Tuning Africa

Design and Implementation of Degree Programmes in Civil Engineering

Stanley Muse Shitote (ed.)

Phase II

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Tuning Africa Project Phase II

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Content

Preface

The harmonisation of higher education in Africa is a multidimensional process that promotes the development of an integrated higher education space on the continent of Africa. The objective is to achieve collaboration across borders, sub-regionally and regionally, in curriculum development, educational standards and quality assurance, joint structural convergence, consistency of systems as well as compatibility, recognition and transferability of degrees to facilitate mobility. Harmonisation is necessary for achievement of the African Union vision of integration, peace and prosperity.

Tuning Africa was adopted as a possible instrument to advance the African Union's harmonisation agenda, in collaboration with the EU through the Joint Africa-EU Strategy. Implementing a second phase of Tuning was one of the commitments taken at the 2014 Africa-EU Summit in 2014 in Brussels, as a follow-up to the very successful pilot phase which took place between 2011 and 2013.

At the November 2017 Africa-EU Summit in Abidjan, Heads of State committed to deepening their collaboration and exchange in education, aiming at increasing the employability of young people bearing in mind that investing in youth and future generations in Africa is a prerequisite for building a sustainable future. In this context, further concrete initiatives in the field of higher education which aim to enhance relevance and the quality of education and training will be encouraged.

By contributing to the harmonisation of higher education in Africa, Tuning Africa is complementing Erasmus+, the Intra-Africa academic mobility programme and the Nyerere scheme; thereby enhancing the mutual recognition of academic qualifications and facilitating exchanges and mobility of students and staff across the continent and with Europe. This is instrumental for acquiring key skills and competences that are important for employability, facilitating collaborative research addressing common challenges, and for ensuring relevant and quality education.. The dialogue on credits and a common credit system for Africa is another major deliverable for Africa. All these initiatives are in line with the Continental Education Strategy for Africa as well as Africa's Agenda 2063 which calls for an education and skills revolution.

Tuning Africa has provided a platform for dialogue on quality assurance and the improvement of teaching, learning and assessment in higher education. Bringing together academia and employers, and importantly in this second phase, the active involvement of students, has been crucial. The success of Tuning Africa has been the involvement of a critical mass of universities and stakeholders, the ownership and commitment of all involved, as well as a transparent and credible leadership.

The AUC and EC are grateful to all the African and European experts involved in the production of this book, which is an outcome of the Joint Africa-EU Partnership Harmonisation and Tuning Africa 2 initiative.

African Union Commission and European Commission

Chapter 1

Introduction

Kabir Bala

Civil Engineering is the field, discipline, or profession that relates to the development, acquisition and application of technical, scientific and mathematical knowledge of the design and construction of public works, such as dams, bridges and other large infrastructure projects (UNESCO, 2010; Lucas, 2014). It is one of the oldest branches of engineering, dating back to when people first began to live in permanent settlements and started shaping their environments to suit their needs Lucas (2014).

Considering its strategic importance in the provision of infrastructure, the Civil Engineering profession has been linked directly with development of any nation (Downey and Lucena 2004, 2005). This is because, civil engineers are responsible for the planning, design, construction and maintenance of infrastructure, buildings and facilities, as well as for improving and maintaining them. They play a significant role in the provision of energy and clean water, including the networks of pipes to handle municipal water supplies, sanitation services, sewage and desalination plants and industrial waste treatment systems. These professionals are also responsible for creating, maintaining and upgrading transportation and traffic systems like highways, bridges, tunnels, underground systems, airports, railway lines and seaports. In fact, history has documented how civil engineers have significantly transformed the development of societies. According to Bilec *et al.* (2007), the contribution of civil engineers is obvious in the exponential improvements in the standard of human life over time—from the Roman viaducts, to the tallest buildings, to the Hoover Dam; civil engineers have undeniably made an impact on society and the Earth in general.

A civil engineer is concerned with planning, determining the right design for structures and managing the construction process to ensure the durability and sustainability of the structures after completion. These structures are meant to satisfy the public's expanding need for comfortable services and operations. According to the University of Southern California School of Engineering, civil engineering is currently one of the most important parts of the engineering fields. The services of a Civil engineer are therefore required at every level of the public sector from municipal to the federal levels, and in the private sector from individual homeowners to international construction giants.

The Civil Engineering profession is conventionally broken down into sub-disciplines which include, among others, environmental engineering, geotechnical engineering, structural engineering, highway and transportation engineering, municipal or urban engineering, water resources engineering, materials engineering, coastal engineering, surveying, and construction engineering (The Nigerian Society of Engineers, NSE 2017). These programmes are therefore designed to produce engineers that can meet the challenges in the afore-mentioned areas through service in governmental agencies and establishments, the construction industry, transportation industry, consulting firms, teaching and research organisations.

In terms of knowledge, civil engineers need an in-depth understanding of physics, mathematics, geology and hydrology. They must also know the properties of a wide range of construction materials, such as concrete and structural steel, and the types and capabilities of construction machinery. With this knowledge, engineers can design structures that meet requirements for cost, safety, reliability, durability and energy efficiency. Civil engineers also need a working knowledge of structural and mechanical engineering. These engineers can be involved in nearly every stage of a major construction project. That can include site selection, writing specifications for processes and materials, reviewing bids from subcontractors, ensuring compliance with building codes, and supervising all phases of construction from grading and earth moving to painting and finishing.

Civil engineers make use of Computer-Aided Design (CAD) systems and Building Information Modelling (BIM) platforms for design and documentation; therefore, computing proficiency is essential. In addition to speeding up the drafting process for civil engineering projects, CAD and BIM platforms make it easy to modify designs and generate working documents for construction crews and related stakeholders.

According to the American Bureau of Labour Statistics (BLS), some civil engineers work indoors in offices, while many others spend time outdoors at construction sites, monitoring operations or solving problems onsite. Most civil engineers get employed in the private sector, where they work for construction contractors or as consultants. Government institutions that employ civil engineers include state works and transportation departments and the military. There are others who work in the educational institutions with the objective of

- Disseminating technological knowledge.
- Providing the society with qualified candidates for the engineering profession to face the engineering and technological challenges of the society.
- Raise adequate awareness about the profession.

Besides, civil engineers can work in the aerospace industry, designing jetliners and space stations; in the automotive industry, perfecting the load-carrying capacity of a chassis and improving the crashworthiness of bumpers and doors; and they can be found in the ship building industry, the power industry, and many other industries wherever constructed facilities are involved. And in some cases, they plan and oversee the construction of these facilities.

To work as a civil engineer, a person requires at least a bachelor's degree in engineering. Many employers, particularly those that offer engineering consulting services, also require professional and regulatory certification as a professional engineer. A master's degree is often required for promotion to management and continuing professional development programmes and trainings are needed to keep up with advances in technology, equipment, computer hardware and software, building codes, and other government regulations.

In Africa, a plethora of developmental challenges underscore the need for significant improvement in Civil Engineering education and practice. This is in order to produce the required manpower that will devote their expertise towards achieving sustainable infrastructure for the development of the continent. These needs are obvious considering the rapid urbanisation, current and projected economic growth, a rising middle class population (African Development Bank Group, 2012), regional integration and strengthened democracy, transparency, accountability and governance in many of Africa's 54 nations. Each of these factors is driving opportunities for civil engineers who will partake in addressing the huge physical infrastructure deficit in most of the countries (Deloitte, 2012).

Africa has been characterised with rapid urbanisation (Satterthwaite, 2015), in such a way that the total number of individuals living in Africa's urban areas is expected to rise from 400 million in 2010 to 1.26 billion in 2050. According to Chenal (2016), Africa's urbanisation rate is expected to reach 50 percent by the year 2035 and will continue growing. These realities pose serious constraints and threats to service delivery in the urban areas Chirisa (2008). The population sizes continue to grow in relation to the demand for the services such as hospitals, schools, industrial and commercial zones, security, transportation, education, leisure and many others.

Moreover, Africa has been reported to have 51 cities with more than a million inhabitants, and only one city —Cairo— with more than 10 million in the year 2010. By the year 2040, it is expected to have more than 100 cities of more than one million inhabitants and seven cities of more than 10 million inhabitants (Chirisa, 2008).

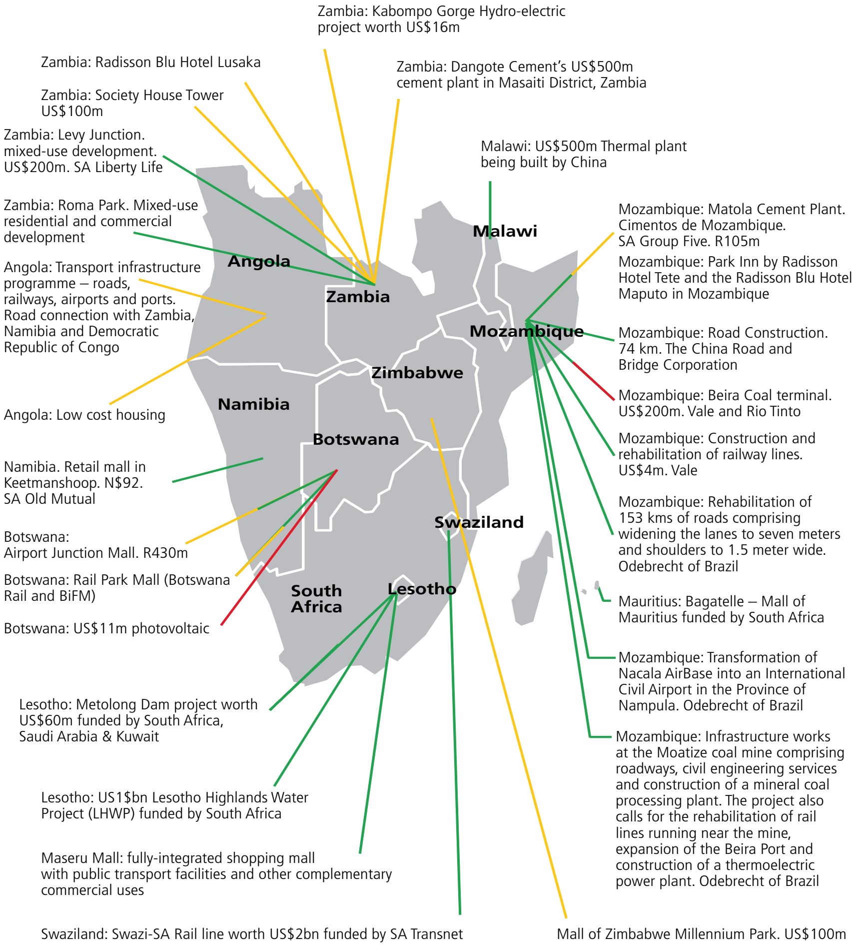
According to Sattertwaite, (2015) in 2015, sub-Saharan Africa's urban population reached 396 million. This was distributed among thousands of urban centres that included two mega-cities (with more than 10 million inhabitants), as well as three cities with populations of 5-10 million and another 41 with populations of 1-5 million. But it is worth noting that there is also a very large number of urban centres with less than 20,000 inhabitants and more than 1,000 urban centres with populations of 20,000-50,000, and these smaller urban centres include a significant share of the urban population in most nations in the region.

The urban population in this region doubled between 2000 and 2015. Greater percentage of these people live in poor quality and overcrowded housing that lack access to the infrastructure and services needed by urban centres, including safe, regular water supplies and good provision for sanitation, drainage, roads, traffic management and health care facilities. These also have relevance for disaster risk and, increasingly, for the threats that arise from or are exacerbated by the direct and indirect impacts of climate change.

By implication, investments in African cities' infrastructure, industrial, and commercial structures have not kept pace with concentration of people, nor have investments in affordable formal housing. The potential for coordinated investments in infrastructure, residential, and commercial structures is great (World Bank Report, 2017), hence a great opportunity for civil engineering graduates in the region.

In terms of regional integration and cross-border infrastructure projects, many of Africa's 54 countries are relatively small, with populations of fewer than 20 million and economies of less than US$10 billion. Their infrastructure systems, like their borders, are reflections of the continent's colonial past, with roads, ports, and railroads built for resource extraction and political control, rather than to bind territories together economically or socially (Deloitte, 2012).

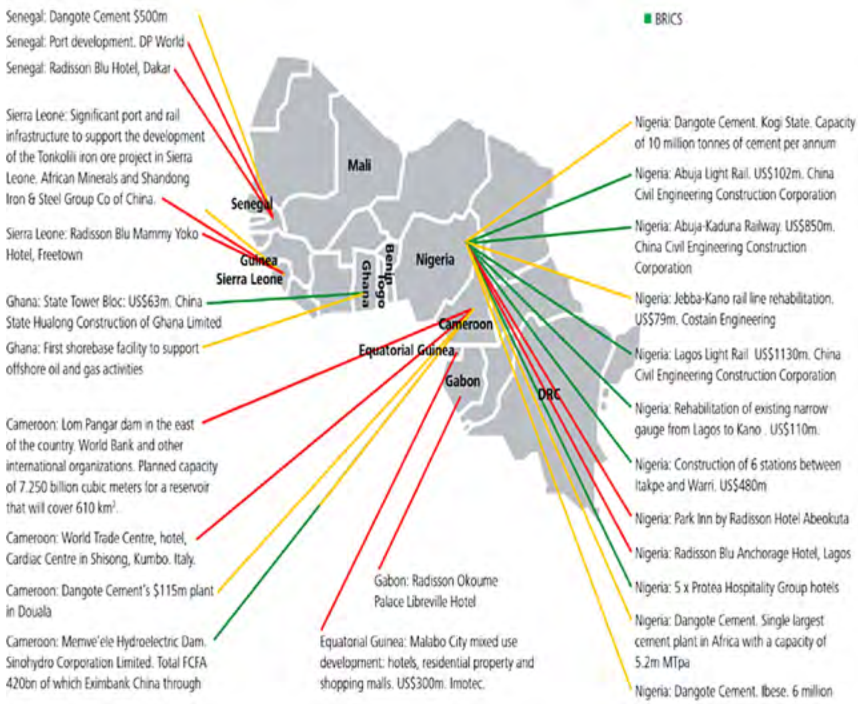
As regional bodies and the African Union continue to drive the integration imperative, this is creating opportunities for an array of large infrastructure projects that span borders. Initiatives such as the North-South Corridor and the Southern Africa Development Community (SADC) Infrastructure Master Plan present massive opportunities for public private partnership (PPP) projects. There is recognition that such PPP arrangements could assist governments close material, financial, managerial and technical gaps, while supporting further regional integration. For example, there is a US$100 billion funding gap for the SADC Infrastructure Plan. The North-South Corridor project is equally ambitious and costly. It comprises 157 projects in the North-South Corridor, conceived as the area between Durban and Dar es Salaam, and includes 59 road projects; 38 rail projects and six bridge projects. These projects will require much more civil engineers than are currently available in the entire continent. Unfortunately, the African continent has been identified to have insufficient number of engineers with the required mix of knowledge, skills and competences to address these important needs. There is therefore a need for concerted effort towards improving the numbers and quality of civil engineering graduates across the entire African continent, considering the volume of construction projects present and in anticipation. These can be seen in the heatmaps (fig. 1.1-1.2) showing the concentration of construction activities in some sub-regions of the continent.



Source: Deloitte, 2012.

Figure 1.1
Southern Africa Construction Activity Heatmap

Civil Engineering education in the different African countries is studied in such a diverse manner with little similarities in the curricula of the African Universities and different methods of instruction and regulation. However, all the programmes are designed and delivered to produce graduates that will address the demands of the construction labour market and provide workable solutions to the relevant societal challenges.



Source: Deloitte, 2012.

Figure 1.2
Central and West Africa Construction Activity Heatmap

The Universities in most African countries are faced with shortage of modern teaching and research facilities such as laboratories, well-equipped workshops, and studios for practical works, seminar rooms and lecture rooms, staff offices, recreation facilities, and fully functional libraries to support teaching, learning and research. Moreover, relevant computer software and hardware are also lacking, internet access is also a problem to most of these institutions. This has a significant negative impact on the quality of graduates.

The curricula of African universities civil engineering programmes are also different in most cases. The diversity in scope and content of the programmes is also manifest in the duration of completing the programmes. While some universities have four-year programmes, others have five years. These differences in degree profiles, duration and structure yield serious difficulty in students exchange and credit transfer among the African universities. Employability of the graduates is also negatively impacted. This situation underpins the Tuning Africa project, which was conceived to provide an avenue for the harmonisation, restructuring and improving of the disparate higher education curricula in African countries. This is to ensure the achievement of improved quality and mutual recognition of university qualifications, increased students' mobility and employability of graduates for a more robust regional integration and sustainable development.

Chapter 2

Context for Curriculum Reform and Modernisation in Civil Engineering

Adapted from Teklemariam et al., *Tuning and Harmonisation of Higher Education: The African Experience, 2014*

2.1. The Importance and Applications of Civil Engineering

Baker Baynes Ldt. (2017) succinctly captures the definition of civil engineering as "the planning, design and construction of the physical world" and thereby illustrate its importance. The growing importance of the Civil Engineering profession in Africa, mainly influenced by rapid urbanisation, demographic growth and regional integration has been explained in Chapter 1 above. Available data shows that construction sector is one of the fastest growing economic sectors in Africa with the industry set to expand through 2020 and beyond. Construction Review Online (2017), reports that in 2014, the Africa construction sector attained a growth of 46.2%, growing from US$ 222,767 million in 2013 to US$ 325,828 million in 2014 (Africa, the Promised Land of Construction Industry, 2017). The *African Statistical Yearbook* (2009) highlights twenty-two African countries with an annual growth rate of above 10 per cent in the construction sector and indicates that in some countries, the growth rate is substantially higher.

Civil engineers are responsible for developing, designing and building good-quality infrastructures, buildings and facilities and improving and maintaining them. Civil engineers supply energy and clean water, including the networks of pipes to handle municipal water supplies, sanitation services, wells, sewage and desalination plants and industrial waste treatment systems. They are also responsible for creating, maintaining and upgrading transportation and traffic systems like highways, bridges, tunnels, underground systems, airports, railway lines and seaports. A civil engineer is concerned with planning, determining the right design for these structures and managing the construction process to assure the longevity and sustainability of these structures after completion. These structures should satisfy the public's expanding need for comfortable services and operations. In general, the work of the civil engineer focuses on the improvement of the quality of life.

