capacity. The chosen track will define the subjects to take in the senior high school. Beyond all these grade levels, each graduate of the K to 12 program will be ready to move to different paths: education, employment or entrepreneurship [3]. Republic Act 10157, or "The Kindergarten Education Law" made Kindergarten the compulsory and mandatory entry stage to basic education. Section 2 of this Act provides that all five (5)-year old children shall be given equal opportunities for Kindergarten Education to effectively promote their physical, social, emotional and intellectual development, including values formation so they will be ready for school [1]. This was so since the Department of Education (DepEd) believes that Kindergarten is the transition period from informal to formal literacy (Grades 1-12) considering that age five (5) is within the critical years where positive experiences must be nurtured to ascertain school readiness. Various researches support that this is the period of greatest growth and development, when the brain develops most rapidly and almost at its fullest. It is also the stage when self-esteem, vision of the world and moral foundations are established. Teachers/parents/caregivers/adults should therefore be guided to facilitate explorations of our young learners in an engaging and creative curriculum that is developmentally appropriate which immerse them in meaningful experiences. Provision of varied play-based activities leads them to becoming emergent literates and, helps them to naturally acquire the competencies to develop holistically. They are able to understand the world by exploring their environment as they are encouraged to create and discover, that eventually

leads them to becoming willing risk takers and ready to tackle formal school works. Grades 1 to 10 students will experience an enhanced, context-based, and spiral progression learning curriculum which includes the following subjects: Mother Tongue, Filipino, English, Mathematics, Science, Araling Panlipunan, Edukasyon sa Pagpapakatao, Music, Arts, Physical Education, Health, Edukasyong Pantahanan at Pangkabuhayan, and Technology and Livelihood Education. Grades 11 and 12 are referred to as senior high school (SHS) level. There are core curriculum and specific tracks in SHS. The core curriculum includes seven learning areas. These are Languages, Communication, Literature, Math, Natural Science, Philosophy and Social. The specific tracks are academic, technical-vocational livelihood, sports and arts and design. Academic tracks include different strands: Accountancy, Business and Management (ABM), Humanities and Social Sciences (HUMSS), Science, Technology, Engineering and Mathematics (STEM) and General Academic Strand (GAS) [7]. Students who will take STEM strand may continue to pursue engineering program in their tertiary level.

3. Engineering Education in the Philippines

Engineering education is a foundation for the development of the society. Technological innovations come with production of new goods, economic growth and human development. Innovations are part of mechanisms to establish new markets which calls for scientific and technological knowledge, innovations and rapid development [8]. This results to several challenges for engineering education such as: 1) knowledge, might be outdated within a few years, which create challenges for engineering education all over the world. Knowledge about yesterday's technology may be outdated by tomorrow's technology. This requires more to teach both educators and the students; 2) innovation is no longer based on individual knowledge but on collaborative knowledge [9]; 3) collaborative knowledge construction is getting more and more complex. Partly because globalization calls for new ways of sharing the work between north and south and between east and west and thus intercultural understanding of international collaboration is involved [10]. It is partly because complexity involves interdisciplinary knowledge constructions; and there is a huge challenge in maintaining sustainability of the fast technological development considering issues on environment and social responsibility. In accordance with the pertinent provisions of RA 7722, otherwise known as the "Higher Education Act of 1994," CHED Memorandum Order (CMO) No. 25 Series of 2005 (May 9, 2005) also known as the "Revised Policies, Standards and Guidelines (PSG) for Engineering Education" CHED Memorandum Order (CMO) No. 27 dated July 25, 2012, subject of which is the policies, standards and guidelines in the establishment of an outcomes-based education (OBE) system in higher engineering institutions offering engineering programs, was issued. This CMO aims to provide the policies, standards and guidelines for all HEIs offering engineering programs to work towards establishing an OBE system. Its purpose is to promote the capacity building of concerned HEIs to plan for the needed infrastructure and continuing quality improvement program in support of the OBE system [4].

3.1 Outcomes-Based Education

Quality education today is not only measured by efficiency, effectiveness and sustainability, but also by relevance. Relevance in the field of education means addressing the needs of the students, the industries and providing a globally comparable curriculum to the future graduates. In Engineering education, Washington Accord (WA) full member signatories agree that graduates from their accredited engineering programs shall be mutually recognized across their countries as having met the academic requirements for entry to the practice of engineering, thus promoting mobility of professional engineers practicing across their borders. Since year 2000, the accreditation standards of WA shifted from input-based to an outcomes-based education system. The focus is for the institutions with accredited programs to demonstrate that their engineering graduates have met an acceptable knowledge, skills and attitude necessary for practice of engineering. Also, accreditation requires that the program outcomes must be aligned with the mission and educational objectives and continuous quality improvement should support the OBE system. The Philippine Technological Council (PTC) is the only umbrella organization of all professional engineering organizations in the country. In 2009, it led the application for the Philippine to be a provisional member of the Washington Accord. PTC created the Accrediting and Certification Board for Engineering and Technology (ACBET), the Engineering Accreditation Commission (EAC), and has completed the Certification and Accreditation System for Engineering Education (CASEE) [11]. In 2007 and 2008, CHED through the recommendation of the Technical Panel for Engineering and Technology (TPET), has released several memoranda for compliance of all HEIs offering engineering programs. An institutional framework was in place for each engineering program to ensure sustainability in OBE system delivery. It consists of : 1) Mission and Vision; 2) Program Educational Objectives; 3) Program Outcomes; 4) Matrix of Courses with program Outcomes (Curriculum Map); 5) Outcomes-Based Teaching and Learning Delivery Process; 6) Program Assessment and Evaluation Process; and 7) Continuing Quality Improvement Program.

3.2 Engineering Programs

According to CHED, as of April 2017, Engineering is ranked second, next to Technology, in terms of the number of enrollees in AY 2016-2017. There are 334,299 students taking engineering programs. There are fifteen (15) engineering programs offered in different HEIs in the country with established policies, standards and guidelines by CHED. These are Aeronautical, Agricultural and Biosystems, Ceramic, Chemical, Civil, Computer, Electrical, Electronics, Geodetic, Industrial, Materials, Mechanical, Metallurgical, Mining, and Sanitary Engineering. However, there are other engineering programs offered in the country such as , Instrumentation, Mechatronics, Petroleum engineering. The establishment of the programs were benchmarked from different educational institutions offering those programs. In November 2016, CHED through TPET, drafted the revised PSG for the fifteen engineering programs. This will take effect in the next academic year 2018-2019. The main purpose of the revision is to integrate the principles of OBE system, the K to12 educational program and the new general education curriculum.

3.3 Engineering Curriculum

The HEIs are allowed to design curricula suited to their own contexts and missions provided that they can demonstrate that the same leads to the attainment of the required minimum set of outcomes. They can have their own curriculum delivery, deployment of human and physical resources as long as there is an assurance of the attainment of the program outcomes and 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 within 3-5 years of graduation. Program or students outcomes specify what the students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that the students acquire as they go through the program. During this academic year 2017-2018, HEIs offering engineering courses have their curriculum to be completed by the students in five years. However, in the next academic year, a new engineering curriculum will be implemented. The program will only be for four years. The number of years will be less because of the implementation of the K to 12 programs. Some general education courses are already included in the last two years of the program, the Senior High School. The curriculum includes technical and non-technical courses. Technical courses are Mathematics, Natural/Physical Sciences, Basic Engineering Sciences, Allied Courses, Fundamental Courses, Professional Courses, Technical Electives and On-the Job-Training. Non-technical courses, on the other hand, includes the General Education courses, Mandated Courses, Physical Education and the National Service Training Program (NSTP).

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