One recent and increasingly important facet of Civil Engineering is Environmental Engineering. In this sub-speciality, civil engineers are concerned with applications of various methods of environmental protection, such as the purification of contaminated air, water and soil. The objective is to remediate polluted systems and sites and to prevent new pollution as well as re-pollution.

2.2. The Scope of Civil Engineering

Civil Engineering is the second oldest engineering science after military engineering (http://whatiscivilengineering.csce.ca/civil1.htm). It has substantially developed and broadened its scope over time. Today, Civil Engineering has diversified into many branches of study. Its major branches include: (1) structural engineering, (2) construction engineering, (3) geotechnical engineering, (4) transportation engineering, (5) hydraulic engineering, (6) water resources engineering, (7) materials engineering, (8) quantity surveying, (9) offshore engineering, (10) coastal engineering, (11) environmental engineering, (12) urban engineering, (13) control engineering and (14) earthquake engineering, to mention only the most prominent specialisations (www.thecivilengg.com/Branches.php).

Civil engineers are employed by a wide range of companies, from small start-up enterprises focused on innovation to large-scale companies that work on major contracts. Because many civil engineering projects involve the creation and maintenance of national (and increasingly regional) infrastructure, a major employer in many African countries is the public sector.

2.3. Trends in Civil Engineering

Industry sources list five major trends in Civil Engineering in the year 2017 (Baker Baynes Ldt., 2017) as:

1. Building Information Modelling (BIM).
2. Revolutions in data capturing techniques, including integrated data gathering (such as drones and thermal imaging).
3. Sustainable design.
4. Water engineering.
5. New materials.

Application of new materials, composite materials and, in particular, local materials is relevant in addressing the rapid urbanisation throughout the continent, highlighted by the importance of low-cost building (Bredenoord, 2016). Another contemporary focus is improving the capabilities of standard materials. Increased attention is given to controlling the effects of natural disasters such as floods and earthquakes and to conducting environmental impact studies of new constructions. A major objective is to prevent cycles of disasters and to control the impacts of climate change in Africa (De Ville de Goyet *et al.,* 2006; EUMETSAT, 2012).

A relatively recent specialisation of Civil Engineering in Africa is Environmental Engineering. This specialisation covers solid waste management, environmental impact assessment and mitigation, water supply and treatment, waste-water treatment and air pollution management amongst other specialisations.

Another recent emphasis is the application of specialised software programmes in the civil engineering industry as part of preparing civil engineers for the tasks emerging in the twenty-first century.

2.4. Career Pathways in Civil Engineering

Most young graduates with Civil Engineering degrees find entry-level positions in the public sector that initially require limited responsibility.

As the young engineers prove their competence, they are entrusted with higher levels of responsibility. An elaboration of the career paths in civil engineering can be found in Raouna (2017) and ASCE.

Within every branch of Civil Engineering, career path options vary. In some fields and enterprises, a primary task of entry-level engineers is monitoring construction on-site, serving as the "eyes and ears" of senior design engineers. In other areas, entry-level engineers perform the more routine aspects of analysis, design and implementation. Experienced engineers perform increasingly complex analyses, do more challenging planning and design work, manage complex design projects, lead engineering teams or engage in specialised consulting.

The Civil Engineering sector is mainly divided into (1) consultants, (2) contractors and (3) project managers. Typically, the options for a new Civil Engineering graduate are consulting or contracting. Usually a high level of professional experience is required to become a project manager.

2.5. The Need for Civil Engineering Graduates in Africa

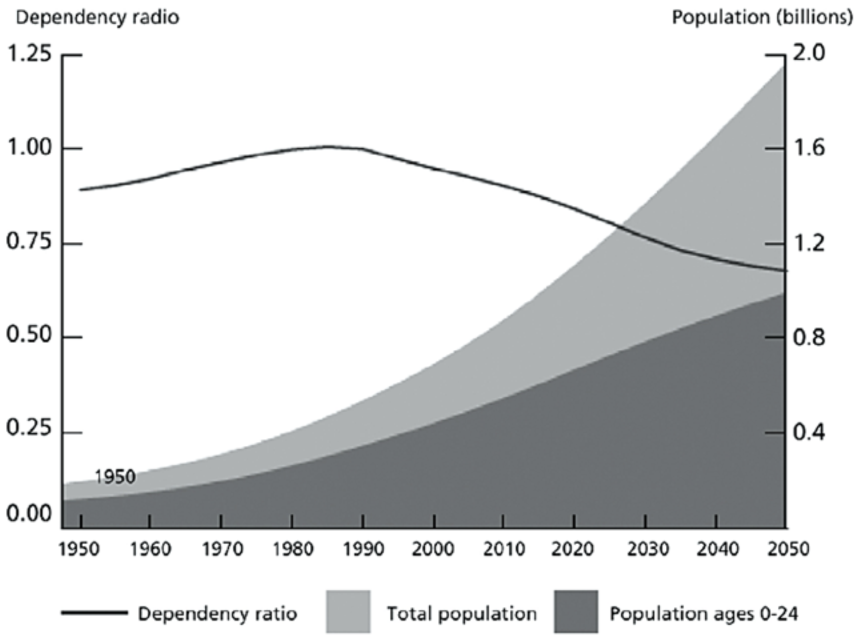
The need for Civil Engineering graduates in Africa is strongly linked to continent-wide demographic developments, the rapid urbanisation, and the regional integration resulting in ever-growing construction demands. Thus, Civil Engineering will continue to be one of the crucial subject areas in African higher education due to the constantly rising demand for Civil Engineering graduates for construction projects in both the public and the private sectors (Construction Review Online, 2017).

The demand has two dimensions: (1) quantitative: demographic developments, urbanisation and regional infrastructures; and (2) qualitative: the need for sustainable construction, preferably with local building materials, reduced dependency on cement and steel imports and the need to develop energy-efficient construction technologies.

The population of Africa has grown exponentially over the past century, and according to the United Nations Development Programme (UNDP), is expected to continue to grow rapidly. The Population

Division of the United Nations Department of Economic and Social Affairs (UNDESA), projects nearly 2 billion inhabitants in Sub-Saharan Africa by 2050 (UNDESA, 2013, pp. xvi ff). "In Africa, the population is expected to grow by 1.8 billion during the second half of the century, substantially more than during the earlier period of 2013-2050, that is by 1.3 billion. During 2050-2100, Africa's population increase will surpass that of the world" (UNDESA, 2013, p. 1).

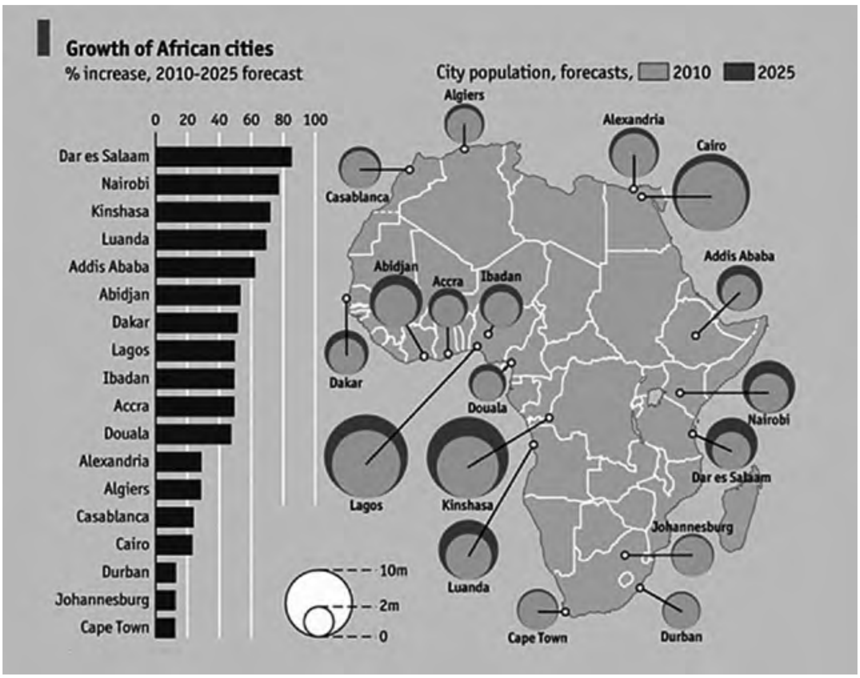
Population growth moves hand in hand with the rapid urbanisation, and Africa's cities are set to swell in size. In 2030, half of the African population will live in urban centres.



Source: UNDESA (2013).

Figure 2.1
Population growth rate in Sub-Saharan countries

According to a recent report from the United Nations Agency for Human Settlements (UN-HABITAT, 2010), the population of some cities will grow by a projected 85 per cent in the next fifteen years. The most populous city in 2010, Cairo, will grow by 23 per cent to 13.5 million people. By 2025, however, it will have been overtaken by both Lagos (15.8 million) and Kinshasa (15 million). Food and water shortages, poor infrastructure and a lack of housing are amongst the problems faced by governments during such rapid urbanisation. Progress in meeting these challenges would be shown by a fall in the proportion of slum-dwellers, who currently account for 70 per cent of urban inhabitants.



Source: UN-HABITAT Report (2010).

Figure 2.2
Projected growth of African cities by 2050

This demographic development has a deep and intensifying impact on energy, water and climate. The built environment will need to grow exponentially in quantity but also in quality in both the public and private sectors. Services must be provided to meet the needs of new millions of inhabitants, including housing, the upgrading of informal settlements, schools, hospitals, kindergartens, sanitation facilities, recreation centres, sports facilities, etc. New waste and water management systems, water and energy supply systems, wells, dams and desalination plants, etc. will be needed. Construction will also increase to accommodate a greater volume of traffic and transport (roads, bridges, railways and airports) and to meet the need for more industrial and office buildings, plants and production, processing and storage facilities.

The African Union recognises that infrastructure plays a key role in economic growth and poverty reduction. Accordingly, initiatives such as PIDA (https://au.int/en/ie/pida) form part of the new strategic endeavours of the African Union for improvement of infrastructure on a regional level with the corresponding adoption of specific infrastructure plans by some African countries. For example, even highly developed countries like South Africa have areas that are under-served in infrastructure. The South African government therefore adopted a National Infrastructure Plan in 2012 with the goal of transforming the economic landscape while simultaneously creating significant numbers of new jobs and strengthening the delivery of basic services. The plan also supports the integration of African economies. Ethiopia has adopted a National Growth and Transformation Plan, in which the improvement of infrastructure in all regions of the country plays a central role. As a consequence, the sector-crossing Engineering Capacity-Building Programme and its successor, the Labour-Market-Oriented Education Programme, have become core reform programmes to educate the needed engineers and technicians in this field.

African civil engineers are trained in Africa or abroad in many different higher education systems. Some graduate from four-year programmes in some countries and from five-year programmes in others. Practically all the countries have regulating bodies for the accreditation of the training programmes and registration of the engineers for purposes of practice. Through the regulating bodies and professional associations, the engineers lobby for their interests and engage in major construction projects.

It is now vital for Africa to train qualified engineers with management and entrepreneurial skills, state-of-the-art IT, practical skills and other generic competences so that they can set up small enterprises as the nuclei of larger African construction enterprises.

Many countries have started reforming their civil engineering curricula in order to make them more responsive to the demand of the labour market. However, the numbers of graduates does not fill the gap, with the result that internationally experienced engineers are still needed.

2.6. Civil Engineering Education in Africa

Based on country reports from members of the Civil Engineering Subject Area Group, it was noted that the profession is highly regulated in the respective countries. Thus regulations, standards and quality assurance are of vital interest. Compliance is normally monitored by duly recongnised engineering councils or boards working within laid down legal framework.

Civil engineers in Africa typically earn an academic degree in a Civil Engineering programme lasting four or five years. An undergraduate degree in Civil Engineering normally provides successful students with an industry-accredited qualification. Thus, a bachelor's degree in civil engineering represents the first step towards professional certification, and the degree programme itself is certified by the professional body in each country. A registered or licensed professional engineer may prepare, sign and seal, and submit engineering plans and drawings to public authorities for approval or seal engineering works for public and private clients.

Engineering councils or boards play an important role in maintaining ethical standards for the profession. Even in jurisdictions where certification has little or no legal bearing on work, engineers are subject to contract law. In cases where an engineer's work fails, he or she may be sued for the tort of negligence and, in extreme cases, charged with criminal negligence. An engineer's work must also comply with numerous other rules and regulations such as building codes and legislation pertaining to environmental law for different countries.

Many reforms of Civil Engineering education in Africa have the goal of providing a comprehensive engineering education and competences to a diverse constituency in engineering and architecture, one that trains students to contribute effectively to the profession and society, prepares them for advanced studies and for lifelong learning, teaches them to conduct research, instructs them in working with other academic disciplines in interdisciplinary teams and assures that they can contribute to the creation of areas of excellence. Reforms aim at technology transfer and practical internships that align Civil Engineering education to the demands of the labour market and make it more relevant to society. However, in many countries, such reform efforts must overcome several bottlenecks and hurdles. Universities often cannot provide state-of-the-art teaching and research infrastructure and facilities like laboratories, seminar rooms and lecture halls, staff offices, a variety of well-equipped and maintained workshops, recreation facilities, libraries and studios for practical work. Other frequent gaps are the availability of computer labs and educational software, internet access and even e-mail addresses for staff and students.

The provision of postgraduate training programmes and research resources is likewise limited.

2.7. Civil Engineering Programmes

Amongst the important subdivisions of the Civil Engineering field are: (1) construction engineering, (2) transportation engineering, (3) soils and foundation engineering, (4) geotechnical engineering, (5) geodetic and hydraulic engineering and (6) structural engineering.

The diversity in scope and content of the Civil Engineering Programmes is complemented by a diversity of further variables. The characteristics of the degree profiles vary with regard to degrees, duration and structure of the programmes, terms/semester, credits, professional registration and employability.

Table 2.1 lists the degree profiles of the ten universities that are part of the Civil Engineering Tuning and Harmonisation pilot project in Africa. These profiles reflect the structural diversity of the academic programmes.

Table 2.1
Degree Profile of Civil Engineering in Participating Universities

	Study Programme (Typical 1st Degree)	Duration of Study Programme	Structure of Study Programme	Terms/Semester	Credits Year (in total)	Professional Registration after Graduation
Algeria	Licence	3 years	Course Units	2 semesters / year (6 semesters)	60 (180)	(Professional licence, Academic licence + Master's)
	Master	2 years	Course Units	2 semesters/year (4 semesters)	60 (120)	Registered professional, Academic master, Professional master
Botswana	BEng CE	5 years	Courses	9 semesters + 1 semester practical and industrial training	30 (150)	Yes, additional training required to be a professional
Cameroon	MEng CE	5 years	Course Units	10 semesters	300	Yes, directly considered as an engineer
DRC	MEng CE	5 years	Modules	10 semesters	Ca.36 (180)	Yes, directly employable
Ethiopia	BSc CE	5 years	Modules	9 semesters + 1 semester practical and industrial training	161 (min 33 credits per year)	Yes, directly employable
Kenya	BEng C and structural engineering	5 years	Courses	10 semesters (+ 36 weeks of internship during vacation)	232 units	Yes, additional on-job training required to be a professional
Nigeria	BEng CE	5 years	Courses	9 semesters + 1 semester practical and industrial training	165 (minimum 30 credits per year)	Yes, additional on-job training required to be a professional
South Africa	BEng CE	4 years	Modules	8 semesters	150	Yes, additional training required to be a professional
South Sudan	BEng CE	5 Years	Courses	10 semesters	208	Yes, additional professional experience is required
Tanzania	BSc CE	4 years	Courses	8 semesters + 24 weeks of industrial training	146 units (minimum 30 per year)	Yes, additional on-job training required to be a professional

As stated above, Civil Engineering is a highly regulated study programme in which many stakeholders play a crucial role. State agencies as well as professional associations and industry lobbyists regulate and/ or influence standards and access to professional pathways. Efficient academic programme reform must therefore be closely coordinated with these agencies and lobbyists. This complexity in reform coordination is making curricular reform in civil engineering slightly more difficult than in purely academic programmes.

The Tuning Higher Education in Africa pilot project provides an opportunity for Africa to harmonise engineering curricula aiming at educating competent human resources in sufficient quality and quantity to provide future national and transnational African firms with adequate personnel. Not the least of Tuning Africa's advantages is that it provides a means of promoting curricula reform across the continent, while simultaneously recognising and accommodating the different stakeholders in each country who need to be informed and involved as appropriate for maximum efficiency when graduates of civil engineering programmes become employees. Undoubtedly the process of reform will be a complex one, but its complexities should not overshadow its promise.

Below is a list of the stakeholders in civil engineering for the ten different countries.

Table 2.2
The Diversity of Stakeholders of Civil Engineering in African Higher Education

Country	Stakeholders
(1) Algeria	Association des Ingénieurs de Génie Civil Centre National de Recherche Appliquée en Génie Parasismique (CGS) Ecole Nationale Supérieure des Travaux Publics Facultés de Génie de la Construction (30 Facultés) Ministère de l'Aménagement du Territoire Ministère de l'Eau Ministère de l'Habitat Ministère de l'Enseignement Supérieur et de la Recherche Ministère de l'Environnement Ministère de Logement et des Equipements Publics Ministère de l'Urbanisme Ministère des Travaux Publics Ministère du Transport L'Ordre des Architectes Organisme National du Contrôle Technique de la Construction (CTC)
(2) Botswana	Association of Consulting Engineers Botswana Bureau of Standards Botswana Institution of Engineers Botswana International University of Science and Technology Engineers Registration Board Faculty of Engineering and Technology, University of Botswana Ministry of Education Ministry of Science and Technology Ministry of Works Student Body in Engineering
(3) Cameroon	Engineering Schools Ministry of Higher Education Ministry of Public Works Association of Civil Engineers

Country	Stakeholders
(4) Democratic Republic of Congo	Association Congolaise des Diplômes (Alumni) Association des Anciens de l'Université de Liège Association des Femmes Ingénieurs du Congo Bureau d'Accréditation des Ingénieurs Civils Le Bureau Technique de Contrôle Commission Permanente des Etudes Conseil d'Administration des Instituts Supérieurs Techniques Facultés Polytechniques (Université de Kinshasa, Université de Lubumbashi, Université de Pays des Grands Lacs) Fédération des Bâtisseurs du Congo Fédération des Entreprises Congo L'Institut National des Bâtiments des Travaux Publics Ministère de la Recherche Scientifique et de Technologie Ministère de l'Energie et de l'Eau Ministère de l'Enseignement Supérieur et Universitaire Ministère de l'Habitat et de L'Urbanisme Ministère de Transport Ministère des Mines Ministère des Travaux Publics et Aménagement du Territoire Office Congolais de Contrôle de Qualité L'Office National de Transport L'Ordre des Architectes du Congo Service Publique des Voiries et Routes Société Générale des Carrières et des Mines La Société Nationale des Chemins de Fer

Country	Stakeholders
(5) Ethiopia	Adama University of Science and Technology Addis Ababa Institute of Technology (AAiT) at Addis Ababa University Association of Construction Technology and Management Association of Ethiopian Architects Consultant and Practicing Engineers Engineering Capacity Building Programme (ECBP) - Bilateral Ethio-German reform programme Ethiopian Institute of Architecture, Building Construction and City Ethiopian Railway Authority Ethiopian Roads Authority Ethiopian Society of Engineers Ethiopian Society of Water Resource Development (EiABC) at Addis Ababa University Gondar University Haramaya University Hawassa University Higher Education Relevance and Quality Agency (HERQA) Higher Education Strategy Centre (HESC) Jimma University (JU) Mekelle Institute of Technology (M-EiT) - Mekelle University Ministry of Education Ministry of Housing Ministry of Science & Technology Ministry of Urban Development and Construction Ministry of Water and Energy Ministry of Water Works Student Council Engineering Capacity Building Programme (ECBP) - Bilateral Ethio-German reform programme

Country	Stakeholders
(6) Kenya	Association of Construction Engineers Commission of Higher Education Engineers Registration Board Institution of Engineers of Kenya Inter-University Council of East Africa (IUCEA; 6 universities with engineering schools) Kenya Bureau of Standards Kenya Industrial Research and Development Institute Ministry of Higher Education, Science and Technology Ministry of Housing Ministry of Local Government Ministry of Public Works Ministry of Roads Ministry of Water State corporations under the listed ministries Technology Students Association
(7) Nigeria	Association of Consulting Engineers Association of Professional Bodies Council for the Regulation of Engineering Engineering Schools Ministry of Education Ministry of Works National Association of Engineering Students National Universities Commission Nigerian Society of Engineers Standards Organisation of Nigeria

Country	Stakeholders
(8) South Africa	Association of Schools of Construction of Southern Africa (ASOCSA) Construction Industry Development Board Council for Science and Industrial Research (CSIR) Council for the Built Environment (CBE) Council on Higher Education (CHE) Durban University of Technology (DUT) Engineering Council of South Africa (ECSA, a statutory council responsible, amongst other things, for the registration of professional engineers and accreditation of academic programmes for engineers at South African universities) Ministry of Environment Ministry of Higher Education Ministry of Human Settlement Ministry of Local and Provincial Government Ministry of Public Works Ministry of Science and Technology Ministry of Transport Ministry of Water Affairs National Housing Builders Registration Council (NHBRC) Nelson Mandela Metropolitan University (NMMU) South African Association for Consulting Engineers (SAACE) South African Black Technical and Allied Career Organisation (SABTACO) South African Bureau of Standards (SABS) South African Federation for Civil and Electrical Contractors (SAFCEC) South African Institute for Civil Engineers (SAICE) South African Quality Authority (SAQA) Southern African Regional University Association (SARUA) Stellenbosch University Tshwane University of Technology (TUT) University of Cape Town (UCT) University of Johannesburg (UJ) University of KwaZulu-Natal (UKZN) University of Pretoria (UP) University of the North West (UNW) University of Witwatersrand (Wits) Walter Sisulu University, East London

Country	Stakeholders
(9) South Sudan	College of Engineering and Architecture, University of Juba Engineering Council of South Sudan (ECOSS) Engineering Sciences Committee Ministry of Dams and Electricity Ministry of Energy and Mining Ministry of General Education Ministry of High Education, Science and Technology Ministry of Housing and Physical Infrastructure Ministry of Physical Infrastructure Planning Ministry of Public Service and Labour Ministry of Roads and Bridges Ministry of Transport Ministry of Water Resources and Irrigation South Sudan Engineering Society (SSES) Technical and Technological Studies Committee Vocational Training Centre
(10) Tanzania	Association of Consulting Engineers Commission for Science and Technology Contractors Registration Board Engineers Registration Board Institution of Engineers Tanzania Inter University Council of East Africa (IUCEA) Ministry of Education and Vocational Training Ministry of Energy and Minerals Ministry of Public Management Ministry of Transport Ministry of Water Resources Ministry of Works National Accreditation Council for Technical Education Planning Commission Seven engineering universities Tanzania Bureau of Standards (TBS) Tanzania Commission of Universities

2.8. General Reflections on Curriculum Reform in Civil Engineering

Global competition, technological developments and international economic action have dramatically changed the needs of modern societies. These changes have imposed new requirements on the civil engineering profession and have changed the profession considerably. During the last decades, changes were largely due to (1) the developments in ICT, (2) the development of new materials and technologies and (3) the increasing involvement of engineers in activities such as planning, administration, and management. These drivers have led to the diversification of the scope of Civil Engineering and have created profiles that differ from traditional academic programmes, which focus on structures, geo-technics, transport, sanitation, water resources, building construction and environment.

The major challenges of Civil Engineering curriculum reform in Africa include those posed by ongoing technological developments, changes in labour market demand for various skills and the impact of the economic crisis. Curriculum reforms thus are directed to meeting these challenges. Reforms are expected to contribute to the national development goals of making the national economies more efficient, competitive and responsive to regional, national and local needs.

On the institutional level, reforms in Civil Engineering curricula face the following challenges:

- Creating a platform for dialogue amongst different stakeholders to create a common understanding of goals and to focus work towards the same goal.

- Overcoming the current disconnection between higher education reform, curriculum development and teaching.

- Strengthening the ownership by Civil Engineering programmes of meta-profiles by assuring robust discussion within Civil Engineering departments and including other departments as appropriate.

- Coordinating common courses provided by schools of engineering that affect other departments and synchronising them using the Tuning Africa methodology.

- Including the Tuning methodology and outputs as part of formal departmental reviews, which currently occur every 4-5 years.

2.9. Reform of Civil Engineering Curricula in Participating Countries

Some countries are fostering curriculum reform and modernisation—in particular, those of engineering and sciences—as part of their national development strategies.

Ethiopia is one of the countries spearheading such efforts. Its Engineering Capacity-Building Programme is a sector-crossing reform programme that has, as its target, the expansion and reform of higher education in engineering and sciences. Seventy per cent of the enrolments are supposed to be in engineering and sciences, only 30 in humanities and social sciences (70:30). One component of the curriculum reform was the integration of a qualified internship programme and collaborative curriculum development with the stakeholders of the sector (including public and private employers as well as international experts). Civil Engineering is one of the core programmes in Ethiopia expected to generate the graduates needed for boosting the Ethiopian construction industry and major national infrastructure projects.

In South Africa, national emphasis on engineering training will be complemented by other key skills: e.g., those of artisans, operators, planners, surveyors, project developers, financial experts, systems experts, etc. Progress has been made in undergraduate engineering and enrolment figures (2008-2010). Now South Africa will address the gap in Stage Two learning—which involves mentored learning in the workplace to achieve professional designations.

In South Africa, the stagnation in numbers of new learners entering Civil Engineering programmes over the last three years suggests that the "economic capacity" for artisan training has been reached. Increasing the numbers of matriculants will require more funding and increased workplace opportunities. Hence, South Africa is developing an integrated skills plan for the next 20 years across all the South African Institution of Civil Engineering (SAICE) based on the demand and supply of skills in the current and anticipated building industries across the country. This plan will be used to inform training colleges, universities and artisan schools in the country and will ensure the smoother transition of construction workers from one stage to the next. Dedicated project training courses, which are modular in design and which are repeated throughout the year, will improve the capacity and standardisation in project implementation across the SAICE International Panel members (SIPs). Another strategy to meet the challenges is to develop a shared pool of scarce skills across and between public entities (SAICE, 2011).

Botswana has also initiated endeavours to upgrade and expand its human resources and future workforce in engineering sciences. Behind these reforms is the need to diversify the economy, which still strongly relies on natural resources, especially diamonds. The establishment of the Botswana International University of Science and Technology is one strategic element of the current reform.

Algeria has launched a strategy to create stronger links of engineering and the sciences to industry, to improve the employability of graduates and to foster technology transfer and entrepreneurship. The creation of innovation centres is the core of this strategy.

Civil engineering education has greatly expanded in Kenya over the last decade with more than ten universities offering the discipline currently compared to only four ten years ago. Enrolment increased at least five times over the period. The new programmes must fulfil a rigorous accreditation process, while the older ones are regularly audited for compliance by the Engineers Board of Kenya. Ironically, the strict regulation for accreditation purposes is also a hindrance for methodology minded reforms in the curricula and remains a subject of debate going forward.

South Sudan has focused its post-conflict efforts in higher education reform on science and technology to provide the qualified labour force needed to reconstruct the country and to boost its economy. Its activities in the construction sector are, amongst other objectives, targeted to integrate South Sudan regionally.

Chapter 3

Generic Competences and their Definition: A Thematic Perspective

Ragaa T. M. Abdelhakim

3.1. Background

One of the most significant current developments in higher education in general and specifically in Civil Engineering education is competence-based learning. The issue has grown in importance in the light of recent needs of the labour market and this was spotlighted and accorded utmost attention in the Tuning Africa Project. Civil engineering graduates from different educational backgrounds or different countries can apply for jobs where they can employ knowledge and skills acquired at the university, the process that should match heterogeneous graduates to heterogeneous jobs. If this match is not optimal, additional learning by training and job experience are needed to improve or adjust the initial competences acquired during education (Heijke, 2003). To make a graduate more employable without the need for more on-job training, Tuning has given much attention to the identification and development of the required competences and the achievement of the related learning outcomes.

3.2. What is a Competence?

Competence has been long understood as a person's ability or capacity to do a job. It was devised in the 1970s by the US Company McBer to identify the specific personal characteristics which resulted in effective and/or superior performance (Management study guide, 2015). An additional definition of competence, but consistent with this one, is discussed in Chapter 3 below.

So, what exactly is the idea behind competences?

1. Every job requires a specific set of competences for it to be undertaken efficiently, and the individuals who would perform the job need to possess those competences. One of the interesting aspects of this concept worth mentioning is that it focuses not only on what a person can do but also on what a person can learn. This forward looking approach makes it quite popular amongst training providers and recruitment experts.

2. With their specific behavioural indicators, competences facilitate the demonstration of appropriate skills and behaviours; they are not a set of tasks to be performed like a robot and neither do they represent underlying capacity which is never demonstrated.

3. Competences also includes motivation and self-knowledge, a desire and willingness to demonstrate effective performance.

So, with this background, a competence can be defined as follows:

1. A set of individual performance behaviours which are observable, measurable and critical to successful individual and company performance.

2. Individual characteristics of a person which result in an effective and superior performance on a job.

Competences include the following elements (Management study guide, 2015).

Competences are classified as generic and subject-specific. Generic Competences can be defined as important non-technical abilities and skills for employment; abilities and skills that are 'transferable', in that people can develop, in different ways and in a wide variety of learning environments. They can also be defined as abilities and skills that could be utilised in new situations.

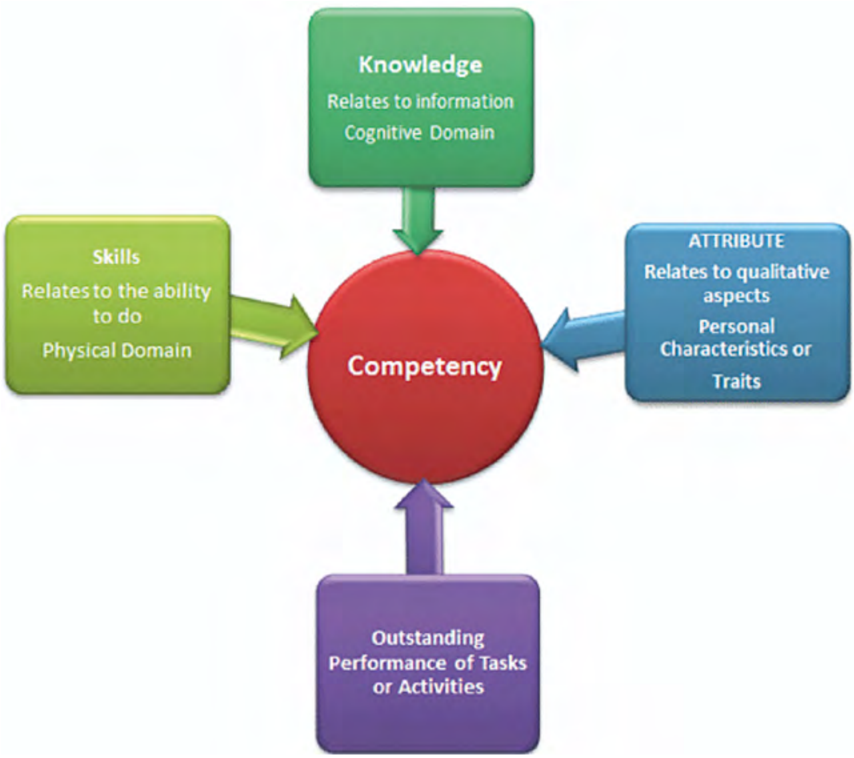


Figure 3.1
Elements Forming a Competence

3.3. Definition of Generic Competences for Africa

The project began at the end of 2011. One of its first tasks was to define generic competences for Africa. Each Subject Area Group (agricultural sciences, civil engineering, mechanical engineering, medicine and teacher education) was tasked with preparing a list of the generic competences considered to be relevant from their perspective. As a starting point for preparing this list, they were given the thirty-one generic competences identified in Europe (http://tuning.unideusto.org/tuningeu/), the twenty-seven generic competences identified in Latin America (http://www.tuningal.org), the thirty generic competences identified in Russia (http://www.tuningrussia.org) and a range of contributions from different participants in the project.

At the first General Project Meeting, held in Yaoundé, Cameroon, in January 2012, the five Subject Area Groups (SAGs) working at that time discussed the proposals for the generic competences. The five groups presented a compilation of the generic competences in draft form, and the five coordinators agreed on a final list. On the last day of the meeting, the participants decided in a plenary session to present a definitive list of eighteen generic competences as follows (Onana *et al.*, 2014):

List of Generic Competences

1. Ability for conceptual thinking, analysis and synthesis.
2. Professionalism, ethical values and commitment to Ubuntu (respect for the well-being and dignity of fellow human beings).
3. Capacity for critical evaluation and self-awareness.
4. Ability to translate knowledge into practice.
5. Objective decision-making and practical cost-effective problem solving.
6. Capacity to use innovative and appropriate technologies.
7. Ability to communicate effectively in both the official/national and the local languages.
8. Ability to learn how to learn and capacity for lifelong learning.
9. Flexibility, adaptability and ability to anticipate and respond to new situations.
10. Ability for creative and innovative thinking.
11. Leadership, management and teamwork skills.
12. Communication and interpersonal skills.
13. Environmental and economic consciousness.
14. Ability to work in an intra- and intercultural and/or international context.

15. Ability to work independently.

16. Ability to evaluate, review and enhance quality.

17. Self-confidence, entrepreneurial spirit and skills.

18. Commitment to preserve African identity and cultural heritage.

A comparison of the lists drawn up in the European project, the Latin American project and the African project shows a high degree of similarity among the main generic competences. The three projects also show many convergent competences, which can be easily compared. Many other competences from the European and Latin America list were regrouped and redefined as one competence by the African project. Finally, the African project incorporates a particular competence that is unique to its list: "Professionalism, ethical values and commitment to Ubuntu (respect for the well-being and dignity of fellow human beings)".

3.4. Methodology for the Consultation Process

An important part of the Tuning Methodology consists of involving the key stakeholders in defining current and optimal practice in curriculum design. This is done through a large scale consultation, using questionnaires to elicit the opinions of Academics, Graduates, Students and Employers about the relevance of the Generic and Subject-specific Competences, and about how well they are formed during university studies at present.

As in other Tuning projects, the SAG participants decided to use a system of cluster sampling, given that the people whose opinions were asked are grouped in the universities themselves. This decision acknowledges that the respondents are not strictly independent of each other, with the result that such sampling cannot be considered random. At the same time, the universities have a certain clustering effect at the level of each country.

It should be emphasized that the consultation is not a poll from which the results can immediately be transformed into recipes for improving higher education: rather it is a tool to assist the SAG in understanding current perceptions with regard to the efficacy of higher education programmes, and to help it to formulate useful indications for future development.

Variables

The participants decided to consult the respondents about two variables. These are:

- The degree of importance, meaning the relevance of each competence, in their opinion, for employment of graduates in the Subject Area.

- The level of achievement, meaning how well each competence is achieved as a result of having followed the university degree programme.

To evaluate these two variables, the questionnaire or the interviewer used a four-point scale: 1 = "none"; 2 = "weak"; 3 = "moderate"; 4 = "strong". This allowed the creation of medians indicating the ratings by the four stakeholder groups consulted, on both the importance and the level of achievement of the Generic and the Subject-specific Competences. In addition, the respondents were asked to complete a ranking exercise, indicating which, in their respective opinions, are the five most important competences. Based on this categorisation of the five most important competences according to academics, graduates, students and employers, a new variable was created for each competence. The competence ranked highest by each respondent was allocated five points, the second four points and so on, with one point for the last competence on the list of five selected. If a competence was not ranked among the five most important ones, it scored zero points.

The Consultation Process

Once the variables had been defined, agreements were reached on what categories and how many people to consult:

- Academics: University lecturers teaching in any of the theme areas of the project. Each university was asked to consult at least 30 academics in the Subject Area in which the university was participating.

- Graduates: People having successfully completed a full study programme/university degree, in one of the areas of the project and had received the corresponding degree. Each participating university was asked to consult at least 30 graduates from the Subject Area in which it was participating. The graduates selected had to have received their degree from three to five years before the date of the survey. This criterion could vary according to the number of graduates who had received their degree during this interval. If the number of graduates was few (under a specified number), the sample had to include graduates from the five previous years. If graduates exceeded the specified number, the sample was to be limited to those from the three previous years.

- Students: People who were either engaged in the last two years of a first degree programme in the project areas in the participating universities or still awaiting graduation despite having completed their studies. Each university was asked to consult a minimum of 30 students from the Subject Area in which it was participating in the project.

- Employers: People and/or organisations who have employed graduates from the university, or people and/or organisations which, although there is no evidence that they have hired graduates from the university, appear to have jobs of interest for graduates. Each university was asked to survey at least 30 employers of graduates in the Subject Area represented by the university in the project.

Various alternatives were proposed for carrying out the survey. Each university could use the form or forms it considered most suitable, depending on its institutional characteristics and the survey groups in question. The systems proposed were (1) an online survey and/or (2) an explanatory face-to-face meeting followed by administration of the consultation questionnaire.

The survey was conducted in March and April 2012, predominantly through the online system, resulting in a very significant number of completed survey instruments. From the thirty-three African countries participating, more than 4,300 questionnaires were returned. The information was analysed by Jon Paul Laka, a statistician at the University of Deusto (Spain), who prepared the tables, graphs and analyses of the information the groups worked with, some of which are presented below.

Analysis of the Results

The data and results gleaned from the questionnaires allowed for three levels of analysis:

1. The general analysis gives the results from the academics, graduates, students and employers throughout Africa.

2. The analysis by Subject Area shows the opinions of these four groups, in relation to each of the participating discipline.

3. The results of the analyses of the questionnaires from each institution were sent to the institution for its consideration and use.

Evidence of high rates of correlation among the four groups consulted (academics, graduates, students and employers) was observed with regard to the eighteen Generic competences, in terms both of importance, and of level of achievement. All four survey groups considered the eighteen competences to be important, awarding them ratings of over 3, on a scale in which 3 is equivalent to "moderate" and 4 to "strong".

The comparatively lower scores these respondents assigned to the level of achievement indicated a serious level of criticism and demand for better quality among those surveyed. It is important to stress that the academics were the most critical group in this regard while the students were the most optimistic.

A complete analysis of the results of the consultation process is available in Teklemariam *et al.* (2014).

Chapter 4

Identification and Definition of Subject-specific Competences

Tadesse Ayalew

Since the early 1990s, engineering education has seen a significant paradigm shift from what was previously an input, content and process orientation towards a system based on educational outcomes. In this regard, the American Society for Engineering Education (ASEE) 1994 report "Engineering Education for a Changing World" and Engineers Australia's 1996 review "Changing the Culture: Engineering Education into the Future" has made a prominent contribution for this development in the context of the drastic social, economic and technological changes (Walther and Radcliffe, 2007).

These systems of educational outcomes brought two fundamental changes to engineering education.

1. The development of an outcomes-based approach changed the underlying instructional principle of engineering education. More specifically, the aspirational attributes postulated in the reports mentioned above were turned into binding outcomes for the educational process.

2. The scope of education was extended to encompass the broader aspects of engineering practice, such as cultural and social awareness and an explicit commitment to the preparation of students for current professional practice.

This trend, of reclaiming the importance of preparation of students for professional practice, was also confirmed by Lemaitre *et al.* (2006) who expressed the view that the preparation "of students to be professionally competent has always been the ultimate goal of engineering curricula". This phenomenon leads to the birth of competence-based learning in the field of engineering.

Table 4.1

Underlying causes of the competency dilemma in engineering education

Underlying Issues			
What Can be achieved	• Nurture • Building Knowledge	*vs.* *vs.*	Nature Forming attitudes
Goal Conflict	• General Education • Ethics • Technical breadth • Different levels of competences are conflictive • Generic skills	*vs.* *vs.* *vs.* *vs.* *vs.*	Preparation for specific job tasks Performance Technical depth A certain level of competences are required Specific Performance

Source: Walther and Radcliffe, 2007.

However, several authors indicate that engineering education still falls short of the goal of preparing students adequately for professional practice. For example, Business Council of Australia (BCA, 2006) indicates that engineering graduates have deficiencies with respect to crucial job skills such as "problem-solving, communication or entrepreneurship". In the USA, on the other hand, it has been observed "many of the students who make it to graduation enter the workforce ill-equipped for the complex interactions" of real world engineering systems.

As indicated in Table 4.1 above, industry requires a fuller preparation of graduates for the job tasks of real world engineering than universities traditionally provide. Conversely, "much of the energy in teaching and learning in universities is still focused on developing the observable skills and knowledge dimension" (Radcliffe, 2005), rather than the less easily observable attributes required by industry. This disconnection shows that the current application of outcomes-based approach to engineering education is not yet able to fully prepare students for the changing demands of professional practice. Also the broader aspects of competence have not found their way into the wider practice of education.

4.1. Definition of Competence

Competences are defined as the knowledge, skills, abilities, attitudes, and other characteristics that enable a person to perform skilfully in complex and uncertain situations such as professional work, civic engagement, and personal life. In this definition, knowledge includes all the types of knowledge defined by Anderson *et al.* (2001) taxonomy: factual knowledge (terminology and details), conceptual knowledge (classifications, principles, theories, and models), procedural knowledge (knowing both how and when to use specific skills and methods), and metacognitive knowledge (self-knowledge and both how and when to use cognitive strategies for learning and problem-solving).

Tuning Europe, on the other hand defined "competence" as a dynamic combination of knowledge, understanding, skills and abilities. Accordingly, competences are articulated so as to be formed or enhanced in various course units and are assessed at different stages. From the above definition one can realise that there are two major categories of competences, generic competences (common to any degree course) and Subject-specific Competences (specific to the field of study).

In this regard, generic competences identify shared elements common to all degrees, such as conceptual thinking, analysis and synthesis; and the ability to learn, to make decisions, to design projects, to exercise appropriate interpersonal skills, etc. Subject-specific Competences, on the other hand, complement generic competences that a degree-holder in a given field of study is expected to acquire as learning outcomes. Thus, competences—and the related term "learning outcomes"—are actual skills and abilities that graduates demonstrate at the end of their study program. Competences are distinct from inputs: that is, the subjects taught and the amount of class time spent on each subject. They are abilities and attitudes possessed by the learners at the end of a successful learning process.

4.2. Identification of Civil Engineering Specific Competences

The Civil Engineering Subject Area Group of Tuning Africa used a two-step approach to identify civil engineering Subject-specific Competences. The first step was to identify the phases of a typical construction project and the second was to list the specific competences required for each phase.

Following this approach, the working group identified six phases of project construction and listed down the possible competences under each phase, making reference to the experiences of civil engineering working groups of Tuning Latin America and Tuning Russia Projects.

Finally, the Civil Engineering SAG in Africa identified the following twenty-one civil engineering Subject-specific Competences and organised them in nine master groups, or dimensions, which include: analysis, design, creativity, management, quality management, leadership, communication, sustainability and regulation as a final relevant civil engineering subject-specific competence for Africa.

Table 4.2
Subject-specific Competences for Civil Engineering adapted from Tuning Africa Civil Pilot Project booklet

Cluster	Subject-specific Competence
Management	Ability to coordinate, manage, supervise and control construction
	Knowledge to reconstruct, maintain, rehabilitate, and renovate infrastructure
	Ability to manage basic construction and programme principles
	Knowledge of plant and equipment
	Basic understanding of contractual and financial management, including insurance and guarantees
Communication	Ability to translate and interpret data and/or drawings into actual construction
	Ability to develop effective and professional interactions with experts in other professions and to achieve well-integrated solutions
Design and Analysis	Ability to design, quantify, and calculate parameters and capacity to model and simulate systems, structures, projects and processes

Cluster	Subject-specific Competence
Design and communication	Ability to analyse, reconfigure and apply relevant drawings, data and technology. Ability to transmit project requirements into sketches and explain them to clients
Leadership	Ability to control costs, quality and time required for construction
Analysis	Ability to analyse data or information (for example, data from surveys, soils, etc.)
	Ability to identify the need for construction by type and structure. Ability to identify different options for achieving construction
	Ability to analyses and make decision based on mathematics and other abstract principles
Regulation	Commitment to health and safety measures. Ability to introduce and maintain safety measures in construction and materials
	Knowledge of national and international construction standards
Quality management	Ability to test the quality of materials
	Ability to manage and address defects and quality issues
Creativity	Skills in developing new, appropriate and sustainable construction technology and materials
Management and Regulation	Ability to finalize financial implications, identify legal responsibilities and operate within appropriate frameworks
Regulation and sustainable	Skills in environmental and social impact assessment, knowledge about the context and the challenges of development

This is a good start for harmonisation of African education in general and the field of Civil Engineering in particular. Because this is a step forward for facilitating students mobility in Africa which is the ultimate goal of the Tuning Africa Project.

4.3. Conclusion

The importance of competences and competence-based learning has been a subject of discussion since the early of 1990's. In this regard, the 1994 ASEE report "Engineering Education for a Changing World" and Engineers Australia's 1996 review "Changing the Culture: Engineering Education into the Future" has made a prominent contribution to this development. However, several authors indicate that engineering education still falls short of the goal of preparing students adequately for professional practice. These are indications that industry requires a more adequate preparation of graduates for the job tasks of real-world engineering.

Competences are defined as the knowledge, skills, abilities, attitudes, and other characteristics that enable a person to perform skilfully in complex and uncertain situations such as professional work, civic engagement, and personal life. These are generic competences (common to any degree course) and Subject-specific Competences (specific to the field of study).

Analysing various sources, the Civil Engineering Subject Area Group of Tuning Africa adapted twenty-one civil engineering Subject-specific Competences and organised them in nine 'master groups', or 'dimensions', which define the main stages of any construction project. Competence groups include: analysis, design, creativity, management, quality management, leadership, communication, sustainability and regulation. Each group was turned into a number of Civil Engineering Subject-specific Competences for Tuning Africa based on the Civil Engineering SAG's previous work in Tuning Africa.

Chapter 5

The Consultation and Reflections on Generic and Specific Competences in Civil Engineering

Mohand Hamizi

5.1. Methodology of Data Collection

In accordance with the pilot project design, the civil engineering group surveyed four stakeholder groups: students, graduates, academics and employers. The SAG distributed the questionnaire in the ten participant countries by two methods: (1) printed questionnaires administered at short meetings during which the respondents received background information and explanations of how the data would be used; and (2) online questionnaires and email attachments in which briefing occurred via email to explain the generic and specific competences. The survey asked participants to rate each competence on a four point scale, in which 1 = "none," 2 = "weak," 3 = "considerable" and 4 = "strong". Respondents rated each competence according to its perceived "importance" in the workplace and their institution's level of "achievement" in imparting this competence. In addition, the respondents ranked the five most important generic and Subject-specific Competences. The numbers of responses were 666 for Generic Competences and 588 for Subject-specific Competences. The difference in numbers was most probably due to the fact that the two lists were sent separately to participants; some of them answered one and ignored the second. Table 5.1 presents the details of respondents for both Generic and Specific Competences.

Table 5.1
Number of respondents

Competences	Academics	Employers	Students	Graduates	Total
Generic	167	139	196	164	666
Specific	123	105	210	150	588

5.2. Evaluation and Interpretation of the Generic Competences Results

The Civil Engineering Subject Area Group analysed the results of the questionnaires and formulated some interpretations and conclusions. Figure 5.1 shows the relative importance of the proposed generic competences as ranked by the four groups consulted (Employers, Academics, Graduates and Students).

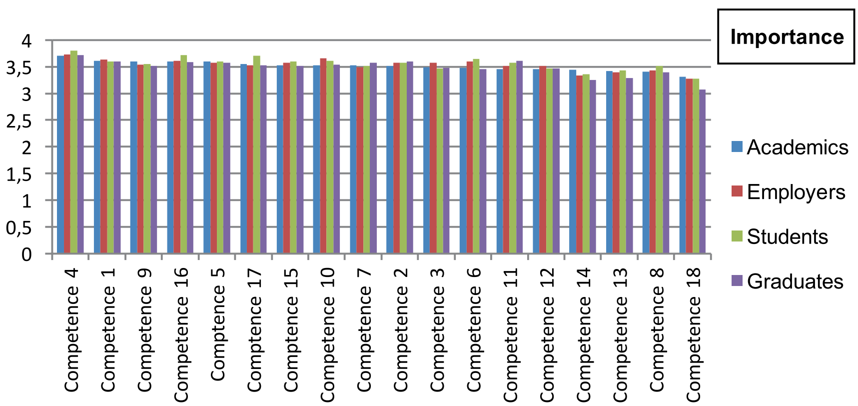


Figure 5.1
Importance of Generic Competences

A number of points can be observed from these results:

1. The graph exhibits clearly that most competences are rated over 3.5; this is a strong indication that competences generated in Yaoundé (Cameroon) by all areas (Civil Engineering, Mechanical Engineering, Medicine, Agriculture and Teacher Education) were very relevant.

2. Only nine competences out of eighteen received a score lower than 3.5 points from one or more of the Civil Engineering stakeholder groups. These were: competence 18 ("Commitment to preserve and to add value to African identity and cultural heritage"); competence 14 ("Ability to work in an intra and intercultural and/ or international context"); and competence 13 ("Environmental and economic consciousness"), by four groups (Employers, Academics, Graduates and Students); competence 12 ("Communication and interpersonal skills") is by 3 groups (Academics, Graduates and Students); competence 3 "Capacity for critical evaluation and self-awareness") by 3 groups (Employers, Graduates and Students); competence 8 "Ability to learn to learn and capacity for lifelong learning by 2 groups (Academics and Graduates); competence 7 ("Ability to communicate effectively in official/national and local language") and lastly, competence 11 ("Leadership, management and team work skills") from the Academics group only.

3. Another point worth mentioning is the fact that of the four groups, Academics gave the lowest ratings (8 competences got a score lower than 3.5 points). The academics gave high ratings to competences related to communication, learning and critical evaluation, cultural values and identity and environmental consciousness.

4. Finally, correlation among the four groups is very high. Table 5.2 shows that the lowest correlation is between academics and students at 0.8084. Correlation reaches 0.8831 between graduates and employers. This high correlation among the four groups emphasizes the validity of the agreed list of generic competences.

Table 5.2

Correlations among groups in terms of Importance of Generic Competences

	Academics	Employers	Students	Graduates
Academics	1			
Employers	0.8411	1		
Students	0.8084	0.8591	1	
Graduates	0.8762	0.8831	0.8241	1

As for achievement, all four groups rated all competences between 2 and 3, as can be seen in Figure 5.2. In other words, achievement was seen by all as not satisfactory enough. Nevertheless, rating results are not too alarming since they are not very low, but rather fall in a middle range. Here too, academics and employers gave the lowest ratings. This can be explained by the fact that academics' and employers' expectations are much higher than graduates' and students'.

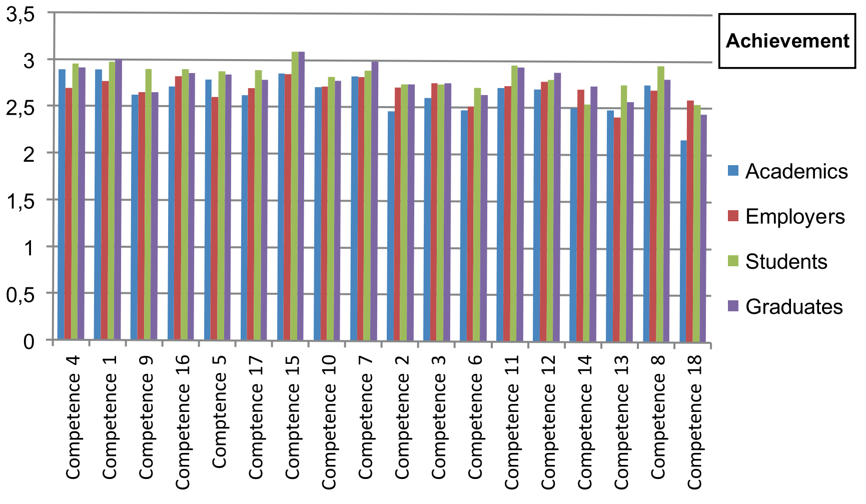


Figure 5.2
Achievement of Generic Competences

Correlation among all groups is also high; but differences are higher here than in the case of the ratings of importance (Table 5.2). It is worth mentioning here that the strong correlation between students and employers which was evident in terms of 'importance' does not exist here. In fact, correlation between these two groups in connection with achievement is the lowest among all groups. The same observation can be made about the correlation between 'academics' and 'employers' groups, where the correlation is just in the middle (Table 5.3). This can be explained by the fact that employers' expectations are much higher than students' and academics'. Employers are increasingly demanding, and they value quality very highly.

Table 5.3
Correlations among groups
in terms of Achievement of Generic competences

	Academics	Employers	Students	Graduates
Academics	1			
Employers	0.5608	1		
Students	0.8546	0.4712	1	
Graduates	0.8987	0.7679	0.7822	1

The ranking of the generic competences also shows consistency among the four groups of stakeholders. Here the stakeholder groups were asked to identify the five competences they consider most important and rank them in order of importance. Only eleven competences were chosen among the eighteen as can be seen below. This indicates that the same competences were chosen repeatedly in the four groups, a fact which underlines the validity of the ranking itself because of the high correlation among all groups. We can see these eleven competences in Table 5.4, from the highest ranked to the lowest.

Table 5.4
The Top Five generic competences
in Civil Engineering as ranked by the groups consulted

Employers	Academics	Graduates	Students
4	4	4	4
10	1	11	16
1	9	2	17
16	16	1	15
6	5	16	6

The Civil Engineering working group analysed the results of the questionnaires and identified the four top generic competences (Table 5.4).

Key:

- **G4** : Ability to translate knowledge into practice.
- **G16** : Ability to evaluate, review and enhance quality.
- **G1** : Capacity for conceptual and critical thinking, analysis and synthesis.
- **G6** : Ability to use innovative and appropriate technologies.

These competences reflect a number of important issues: firstly, stakeholders are in agreement on the importance of translating knowledge into practice, evaluating and reviewing quality, critical and creative thinking, analysis and synthesis, innovation and appropriate technologies as qualities to be present in any civil engineer.

The working group highlighted the importance of critical thinking and synthesis and therefore identified them as meta-competences.

According to our analysis of the gap between ratings of importance and level of achievement, respondents perceived that current Civil Engineering programmes displayed gaps in five areas. In these five areas, attention to Generic Competences is missing completely or partially in existing curricula. The conclusion was that this does not lead the student to acquire the expected learning outcomes by graduation.

Table 5.5
Top five gaps in Generic Competences in Civil Engineering

	Employers	Academics	Graduates	Students
1	6	2	18	6
2	13	6	13	2
3	2	18	9	14
4	17	2	6	18
5	18	4	17	17

Key:

G6 : Capacity to use innovative and appropriate technologies.

G18 : Commitment to preserve and to add value to African identity and cultural heritage.

G13 : Environmental and economic consciousness.

G17 : Self-confidence, entrepreneurial spirit and skills.

G2 : Professionalism, ethical values and commitment to Ubuntu.

Weak achievement of these five generic competences has a negative impact on individual professionals, on the profession of Civil Engineering as a whole, and also on a regional African level. The capacity to use innovative and appropriate technologies is basic for the construction of modern facilities and infrastructures, and has a long-lasting effect because of their impact on quality. Self-confidence, entrepreneurial spirit and skills, as well as environmental and economic consciousness, are crucial in meeting the requirements of social development, in developing the labour market and in improving employment opportunities, particularly for African youth. Professionalism, ethical values and commitment to Ubuntu, as well as the commitment to preserve and to add value to African identity and cultural heritage, are core to the continental objectives of an integrated and prosperous Africa as promoted by the African Union.

Therefore, the working group highlighted the need for fostering the above competences in university-level Civil Engineering programmes in Africa.

Further discussion of the competences showing the greatest gaps between the importance of a competence and its achievement in the curriculum focused on how to integrate these competences into the curriculum, teach them effectively and assess whether they have been achieved. The group agreed that a particularly important obstacle in achieving these goals was the lack in African universities of infrastructure to support innovative learning. As a result, African universities experienced handicaps in achieving the broader goal of reform of curricula, teaching and learning.

5.3 Evaluation and Interpretation of the Subject-specific Competences Results

The Civil Engineering SAG identified 54 subject-specific competences. Table 5.6 presents the rankings of the specific competences from the highest to the lowest.

Figure 5.3 presents similar points to those observed with respect to the Generic Competences.

All the 54 specific competences were considered of high importance. All competences obtained a value of 3.2 or above. It may be noted that only the group of academics rated 12 competences below 3.5. The other groups (employers, students and graduates) rated 49 competences above 3.5. This can be seen as an indication of realistic view of the subject-specific competences identified by the Subject Area Group.

The five competences rated just below 3.5 were:

- 54 "Skills in commissioning."
- 23 "Ability to identify appropriate legal frameworks."
- 6 "Knowledge about the context and challenges of environment and development."
- 4 "Skills in environmental and social impact assessment."
- 17 "Skills of testing materials and technologies."

Table 5.6
Subject-specific Competences Ranked by Importance

Academics		Employers		Students		Graduates	
33	3.73	36	3.77	36	3.75	45	3.8
8	3.71	33	3.77	45	3.72	40	3.79
40	3.7	26	3.69	3	3.72	33	3.78
19	3.7	8	3.68	26	3.71	12	3.78
12	3.69	44	3.68	8	3.7	49	3.75
7	3.69	35	3.68	44	3.69	36	3.74
36	3.68	38	3.67	42	3.69	44	3.74
3	3.66	46	3.67	12	3.68	26	3.72
45	3.65	12	3.66	7	3.65	8	3.7
2	3.65	7	3.66	19	3.65	19	3.7
20	3.65	39	3.66	39	3.65	3	3.7
26	3.64	45	3.65	21	3.65	35	3.7
49	3.64	19	3.63	49	3.64	53	3.69
44	3.63	49	3.63	35	3.64	11	3.69
1	3.62	22	3.63	1	3.64	7	3.68
39	3.59	53	3.62	48	3.63	10	3.68
21	3.58	2	3.61	33	3.62	39	3.67
53	3.58	42	3.61	40	3.62	2	3.67
38	3.56	51	3.61	2	3.61	21	3.67
22	3.55	40	3.59	38	3.61	38	3.66
43	3.54	11	3.59	37	3.61	46	3.66
51	3.53	3	3.58	11	3.6	1	3.65
35	3.52	43	3.58	20	3.59	42	3.64
42	3.52	21	3.57	22	3.59	20	3.63
46	3.5	48	3.57	43	3.59	43	3.61
48	3.5	50	3.56	46	3.58	51	3.59
28	3.48	1	3.55	17	3.58	37	3.59
6	3.47	20	3.55	53	3.56	50	3.59
11	3.46	37	3.52	50	3.53	28	3.59
10	3.44	52	3.51	15	3.53	22	3.58
37	3.42	10	3.5	10	3.52	15	3.58
4	3.42	6	3.5	4	3.51	48	3.57
50	3.41	54	3.43	51	3.5	52	3.53
15	3.39	28	3.42	28	3.49	17	3.46
52	3.35	17	3.42	6	3.44	23	3.45
17	3.29	23	3.38	52	3.42	6	3.43
23	3.28	15	3.37	54	3.38	4	3.34
54	3.2	4	3.37	23	3.32	54	3.34

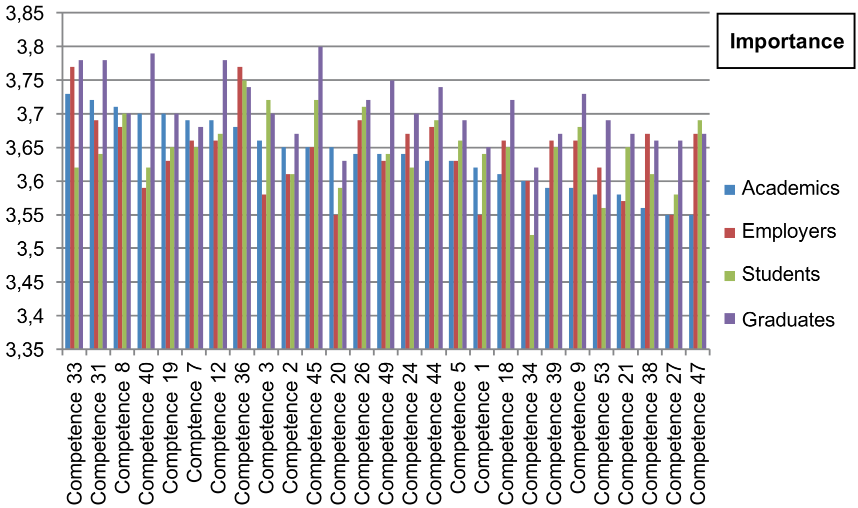
Firstly, it may be noted that these five competences are rated below 3.5 by all groups except for competence 17, which the students' group rated above 3.5.

The Civil Engineering SAG analysed the results of the ranking questionnaires and identified the top five specific competences (Table 5.7):

- 36 "Ability to coordinate, supervise and control."
- 33 "Ability to translating, interpreting of data and/or drawings into actual construction."
- 45 "Ability to control construction."
- 12 "Ability to design."
- 8 "Ability to analyse, reconfigure and apply relevant drawings, data and technologies."

Table 5.7
Top five Subject-specific Competences
in Civil Engineering as Ranked by the Stakeholder Groups

Specific Competence	Academics	Employers	Students	Graduates	Average
(36)	3.68	3.77	3.75	3.74	3.7350
(33)	3.73	3.77	3.62	3.78	3.7230
(45)	3.65	3.65	3.72	3.80	3.7050
(12)	3.69	3.66	3.68	3.78	3.7025
(8)	3.71	3.68	3.7	3.7	3.6975



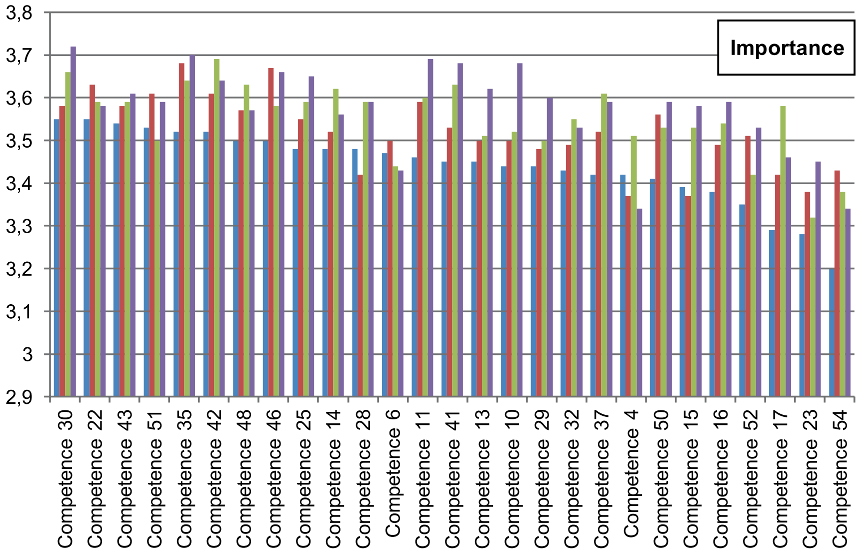


Figure 5.3
Rating of importance of specific competences
by the four surveyed Groups

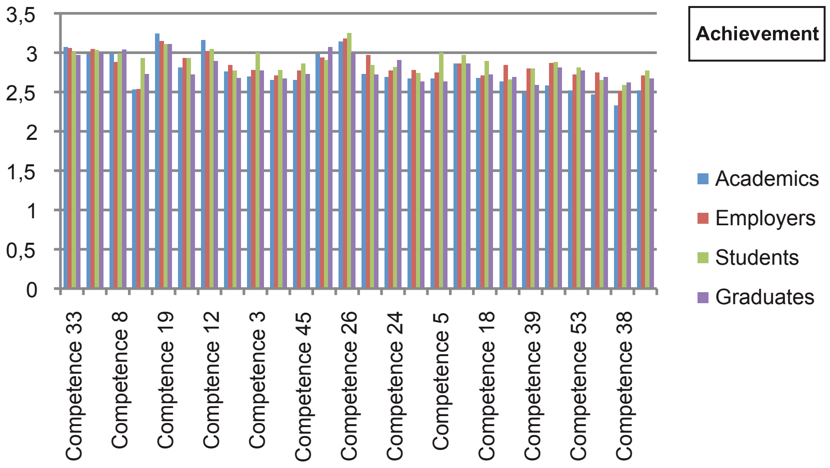
Once again, correlation among the four groups was found to be very high. Table 5.8 shows that the lowest correlation is between Employers and Students, at 0.7186. Correlation reaches 0.8080 between Graduates and Academics. This high correlation among the four groups emphasizes the validity of the agreed list of competences.

Table 5.8
Correlations among groups
with regards to importance of specific competences

	Academics	Employers	Students	Graduates
Academics	1			
Employers	0.7986	1		
Students	0.7414	0.7186	1	
Graduates	0.8080	0.7755	0.7480	1

All four groups agreed that the level of achievement of the competences is lower than their importance would merit. Still, they all seemed to judge achievement above average; between 2 and 3 (Figure 5.4). Four Subject-specific Competences got a score higher than 3 points: these are:

- 12 "Ability to design."
- 19 "Ability to calculate design parameters (mathematical skills)."
- 26 "Ability to calculate and quantify."
- 31 "Ability for translating, interpreting of data and/or drawing into actual construction."



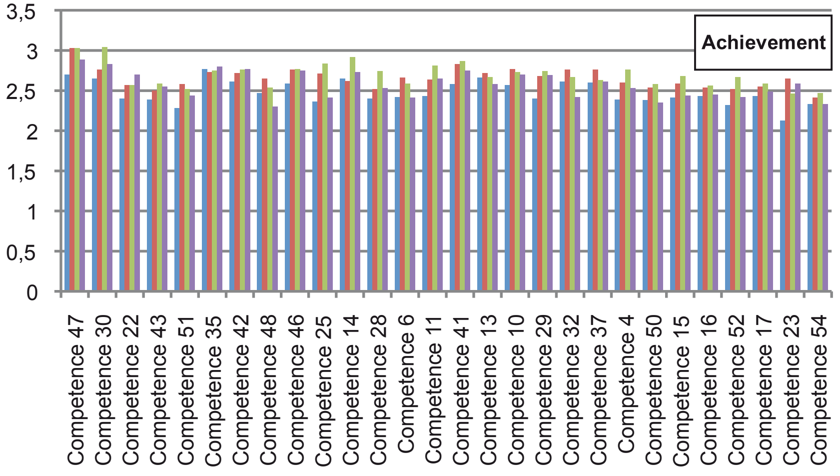


Figure 5.4
Rating of achievement of specific competences by the four Groups

In terms of achievement, the correlation among the four groups is very high too. Table 5.9 shows that the lowest correlation is between Employers and Students at 0.7774. Correlation reaches 0.8631 between Employers and Academics.

Table 5.9
Correlations among groups
in terms of achievement of Subject-specific Competences

	Academics	Employers	Students	Graduates
Academics	1			
Employers	0.8631	1		
Students	08083	0.7774	1	
Graduates	0.8197	0.7797	0.7786	1

Correlations among groups in relation to ranking of the specific competences are not very good in comparison to those found in the ratings of importance and achievement of the Subject-specific Competences (Table 5.10). The highest correlation is between Students and Academics. This seems to indicate the fact that students and their teachers appreciate competences in the same way. The lowest correlation is between Employers and Graduates. This shows that these groups have very different opinions when it comes to ranking the specific competences. Employers feel that freshly graduating engineers do not have enough competences to be ready for practice.

Table 5.10
Correlations among groups in terms
of ranking of Subject-specific Competences

	Academics	Employers	Students	Graduates
Academics	1			
Employers	0.6003	1		
Students	0.9063	0.6003	1	
Graduates	0.8702	0.4738	0.8583	1

Analysis of the survey results shows the top five competences in Civil Engineering, rated according to importance, are:

- SC7 "Ability to transmit project requirements into sketches and explain them to clients."
- SC36 "Ability to coordinate, supervise and control."
- SC45 "Ability to control construction."
- SC44 "Ability to supervise/manage."
- SC49 "Skills in handling data or information (data from surveys, soil, etc.)."

Further analysis of gaps between the "importances" that respondents assigned to a particular competence and their perception of how well it was achieved in the curriculum shows the following results where the largest discrepancies are related to:

- SC18 "Ability to plan the process and allocate resources."
- SC26 "Commitment to health and safety."
- SC32 "Capacity to introduce health and safety measures in construction and materials."
- SC35 "Skills in resolving disputes."
- SC37 "Skills in commissioning."

Possible explanations of these gaps are:

- The content may not be taught at the university level since many civil engineering programmes spend a majority of the time on teaching students how to design and to analyse problems mathematically. The SAG expressed its view that this focus on mathematics and science is appropriately taught at the university level while programming, health and safety, dispute resolutions and skills in commissioning may be best gained in the workplace.

- As mentioned above, these additional competences may be learned on-site as part of hands-on experiences or as extra courses offered by employers. They are not part of the core curriculum but could also be offered as additional courses at the university level.

- The competences are not part of the programme as issues like safety and health may have financial implications for the employers. Some participants noted that some employers tend to avoid costs in the areas of safety and health.

- Legal frameworks with their constraints, health, safety and security should be integrated into programmes or courses teaching environmental impact assessment methodology and frameworks.

- Rather than being part of the core content of Civil Engineering, these topics may be better treated in the more specialised programmes of construction technology and management.

- Governing bodies that set the course frameworks may leave little room to deal with topics not seen as core for the Civil Engineering programme.

In short, the Civil Engineering SAG generally agreed that the consultation results accurately reflect the reality in Civil Engineering programmes in African universities. This agreement then generated the following questions: How can the gaps thus identified be closed? How can the discrepancies be addressed between the importance of some generic and Subject-specific Competences and their lack of actual achievement in the present curriculum be addressed?

As suggested by the group, one of the solutions could lie in the 'course-practical attachment', the 'industrial attachment' or the 'work-integrated' learning approaches currently being used in South African universities. Another possible solution is the 'qualified internship under academic mentorship' as practised in Ethiopia's Engineering Capacity Building Programme.

Another best practice mentioned may be 'service learning', which means that students provide service to the community, attached to, but separate from the in-class courses. This model is practised in South Africa, which encourages student participation by allowing students to earn ten notional hours (per academic credit that can be earned) up to a maximum of eighty service-learning hours.

Multidisciplinary teams consisting of experts in health and safety could offer additional lectures on these topics while the relevant physical practices can be learned on-site. Other lectures could provide information regarding regulations, safety and project management, but most of these aspects should be learned on-site or by examining case studies.

5.4. Conclusion

The high correlation among the four groups emphasizes the validity of the agreed list of Generic competences generated in Yaoundé (Cameroon) by all areas. It appears that generic competences which are ranked the highest complement each other. The highest competences emphasize ability to translate knowledge into practice, ability to evaluate, review and enhance quality, capacity for conceptual and critical thinking, analysis and synthesis and ability to use innovative and appropriate technologies. All four groups agreed that achievement of Generic competences is much lower than their importance. The Civil Engineering group agreed that a particular important obstacle in achieving these goals was the lack in African universities of infrastructure to support innovative learning; as a result, they experienced handicaps in achieving the broader goal of reform of curricula, teaching and learning.

Almost all Specific competences were considered of high importance, all competences were rated over 3.2. Results of all groups were relatively close as presented in the previous discussion of the specific lists of competences. The group identified the top five Specific competences and, also noticeable is that all five competences were related to very high professional areas in the practice of Civil Engineering: coordinate, supervise, control, translate, interpret, design and draw. All four groups agreed that the level of achievement of the specific competences is lower their importance would merit.

The Civil Engineering SAG generally agreed that the consultation results accurately reflect the reality in Civil Engineering programmes in African universities. Results of all groups were relatively close as presented in the previous discussion of the Generic and Specific lists of competences. The work group highlighted the need for fostering the above Generic and Specific competences in university-level Civil Engineering programmes in Africa and introduce them in the Meta-profile.

Chapter 6

Meta-profile of Civil Engineering in Africa

Helen Michelle Korkor Essandoh

6.1. Introduction

A meta-profile explains the relationship between generic and Subject-specific Competences and provides reference for the particular subject area regarding what is central, common and necessary in order for a given qualification to be recognised (Knight and Woldegiorgis, 2017). It categorises competences into major recognised components and illustrates their interrelationships (González and Yarosh, 2013), and also represents the importance and weight of the different factors involved (Knight and Woldegiorgis, 2017). A meta-profile therefore is a representation of the structure and combination of knowledge and competences which gives identity to a Subject Area (González and Yarosh, 2013).

Meta-profiles offer a new and different path to regionalisation of higher education and make it possible for degree profiles to receive regional and international recognition. In order for a qualification to be recognised outside the awarding institution it is necessary that the degree profile includes all the central components in the meta-profile (Knight and Woldegiorgis, 2017).

The meta-profile for Civil Engineering was developed during the first phase of the Tuning Africa Project. This chapter presents the meta-profile and a summary of the processes that were involved in its development. The profile herein described pertains to the knowledge and skills undergraduate Civil Engineering students must acquire during their undergraduate studies, and the competences they should be able to demonstrate upon graduation from their programmes of study. Further details can be obtained from Teklemariam *et al.* (2014).

6.2. Methodology Adopted in the Development of the Meta-profile

A multi-stage approach was adopted in the development of the meta-profile. It involved a review of Generic and Subject-specific Competences and rigorous analysis of the field of Civil Engineering and the requirements and expectations of industry with respect to competences each civil engineer should possess in order to perform effectively and efficiently in the four main fields of Civil Engineering, that is, Structural Engineering, Geotechnical Engineering, Transportation Engineering, and Hydraulics or Water Engineering.

The meta-profile was developed based on three core clusters of required knowledge in Civil Engineering in Africa identified from the educational programmes of the participating universities to be: design and analysis, construction and project management; eighteen generic competences previously agreed on by the five Subject Area Groups (SAGs) in the Tuning Phase 1 Project; and twenty Subject-specific Competences developed by the Civil Engineering SAG. The three core clusters in Civil Engineering were established by the SAG to be central in most Civil Engineering curricula in the participating universities and represented the areas in which each Civil Engineering student should acquire competences. The design and analysis cluster was to encompass all forms of design and analysis carried out within Structural, Geotechnical, Transportation or Hydraulic (Water) Engineering, which are considered as the main branches of Civil Engineering.

6.3. Clusters of Generic and Subject-specific Competences in Civil Engineering

The eighteen Generic Competences were first classified by related functions into six clusters: critical thinking, professionalism, creativity, communication, leadership and regulation as given in Table 6.1. The Appendix provides a summary of the meaning of the Generic Competences as given by the Civil Engineering SAG.

Table 6.1
Generic Competences in Civil Engineering

Cluster	Generic Competence	Code
Critical thinking	Ability for conceptual thinking, analysis and synthesis	G1
	Capacity for critical evaluation and self-awareness	G3
	Ability to translate knowledge into practice	G4
	Objective decision-making and practical cost-effective problem solving	G5
	Ability to evaluate, review and enhance quality	G16
Professionalism	Professionalism, ethical values and commitment to Ubuntu (respect for the well-being and dignity of others; good will)	G2
	Ability to work in an intra- and intercultural and/or international context	G14
	Ability to work independently	G15
Creativity	Capacity to use innovative and appropriate technologies	G6
	Flexibility, adaptability and ability to anticipate and respond to new situations	G9
	Ability for creative and innovative thinking	G10
Communication	Ability to communicate effectively in official/national and local languages	G7
	Ability to learn how to learn and capacity for lifelong learning (continued development)	G8
	Communication and interpersonal skills	G12
Leadership	Leadership, management and teamwork skills	G11
	Commitment to preserve and add value to the African identity and cultural heritage	G18
Regulation	Environmental and economic consciousness	G13
	Self-confidence, entrepreneurial spirit and skills	G17

Adapted from Teklemariam *et al.*, 2014.

Similar to the Generic Competences, the Subject-specific Competences were reorganised from the nine master groups of competences comprising analysis, design, creativity, management, quality management, leadership, communication, sustainability and regulation, previously established by the group (Table 6.2), into six clusters of critical thinking and synthesis, creativity, leadership, management, communication and regulation as shown in Table 6.3.

Table 6.2
Subject-specific Competences in Civil Engineering

Cluster	Subject-specific Competence	Code
Analysis	Ability to analyse data or information (e.g., data from surveys, soils, etc.)	C7
	Ability to identify the need for construction by type and structure. Ability to identify different options for achieving construction	C8
	Ability to analyse and make decisions based on mathematics and other abstract principles	C13
Design and analysis	Ability to design, quantify and calculate parameters and capacity to model and simulate systems, structures, projects and processes	C3
Design and communication	Ability to analyse, reconfigure and apply relevant drawings, data and technology. Ability to transmit project requirements into sketches and explain them to clients	C4
Creativity	Skills in developing new, appropriate and sustainable construction technologies and materials	C16
Management	Ability to coordinate, manage, supervise and control construction	C1
	Knowledge to reconstruct, maintain, rehabilitate, and renovate infrastructure	C5
	Ability to manage basic construction and programme principles	C9
	Knowledge of plant and equipment	C18
	Basic understanding of contractual and financial management, including insurance and guarantees	C19

Cluster	Subject-specific Competence	Code
Quality management	Ability to test the quality of materials	C11
	Ability to manage and address defects and quality issues	C12
Management and regulations	Ability to finalise financial implications, identify legal responsibilities and operate within appropriate frameworks	C17
Leadership	Ability to control costs, quality and time required for construction	C6
Communication	Ability to translate and interpret data and/or drawings into actual construction	C2
	Ability to develop effective and professional interactions with experts in other professions and to achieve well-integrated solutions	C15
Regulations	Commitment to health and safety measures. Ability to introduce and maintain safety measures in construction and materials	C10
	Knowledge of national and international construction standards	C14
Regulations and sustainability	Skills in environmental and social impact assessment, knowledge about the context and the challenges of development	C20

Adapted from Teklemariam *et al.,* 2014.

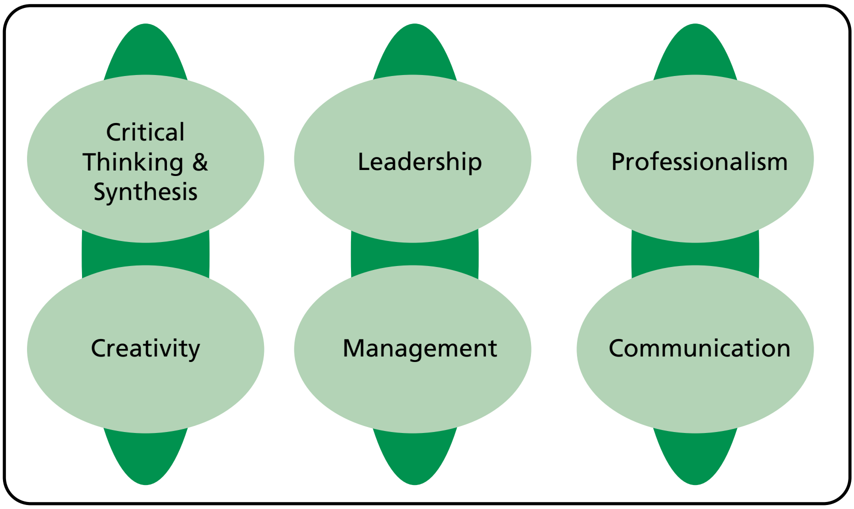
Table 6.3
Clusters of Subject-specific Competences in Civil Engineering

Cluster	Subject-specific Competence
Critical thinking and synthesis	C3, C4, C7, C8, C13
Creativity	C16
Leadership	C6
Management	C1, C5, C9, C11, C12, C17, C18, C19, C20
Communication	C2, C4, C15
Regulation	C10, C14, C17

Adapted from Teklemariam *et al.,* 2014.

The six clusters of competences were further grouped into mega-clusters as shown in Figure 6.1, according to their complementary roles as:

- Critical thinking and synthesis, and creativity;
- Leadership and management; and
- Professionalism and communication.

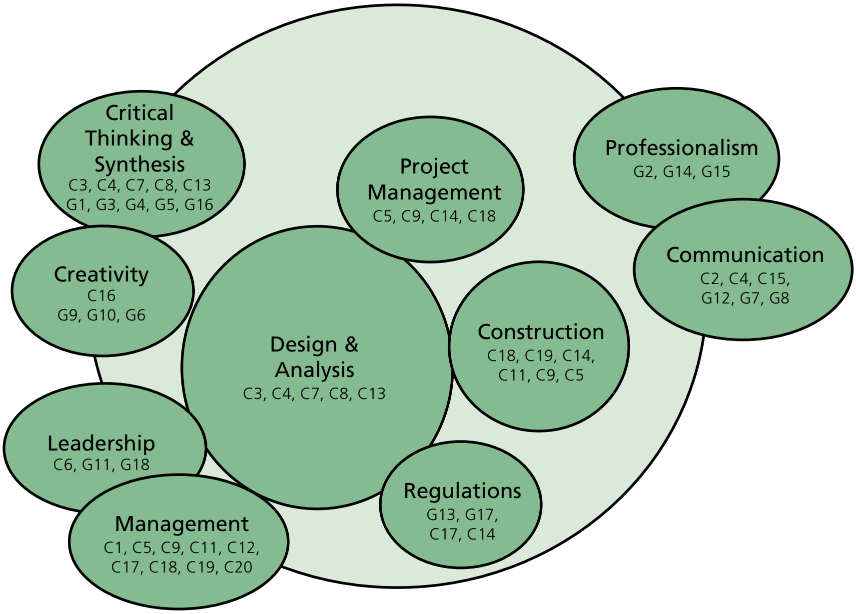


Source: Teklemariam *et al.*, 2014.

Figure 6.1
Mega-clusters of Generic and Subject-specific Competences in Civil Engineering

6.4. Meta-profile of Civil Engineering

The Civil Engineering meta-profile (Figure 6.2) was set up by combining the mega-clusters of Generic and Subject-specific Competences with the three core clusters in Civil Engineering into a knowledge sphere. Regulation was included as a core competence in the meta-profile to facilitate degree portability and international equivalence.



Source: Teklemariam *et al.,* 2014.

Figure 6.2
Civil Engineering Meta-profile linking Generic and Subject-specific Competences

6.5. Weighting of Core Areas of Curriculum

Recommendations made by the working group for weightings to be assigned to the various areas of the Civil Engineering curriculum are given in Table 6.4. Construction and project management were assigned much lower weights than design and analysis because it was the view that in most universities the aforementioned courses were usually offered as separate programmes of study. Its inclusion therefore in the Civil Engineering curriculum and the level to which it should be taught was deemed necessary only to a basic level to serve as a base for further studies in construction management and project management.

Table 6.4
Recommended weightings for areas of curriculum

Area of curriculum	Weight (%)
Design and analysis	80
Construction	8
Project management	8
Regulation	4

6.6. Gaps in Existing Curricula

The working group noted, upon comparison of the newly developed meta-profile with existing curricula, that there are gaps between the proposed Tuning meta-profile and the Civil Engineering curricula offered in most of the participating universities. Existing curricula were lacking in both Generic and Subject-specific Competences. The exception was the curriculum of University of Pretoria, South Africa, where the meta-profile was found to have no key elements missing and was well aligned with the requirements of the Engineering Council South Africa (ECSA). Table 6.5 shows the gaps between the meta-profile and the curriculum followed in the participating universities. No information was available for Cameroon and South Sudan.

In incorporating the agreed Generic and Subject-specific Competences into existing curricula, most universities envisaged that the Generic Competence of professionalism, ethical values and commitment to Ubuntu would pose some challenges considering that the term "Ubuntu" was unfamiliar to universities outside Southern and Eastern Africa. There would therefore be the need for a proper definition of the term to facilitate the process.

Table 6.5
Gaps in Civil Engineering meta-profile
and existing curricula at participating universities

Competence	Algeria	Botswana	DR Congo	Ethiopia	Kenya	Nigeria	Tanzania	South Africa
Design and analysis	C5					C4		NIL
Project management	C4				C5, C18	C5		
Construction	C4				C18, C5	C5		
Regulations	G13, C20	G17	G13, G17, C17, C14	C20		G13		
Critical thinking and synthesis	C16, G16					C4	C3	
Creativity			G6					
Leadership	G18	G18		G18	C6, G18			
Management	C5				C5, C18	C5	C18	
Professionalism	G2		G2	G2	G2, G14			
Communication	C4				G7, G18	C4		

Source: Teklemariam *et al.*, 2014.

6.7. Conclusion

The Tuning Project has facilitated the development of meta-profiles for Civil Engineering in Latin America and Africa, among others. The meta-profile developed by the Tuning Africa SAG offers a very good opportunity for harmonising curricula and minimising conflicts regarding recognition of qualifications across the African continent. Gaps and discrepancies in curricula can easily be bridged by the incorporation of the meta-profile in curriculum review processes across Africa.

Although some differences exist between competences for Latin America and Africa, most of the elements of cognitive, social and interpersonal skills as well as technological and international dimensions as captured in the Latin American experience (Guerrero Spínola *et al.,* 2014) can be identified in the African meta-profile. This gives the opportunity for easier integration of qualifications between the two continents.

Chapter 7

Comparison of Meta-profile at Regional and Global Level

Oagile Kanyeto

7.1. The African Civil Engineering Meta-profile Compared with Findings in other Regions

As explained in Chapter 6, the Civil Engineering Meta-profile developed by the Civil Engineering Subject Area Group (SAG) members was compared with the existing curricula at their respective universities to identify any gaps. Although Civil Engineering programmes were found to be not identical in the different regions represented in the Civil Engineering SAG, a strong convergence was noted in the characteristics of the undergraduate course content (Teklemariam *et al.,* 2014). Most Civil Engineering programmes represent one of two major models: (1) a broad-based programme that allows the graduate either to embark immediately on a profession, or (2) preparation for entering a specialised master's programme, such as Transportation Engineering. Members of the Tuning Africa SAG in Civil Engineering compared existing curriculum in Africa to the other existing Tuning models in Latin America, Europe and Russia. The following observations were made: In Latin America (Guerrero Spínola *et al.,* 2014), risk management is seen as an essential part of the Civil Engineering curriculum with a focus in the syllabus on construction. Latin American academic experiences are designed to provide a higher level of hands-on internships in conjunction with classroom instruction, while in Africa the practical experience mainly comes during professional on-the-job training. An exception is the qualified internship period currently employed in a few countries. The African Civil Engineering group was much impressed by and interested in the Latin American and European approach of working with level descriptors related to the competences and defined according to study years. Latin America has a precise catalogue of defined competences for Engineering in a broader sense. Another characteristic of Latin America competences is that they were systematised in advance into social, cognitive, technological and ethical categories and groupings, while the African group formed clusters as a step following the identification of their Generic and Subject-specific Competences. In general, the Latin American and African meta-profiles contain very similar competences, as can be seen from Table 7.1. The meta-profiles only differ in terms of clustering of the competences, as demonstrated by Fig.7.1 and Fig.7.2.

Table 7.1
Subject-specific Competences within the African and Latin American Meta-profiles

African Subject-specific Competences	Latin American Subject-specific Competences
1. Ability to coordinate, manage, supervise and control construction 2. Knowledge to reconstruct, maintain, rehabilitate, and renovate infrastructure 3. Ability to manage basic construction and programme principles 4. Knowledge of plant and equipment 5. Basic understanding of contractual and financial management, including insurance and guarantees 6. Ability to translate and interpret data and/or drawings into actual construction 7. Ability to develop effective and professional interactions with experts in other professions and to achieve well-integrated solutions 8. Ability to design, quantify, and calculate parameters and capacity to model and simulate systems, structures, projects and processes	1. Apply knowledge of basic science and civil engineering science. 2. Identify, assess and implement suitable technologies according to their context. 3. Create, innovate and undertake business ventures in order to contribute towards technological development. 4. Devise, analyse, plan and design civil engineering work. 5. Plan and schedule civil engineering work and services. 6. Build, supervise, inspect and assess civil engineering work. 7. Operate, maintain and renovate civil engineering work. 8. Assess and alleviate the environmental and social impact of building work.

African Subject-specific Competences	Latin American Subject-specific Competences
9. Ability to analyse, reconfigure and apply relevant drawings, data and technology. Ability to transmit project requirements into sketches and explain them to clients 10. Ability to control costs, quality and time required for construction 11. Ability to analyse data or information (for example, data from surveys, soils etc. 12. Ability to identify the need for construction by type and structure. Ability to identify different options for achieving construction 13. Ability to analyses and make decision based on mathematics and other abstract principles 14. Commitment to health and safety measures. Ability to introduce and maintain safety measures in construction and materials 15. Knowledge of national and international construction standards 16. Ability to test the quality of materials 17. Ability to manage and address defects and quality issues 18. Skills in developing new, appropriate and sustainable construction technology and materials 19. Ability to finalize financial implications, identify legal responsibilities and operate within appropriate frameworks. 20. Skills in environmental and social impact assessment, knowledge about the context and the challenges of development	9. Shape and simulate civil engineering systems and processes. 10. Manage and supervise human resources. 11. Administer material resources and equipment. 12. Understand and associate legal, economic and financial concepts with decision-making, project management and civil engineering work. 13. Use spatial abstraction and graphic representation. 14. Propose solutions that may contribute towards sustainable development. 15. Prevent and assess risks attached to civil engineering work. 16. Handle and interpret field information. 17. Use information technologies, software and tools for civil engineering. 18. Interact with multidisciplinary groups and provide comprehensive civil engineering solutions. 19. Use quality control techniques in civil engineering materials and services.

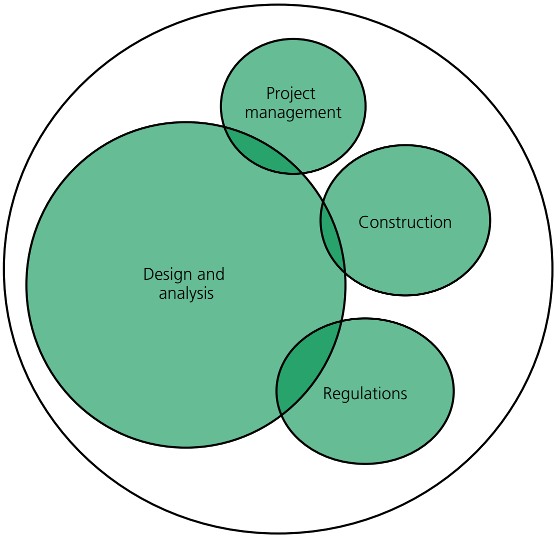


Figure 7.1
African Meta-profile for the Civil Engineering Subject Area

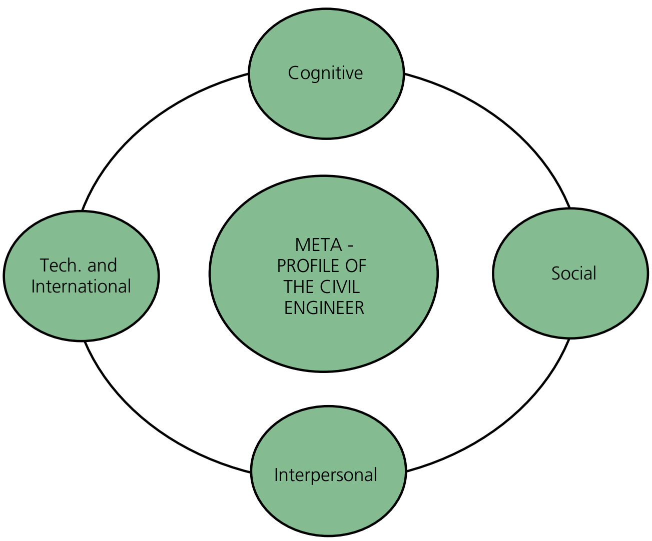


Figure 7.2
Latin American Meta-profile for the Civil Engineering Subject Area

At the time of the study, the Russian Tuning experience had not yet included Civil Engineering, but it did present its group work on Environmental Engineering. The Russian Tuning approach differentiated amongst three categories of competences:

- General competences for Engineering (broadly based programmes).
- General competences for Environmental Engineering.
- Subject-specific Competences for Environmental Engineering.

As it can be noted above, the Russian Tuning approach uses the term "general" competences as opposed to "generic" competences.

The large country of Russia (the Russian Federation) did not distinguish between its regions in its programmes and standards, so the programmes were widely homogenous. The Russian Tuning Environmental Engineering SAG identified "quality" as a central issue as opposed to the African Tuning SAG which identified "design and analysis" as the fundamental aspect.

The European Tuning approach defines a "subject frame" system as opposed to the meta-profile (González and Yarosh, 2014). The subject frame is a brief list of topics which should be known to every graduate of any civil engineering faculty irrespective to her/his specialisation and the place of study. The approved list of topics must lead to defined outcomes in the form of competencies, which every graduate of a BSc or MSc course should achieve. The lists of subject-specific competences were proposed by the Body of Knowledge Committee (BOK) of the American Society of Civil Engineers (ASCE). This Committee was in charge of defining the BOK needed to enter the practice of civil engineering at the professional level (licensure) in the 21st Century. Although the European approach does not make use of a meta-profile cluster system, there is high level of similarities between the two lists of subject-specific competences, as clearly demonstrated in Table 7.2.

Table 7.2
Comparison of Subject-specific Competences between African and European Tuning SAG's

African Subject-specific Competences	European Subject-specific Competences
1. Ability to coordinate, manage, supervise and control construction 2. Knowledge to reconstruct, maintain, rehabilitate, and renovate infrastructure 3. Ability to manage basic construction and programme principles 4. Knowledge of plant and equipment 5. Basic understanding of contractual and financial management, including insurance and guarantees 6. Ability to translate and interpret data and/or drawings into actual construction 7. Ability to develop effective and professional interactions with experts in other professions and to achieve well-integrated solutions 8. Ability to design, quantify, and calculate parameters and capacity to model and simulate systems, structures, projects and processes 9. Ability to analyse, reconfigure and apply relevant drawings, data and technology. Ability to transmit project requirements into sketches and explain them to clients 10. Ability to control costs, quality and time required for construction 11. Ability to analyse data or information (for example, data from surveys, soils, etc.) 12. Ability to identify the need for construction by type and structure. Ability to identify different options for achieving construction 13. Ability to analyses and make decision based on mathematics and other abstract principles	1. An ability to apply knowledge of mathematics and other basic subjects 2. An ability to use knowledge of mechanics, applied mechanics and of other core subjects relevant to civil engineering 3. An ability to apply knowledge in a specialised area related to civil engineering 4. An ability to identify, formulate and solve civil engineering problems 5. An ability to design a system or a component to meet desired needs 6. An ability to design and conduct experiments, as well as analyse and interpret data 7. An ability to identify research needs and necessary resources 8. An ability to use the techniques, skills and modern engineering tools, including IT, necessary for engineering practice 9. An understanding of the elements of project and construction management 10. An understanding of ethical commitment and professional responsibility of civil engineers 11. An understanding of the interaction between technical and environmental issues and ability to design and construct environmentally friendly civil engineering works

African Subject-specific Competences	European Subject-specific Competences
14. Commitment to health and safety measures. Ability to introduce and maintain safety measures in construction and materials 15. Knowledge of national and international construction standards 16. Ability to test the quality of materials 17. Ability to manage and address defects and quality issues 18. Skills in developing new, appropriate and sustainable construction technology and materials 19. Ability to finalise financial implications, identify legal responsibilities and operate within appropriate frameworks. 20. Skills in environmental and social impact assessment, knowledge about the context and the challenges of development	12. An understanding of the impact of solutions for civil engineering works in a global and societal context 13. An ability to communicate effectively 14. An ability to function in multidisciplinary teams 15. An understanding of the role of the leader and leadership principles and attitudes 16. A recognition of the need for, and the ability to engage in, life-long learning

7.2. Conclusion

Civil Engineering Meta-profile developed by the Civil Engineering Subject Area Group (SAG) members was found to be aligned with existing curricula at most of the universities that were represented in the group, especially where the curricular was based on requirements of Professional Engineering Institutions or Regulators. In general, larger variation between institutions existed over Generic Competences as opposed to Subject-specific Competences.

Although Civil Engineering meta-profiles were found to be not identical between Africa and other regions, a strong convergence was noted with regard to the Subject-specific Competences for undergraduate programmes. The Latin American meta-profile was found to be very similar to the African one in terms of its structure, but different in terms of emphasis on knowledge areas. The European approach differed with both the African and Latin American in the sense that Europe did not specify a meta-profile, but defined a subject frame system.

In conclusion, the African meta-profile was found to fit well with profiles from other regions of the Tuning Academy, and is well aligned with curricular of most African universities.

Chapter 8

Examples of Revised / New Programmes

Hassan Ibrahim Mohamed Mohamed

8.1. Peer Assessment of Revised/New Programmes

As a task in applying knowledge learnt in the preparation of academic programmes using the Tuning Methodology, each member of the Civil Engineering Subject Area Group (SAG) either revised an existing programme or developed a new one. The Group then discussed and agreed on a tool for peer review of the programmes to ensure that all the salient features for a programme meeting the Tuning Methodology criteria are included. The tool is shown in Table 8.1. As an illustration, a sample programme prepared and implemented at Assiut University, Egypt, is presented in the following sections.

Table 8.1
Peer Review Assessment Form for Revised or New Programmes

<table>
<tr><th>No.</th><th>Key aspects</th><th colspan="3">Description</th></tr>
<tr><td>(a)</td><td colspan="2">Name of the revised programme</td><td colspan="2"></td></tr>
<tr><td>(b)</td><td colspan="2">Explain the social need of the revised programme</td><td colspan="2"></td></tr>
<tr><td>(c)</td><td colspan="2">Description of the degree profile of the revised programme in terms of generic and/or subject-specific competences</td><td colspan="2"></td></tr>
<tr><td>(d)</td><td colspan="2">Definition of the length and level of the programme</td><td colspan="2"></td></tr>
<tr><td>(e)</td><td colspan="2">Identification of the future fields, sectors of employment/occupation of graduates</td><td colspan="2"></td></tr>
<tr><td rowspan="9">(f)</td><td rowspan="9">Definition of the competences of the revised programme</td><td>Competence</td><td colspan="2">Definition of competence</td></tr>
<tr><td>C1</td><td colspan="2"></td></tr>
<tr><td>C2</td><td colspan="2"></td></tr>
<tr><td>C3</td><td colspan="2"></td></tr>
<tr><td>C4</td><td colspan="2"></td></tr>
<tr><td>C5</td><td colspan="2"></td></tr>
<tr><td>C6</td><td colspan="2"></td></tr>
<tr><td>C7</td><td colspan="2"></td></tr>
<tr><td>C8</td><td colspan="2"></td></tr>
<tr><td rowspan="9">(g)</td><td rowspan="9">Check-up of link of the competences with the agreed meta-profile</td><td>Competence</td><td>Definition of competence</td><td>Agreed meta-profile</td></tr>
<tr><td>C1</td><td></td><td rowspan="8">Core areas:</td></tr>
<tr><td>C2</td><td></td></tr>
<tr><td>C3</td><td></td></tr>
<tr><td>C4</td><td></td></tr>
<tr><td>C5</td><td></td></tr>
<tr><td>C6</td><td></td></tr>
<tr><td>C7</td><td></td></tr>
<tr><td>C8</td><td></td></tr>
</table>

<table>
<tr><th>No.</th><th>Key aspects</th><th colspan="10">Description</th></tr>
<tr><td>(h)</td><td>Specification of the level of the competences described in the revised degree profile</td><td colspan="10"></td></tr>
<tr><td>(i)</td><td>Description of the expected learning outcomes related to the competences</td><td colspan="10"></td></tr>
<tr><td>(j)</td><td>Description of the methodology of learning strategy for achieving the competences</td><td colspan="10"></td></tr>
<tr><td rowspan="8">(k)</td><td rowspan="8">Specification of the units of the programme (courses and modules)</td><td>Year</td><td colspan="3">Semester</td><td colspan="2">Course Code</td><td colspan="2">Course Title</td><td colspan="2">Total Credit Hours</td></tr>
<tr><td>ONE</td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td></td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
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<tr><td></td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>TWO</td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="6">(l)</td><td rowspan="6">Check-up of the consistency of the programme with the competences, the expected learning outcomes and activities that will lead you to the learning outcomes (overall consistency of the programme)</td><td colspan="2" rowspan="2">Expected Learning Outcomes</td><td colspan="8">Competences</td></tr>
<tr><td>C1</td><td>C2</td><td>C3</td><td>C4</td><td>C5</td><td>C6</td><td>C7</td><td>C8</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="7">(m)</td><td rowspan="7">Check the consistency of the courses with the competences</td><td colspan="2" rowspan="2"></td><td colspan="8">Competences</td></tr>
<tr><td>C1</td><td>C2</td><td>C3</td><td>C4</td><td>C5</td><td>C6</td><td>C7</td><td>C8</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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8.2. Undergraduate Programme in Construction Engineering and Project Management, Assiut University- Egypt

8.2.1. *Introduction*

The Arab region has an urgent need of well qualified engineers in Construction Engineering and Project Management in order to realise its sustainable development programme. New appropriate curricula based on the credit system have been designed and implemented since the academic year 2016-2017 by the Faculty of Engineering Council. The teaching staff consists of academics and highly experienced professionals in Construction Engineering and Project Management who can transmit to graduates both theoretical aspects and up-to-date technology.

Awarded Degree

Assiut University awards the Bachelor Degree in "Construction Engineering and Project Management" according to the recommendation of the Faculty of Engineering Council.

General Courses

The syllabus comprises the following transversal courses:

Technical English Language - Introduction to Engineering Sciences - Human Rights - Engineering Economics - Communications and Presentation Skills - Ethics of the Engineering Profession and its laws - Writing of Technical Reports - Environmental Protection, Marketing, Accounting and Cost and Feasibility Study.

8.2.2. *Study System and Curriculum Symbols*

The Construction Engineering and Project Management degree is a ten semester or five year programme based on the credit system. The teaching language is English.

1. Credit hour: a scientific unit weight for a lecture with a duration of not less than fifty minutes per week, or for tutorial or experimental lessons of between 2 and 3 hours per week.

Table 8.2
Student level
(after the Committee of Engineering Study Sector, May 2013)

Study level	Student level	Achieved credit hours
0	Freshman	From 0% to 20%
1	Sophomore	More than 20 % less or equal to 40%
2	Junior	More than 40 % less or equal to 60%
3	Senior -1	More than 60 % less or equal to 80%
4	Senior -2	More than 80% to 100%

Main semester: the duration of a main semester is 14 weeks.

2. Academic year: an academic year consists of two main semesters and a summer semester which has seven weeks with duplicated lectures and tutorial hours.

3. Study plan: this comprises Mandatory and Elective groups of courses and study activities (theoretical, tutorial or experimental). Success in these groups leads to the award of the Bachelor degree in "Construction Engineering and Management of Projects".

4. Pre-requisite: this is a course that a student must validate before registering in another one for which it is a requirement.

5. Workload: this is the number of credit hours allocated to courses in a main semester. Its average is 18 credit hours with a minimum of 12 credit hours and a maximum of 21 credit hours per week. For summer semester, it is 6 credit hours.

6. Academic guidance: a staff member is chosen by the academic executive committee to help the students for the choice of courses according to the study plan.

7. Year work marks: these are the total marks scored by a student in small tests, reports and scientific activities related to a certain course.

8. Final examination: this is the final examination held once at the end of the semester.

9. Final examination mark: this is the mark scored by a student in the final examination in each course unit. The student is considered to have failed if he/she has received a mark lower by 30% or more from the upper mark of this examination.

10. Final mark: this is the sum of year work and final examination marks for each course.

11. Grade: this is a letter symbol corresponding to the final mark of a student for any course.

12. Accumulative general grading: this is a description of the scientific level of a student during the entire duration of study in the Faculty.

13. Summer Internship: during summer vacation, students must do an industrial internship in a construction company or society. The programme of the internship is decided by the academic executive committee of the Faculty. Two internships are needed before graduation. The duration of each internship should not be less than two weeks.

- During summer vacation, a student is allowed to have the first internship of about two weeks after the academic level (1). The student must pass two semesters after the first internship before taking the next one.
- The internship must be carried out under the supervision of staff members. Student must submit a report to the academic executive committee for evaluation.
- The student, after the defense of her/his Bachelor thesis, is evaluated with a Pass or Fail.

14. Student Enrollment in the Programme

- Students enroll in the Construction Engineering and Management of Projects Programme after a preparatory year in a Faculty of Engineering of a Government University in Egypt.
- The programme accepts students who have succeeded in the preparatory year in Assiut University, Faculty of Engineering or other universities in Egypt according to the Assiut Faculty of Engineering rules.

15. Student Mobility in the Programme

- In the Construction Engineering and Project Management Programme there are two systems: the credit hour system and the two-semester system. A student who does not obtain 60% of the total credit needed for graduation in the credit hour system is transferred by the Faculty of Engineering Council to the two-semester system. The student must be accepted in the department at his enrolment year.

- A student who succeeds in the two-semester system is allowed to move to the Construction Engineering and Project Management Programme.

- A student in the credit hour system can move to the two-semester system only in the department where he/she was enrolled after his/her preparatory year.

The following tables may be used for the equivalent evaluation between the credit hour system and the two semester system.

Table 8.3
The change from credit hour system to two-semester system
(from the Committee of Engineering Study Sector, May 2013)

From credit hour system			To two-semesters system	
Student percent %	**Points**	**Grading**	**Equivalent grading**	**Equivalent percent %**
Greater than 97	4.0	A^{+}	Excellent	98
From 93 to < 97	4.0	A		93
From 89 to < 93	3.7	A^{-}		88
From 84 to < 89	3.3	B^{+}	Very good	83
From 80 to < 84	3.0	B		78
From 76 to < 80	2.7	B^{-}	Good	73
From 73 to < 76	2.3	C^{+}		70
From 70 to < 73	2.0	C		67
From 67 to < 70	1.7	C^{-}	Pass	63
From 64 to < 67	1.3	D^{+}		58
From 60 to < 64	1.0	D		53
Less than 60	0.0	F	Fail	Less than 50

Table 8.4
The change from two-semester system to credit hour system
(from the Committee of Engineering Study Sector, May 2013)

From two-semesters system		To credit hours system	
Student grading	**Student percent %**	**Number of Points**	**Equivalent grading**
Excellent	From 95 to 100	4.0	A+
	From 90 to < 95	4.0	A
	From 85 to < 90	3.7	A−
Very good	From 80 to < 85	3.3	B+
	From 75 to < 80	3.0	B
Good	From 71 to < 75	2.7	B−
	From 68 to < 71	2.3	C+
Pass	From 65 to < 68	2.0	C
	From 60 to < 65	1.7	C−
	From 55 to < 60	1.3	D+
	From 50 to < 55	1.0	D
Fail	From 0 to < 50	0.0	F

16. Duration of study and the Graduation

- Duration of study in the programme is ten main semesters. A student can graduate after nine semesters if he/she fulfills the graduation requirements.

- The maximum study duration is twenty main semesters in which a student is registered without the approved suspended semesters by the Faculty Council.

- The student graduation may take place at the end of any semester as follows:

  1. *January Graduation:* For students who fulfill the graduation requirements in the first semester of the graduation year.

  2. *June Graduation:* For students who fulfill the graduation requirements in the second semester of the graduation year.

3. *September Graduation:* For students who fulfill the graduation requirements in the summer semester of the graduation year.

- At the graduation, the student is awarded a graduation certificate after the payment of the required fees. The certificate includes student accumulation (GPA) and Symbolic graduation project and its grade. If the graduated engineer needs a certificate with grades in the two semester system, he/she is awarded another certificate after payment of the required fees.

17. Study tuition fees

- The Supreme Council of Universities decides yearly the tuition fees for each credit hour after the suggestion of the University Council. These fees may increase yearly.

- The Faculty Council has the possibility to increase the yearly fees by 6-10% for the new students after approval of the University Council.

18. Schedule of study and registration

The academic year may have three semesters as scheduled:

- The first main semester: starts in September and lasts 14 weeks.

- The second main semester: starts in February and lasts 14 weeks.

- The third (summer) semester: starts in June and lasts 7 weeks, during which the study hours and the tuition fees are duplicated.

19. System of scientific evaluation of students

- Marks of each course may be divided into semester works (Tutorial / Experimental, written mid-term and final examination).

- The written mid-term exam is 20% of total marks while the final exam is not less than 40% of the same.

- Passing conditions of any course are:

1. The student must have at least 60% of total marks of the course.

2. The student must have at least 30% of total marks of the final written exam.

- The student must attend more than 75% of the lectures, tutorials and laboratory exercises for each course, in order to be allowed to write the final exam in the courses attended.

- The student is considered to have failed the courses if his/her total marks are less than 60% or if he/she did not attend the final written exam whatever the circumstances.

- Some student activities may be evaluated by pass/failed according to the academic executive committee's decision.

20. Admission and Withdrawing Conditions

- A student has the right to claim his tuition fees if he/she withdrew during the expected period, and is evaluated "W" in the course.

- A student has no right to claim his tuition fees if he/she withdrew after the expected period, and is evaluated "W" in the course.

- If a student is evaluated "W" in a course, he/she must resume the course enrollment and exams.

- Withdrawal from the whole semester must have the approval of the Faculty Council after the recommendation of the academic executive committee.

- If a student does not register during the expected period, the Department of Student Affairs sends a letter to the student's parent (Father, for example). If there is no response, the Faculty Council suspends his/her semester registration.

- The suspension of the semester of the student is considered as one of his/her chances to suspend studies (the allowable possibilities are two academic years or four semesters).

- If the suspension of a student exceeds two academic years or four semesters, he is excluded from the Faculty according to the regulations.

- A student has three weeks before examination period to seek permission from the Faculty council after he/she has introduced a request to the academic executive committee to be absent in a course exam. Otherwise, his evaluation is zero. But if permission is accepted, his/her semester work evaluation is considered for the next final exam.

- Mobility conditions between other universities and Assiut University are as follow:

  1. Courses chosen in another university must be compatible with those in this bylaw.

  2. 80% of total credit hours needed for graduation must be done in Assiut University, so also the last two semesters and the graduation project.

  3. In any case, the total number of accomplished semesters in another university and Assiut University must be greater or equal to nine.

21. Study suspension conditions and grading management

- A student receives a warning for poor academic performance if his/her GPA is less than 1.0.

- A student is dismissed if he/she has received three warnings during the first four semesters for poor performance. The University Council may allow a last chance.

- If the GPA of a student is less than 2.0 at the end of any semester, he/she receives a warning and is urged to improve GPA to at least 2.0.

- A student is dismissed if his/her GPA is less than 2.0 for six separate or successive semesters.

- A student is dismissed if he/she does not graduate after twenty main semesters.

- The faculty council may allow two main semesters to a student concerned in 4 to complete studies if he/she has obtained at least 80% of the total number of credits needed for graduation.

- A student is allowed to retake not more than five courses in which he/she scored no greater than B+ for the purpose of improving his GPA. The latest grade is considered and both grades are mentioned in his/her final record. The number of courses to be retaken can be increased in case it permits to prevent dismissal or in case it may ameliorate graduation requirements.

22. Courses registration conditions

A student, after consultation with his/her Academic Instructor and taking into consideration the pre- requisite, can register in the planned courses that he/she needs to study in each semester for credit hours between 12 and 21 under the following conditions:

- If the student's accumulated GPA is greater than or equal to 3.0 points, he/she can register up to 21 credit hours.

- If the student's accumulated GPA is greater or equal to 2.0 and less than 3.0 points, he/she can register up to 18 credit hours.

- If the student's accumulated GPA is less than 2.0 points, he can register up to 14 credit hours.

- A student can register in up to 6 credit hours and maximum three courses for summer semester.

23. Grading calculations

The grade of a student in each course is calculated as shown in the following table.

Table 8.5
Equivalence between grading systems
(after the Committee of Engineering Study Sector Revision)

Percent %	Symbol	Grading weight in points	Equivalent range in percentage %
Greater than 97	A^+	4.0	97-100
From 93 to < 97	A	4.0	93-96
From 89 to < 93	A^-	3.7	89-92
From 84 to < 89	B^+	3.3	84-88
From 80 to < 84	B	3.0	80-83
From 76 to < 80	B^-	2.7	76-79
From 73 to < 76	C^+	2.3	73-75
From 70 to < 73	C	2.0	70-72
From 67 to < 70	C^-	1.7	67-69
From 64 to < 67	D^+	1.3	64-66
From 60 to < 64	D	1.0	60-63
Less than 60	F	0.0	—

24. Semester GPA

Average sum of points of the total credit hours of the courses taken in a semester. The point can be calculated by multiplying the credit hours with the grading weight of each course that the student studied it accordance to the above table.

If the student repeated a course in which he failed, the last grade with maximum "B^+" is considered in the calculation of Semester GPA.

25. Accumulative GPA

Average sum of points on the total credit hours of all courses since the student enrolled in the university.

26. General grading

The general grade for accumulative GPA of the student according to his/her accumulative GPA can be calculated as follows:

- *Excellent:* If the accumulative GPA is greater than or equal to 3.7.
- *Very good:* If the accumulative GPA is greater than or equal to 3.0 and less than 3.7.
- *Good:* If the accumulative GPA is greater than or equal to 2.0 and less than 3.0.
- *Pass:* If the accumulative GPA is greater than or equal to 1.0 and less than 2.0.

27. Honors degree and grant

Proposed students for honors and grant must fulfill the following conditions:

a) Must not have received a Fail grade in any course nor repeat any course during the total academic years.

b) Must fulfill graduation requirements within the normal expected period.

c) Must obtain at least 60% of the graduation required credit hours in Assiut University.

   i) First class Honors degree: is awarded at graduation to a student who has academic accumulative GPA not less than 3.7 in all his/her academic years.

   ii) Second class Honors degree: is awarded at graduation to a student who has accumulative GPA greater than or equal to 3.0 and less than 3.7 in all his/her academic years.

Students who have GPA greater than 3.7 are awarded a discount in percentage of the tuition fees, proposed by the academic executive committee and approved by the higher executive committee.

28. Graduation Project

- A student cannot graduate unless he/she succeeds in his/her graduation project.
- Only students who have obtained 130 credit hours can register for the graduation project.
- After approval of the academic executive committee of the proposed graduation projects, supervisors of these projects are appointed among staff members.

29. Graduation Requirements

Students can graduate under the following conditions:

- Must pass successfully courses with a total of 180 credit hours and an accumulative GPA greater or equal to 2.0 including the graduation project.
- Courses sanctioned with Pass/Fail grade are not considered in the calculation of GPA; for example summer internship training.
- Must succeed in the Military training and education.
- Courses considered for calculating GPA must contain subjects that fulfill the requirements of (NARS) specifications on graduate engineers (see Article 21).
- These courses must also contain subjects that fulfill the University, Faculty, related department and programme specialist requirements according to NARS specifications. These requirements must include about 10% of elective courses. The programme should fulfill these requirements as shown in Article (21).

30. Additional Rules

i) The Faculty council may approve any subject which is not mentioned in the present bylaw, or may suggest recommendation to be approved by the University Council/Supreme Council of Universities.

ii) The rules of university law apply to any subject which is not mentioned in the present by law.

8.2.3. *Course Coding System*

Course Code consists of three letters followed by three numbers as follow:

Table 8.6
Code description

AAA	N1	N2	N3
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AAA	Three letters represent the department which has the responsibility to teach the course
HUM	Represents the Human Science
ARC	Represents the Architecture Engineering Science
CVE	Represents the Civil Engineering Science
ELC	Represents the Electrical Engineering Science
MEC	Represents the Mechanical Engineering Science
MIE	Represents the Mining Engineering Science
ENG	Represents the General Engineering Science
MTH	Represents the Mathematical Science
PHY	Represents the Physics
CPM	Represents the Construction Engineering and Management of Projects Science
N1	One number represents Academic level
(0)	Level (0), Freshman
(1)	Level (1), Sophomore
(2)	Level (2), Junior
(3)	Level (3), Senior -1
(4)	Level (4), Senior -2
N2	Number represents the course type (Mandatory or Elective)
(1)	For Mandatory courses
(0)	For Elective courses
N3	Number consists of two digits, representing the course arrangement in its specialty.

The Required Courses and Credit Hours

The programme courses are designed to fulfill the University, Faculty, Department and Programme required percentages as shown in the following table in comparison with the required ones which were decided by the Supreme Council of Universities in April 2009. The percentages include 10-12% elective courses

Table 8.7
Required courses and hours

Required			Fulfilled by the programme		
			Hours		Total %
Type	Hours	%	Mandatory	Elective	
University requirements	18	10	16	2	10.00
Faculty requirements	45	25	43	0	23.89
Department requirements	63	35	60	3	35.00
Programme requirements	54	30	43	13	31.11
Total	**180**	**100**	**18**	**162**	**100.00**

Table 8.8
Courses for fulfillment of the University requirements

Code No	Course Title	Credit Hours
HUM0101	Technical English Language	2
HUM0102	Introduction to Engineering Science	2
HUM0103	Human Rights	2
HUM0104	Engineering Economics	2
HUM1105	Communications and Presentation Skills	2
HUM1106	Ethics of Engineering profession and its law	2
HUM2107	Writing of Technical Reports	2
HUM20 (01-03)	Elective Course (1)	2
HUM3108	Environmental Protection	2
Total		18 with 10%

Table 8.9
Courses for fulfillment of the Faculty requirements

Code No	Course Title	Credit Hours
MTH0101	Mathematics (1): Algebra and Analytical Geometry	3
MTH0102	Mathematics (2): Integral and Differential Calculus	3
MTH1103	Mathematics (3): Differential Equations	3
PHY0101	Physics (1)	3
PHY0102	Physics (2)	3
ENG0101	Engineering Drawing	3
ENG0102	Descriptive Projection	3
MEC1101	Principles of Mechanical Engineering	2
MIE0101	Engineering Chemistry	3
MIE0102	Engineering Geology	3
ELC0101	Introduction to Computers and Programming	3
ELC1102	Principles of Electrical Engineering	2
CVE0102	Engineering Mechanics	3
CPM 4118	Graduation Project (A)	3
CPM 4119	Graduation Project (B)	3
Total		43 with 23.89%

Table 8.10
Courses for fulfillment of the Department requirements

Code No	Course Title	Credit Hours
CVE0101	Computer Aided Civil Drawing	3
CVE1103	Theory of Structures (1)	3
CVE1104	Properties and Strength of Materials (1)	3
CVE1105	Hydraulics (1)	3
CVE1106	Numerical Analysis	3
CVE1107	Surveying (1)	3
CVE2108	Theory of Structures (2)	3
CVE2109	Hydraulics (2)	3
CVE2110	Soil Mechanics	3
CVE2111	Reinforced Concrete (1)	3
CVE2112	Steel Constructions	3
CVE2113	Surveying (2)	3
CVE2114	Properties and Strength of Materials (2)	3
CVE3115	Roads and Traffic Engineering	3
CVE3116	Foundations	3
CVE2117	Reinforced Concrete (2)	3
CVE3118	Irrigation Engineering and Its Structures Design	3
CVE3119	Theory of Structures (3)	3
CVE3120	Reinforced Concrete (3)	3
CVE4121	Sanitary and Environmental Engineering	3
CVE30 (01-04)	Elective Course (3)	3
Total		63 with 35%

Table 8.11
Courses for fulfillment of the Programme requirements

Code No	Course Title	Credit Hours
CPM 1101	Introduction to Construction Engineering	2
CPM 1102	Construction Strategy	2
CPM 1103	Natural Recourses and Its Management	2
CPM 2104	Planning and Control of Construction Projects	3
CPM 2105	Management Bases	2
CPM 2106	Construction Technology and Its Management	3
CPM 3107	Protection from Risks Associated to Construction Projects	3
CPM 3108	Advanced Construction Technology	3
CPM 3109	Quantities and Project Costs Control	3
CPM 4110	Construction Management and Project Control	2
CPM 4111	Management of Energy Resources in Construction Sites	2
CPM 4112	Contractors and Specifications	3
CPM 4113	Quality Control	3
CPM 4114	Human Factors in Engineering and Management of Construction	2
CPM 4115	Temporary Structures and Frame Work Design	3
CPM 4116	Tunnels and Networks Engineering	3
CPM 4117	Risk Management	2
CPM 30 (01-04)	Elective Course (2)	3
CPM 30 (05-08)	Elective Course (4)	3
CPM 30 (09-11)	Elective Course (5)	2
CPM 40 (12-13)	Elective Course (6)	3
CPM 40 (14-17)	Elective Course (7)	2
Total		56 with 31.11%

Plan of Study Courses

Plan of study is the group of study courses and other requirements needed for student graduation. The lecture and tutorial and / or experimental study hours may be different from one course to another. In order to discriminate between them each one has a certain credit hours and a code number as shown in the following guidance tables:

Table 8.12
Guidance table at level 0, semester 1

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
HUM0101	Technical English Language	2	2	2	—	Consult with Instructor
MTH0101	Mathematics (1)	3	2	2		Consult with Instructor
PHY0101	Physics (1)	3	2	2		Consult with Instructor
ENG0101	Engineering Drawing	3	1	3		Consult with Instructor
ENG0102	Descriptive Projection	3	2	2		Consult with Instructor
HUM0102	Introduction to Engineering Science	2	2	2		Consult with Instructor
HUM0103	Human Rights	2	2	3		Consult with Instructor
Total		18	13	8		

Table 8.13
Evaluation guidance, level 0 semester 1

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions			
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam
HUM0101	Technical English Language	2	20	30	—	50
MTH0101	Mathematics (1)	3	20	30	—	50
PHY0101	Physics (1)	3	20	30	—	50
ENG0101	Engineering Drawing	3	20	30	—	50
ENG0102	Descriptive Projection	3	20	30	—	50
HUM0102	Introduction to Engineering Science	2	20	20	10	50
HUM0103	Human Rights	2	20	30	—	50
Total						

Table 8.14
Guidance table at level 0, semester 2

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
MTH0102	Mathematics (2)	3	2	2	MTH0101	Mathematics (1)
CVE0101	Computer Aided Civil Drawing	3	1	4	ENG0101	Engineering Drawing
CVE0102	Engineering Mechanics	3	2	2	MTH0101	Mathematics (1)
PHY0102	Physics (2)	3	2	2	PHY0101	Phys (1)
MIE0101	Engineering Chemistry	3	2	2		Consult with Instructor
ELCC0101	Introduction to Computers and Programming	3	2	2		Consult with Instructor
HUM0104	Engineering Economics	2	2	—		Consult with Instructor
Total		18	20	13	14	

Table 8.15
Evaluation guidance at level 0, semester 2

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
MTH0102	Mathematics (2)	3	20	30	—	50	100
CVE0101	Computer Aided Civil Drawing	3	20	30	—	50	100
CVE0102	Engineering Mechanics	3	20	30	—	50	100
PHY0102	Physics (2)	3	20	30	10	40	100
MIE0101	Engineering Chemistry	3	20	30	10	40	100
ELCC0101	Introduction to Computers and Programming	3	20	20	10	50	100
HUM0104	Engineering Economics	2	20	30	—	50	100
Total							700

Table 8.16
Guidance table at level 1, semester 3

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CVE1103	Theory of Structures (1)	3	2	2	CVE0102	Engineering Mechanics
CVE1104	Properties and strength of materials (1)	3	2	2	PHY0101	Physics (1)
HUM1105	Communications and Presentation Skills	2	1	2	ELCC0101	Introduction to Computers and Programming
MIE1102	Engineering Geology	3	2	2		Consult with Instructor
ELC1102	Principles of Elect. Eng	2	2	1		Consult with Instructor
MEC1101	Principles of Mech. Eng.	2	2	1		Consult with Instructor
CPM1101	Introduction to Construction Engineering	2	2	—		Consult with Instructor
Total		17	13	10		

Table 8.17
Evaluation guidance at level 1, semester 3

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CVE1103	Theory of Structures (1)	3	20	30	10	40	100
CVE1104	Properties and strength of materials (1)	3	20	30	10	40	100
HUM1105	Communications and Presentation Skills	2	20	30	10	40	100
MIE1102	Engineering Geology	3	20	30	10	40	100
ELC1102	Principles of Elect. Eng	2	20	30	10	40	100
MEC1101	Principles of Mech. Eng.	2	20	20	10	50	100
CPM1101	Introduction to Construction Engineering	2	20	20	10	50	100
Total							700

Table 8.18
Guidance table at level 1, semester 4

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
MTH1103	Mathematics (3)	3	2	2	MTH0102	Mathematics (2)
CPM1102	Construction Strategy	2	2	—	CPM1101	Introduction to Construction Engineering
CVE1105	Hydraulics (1)	3	2	2	CVE0102	Engineering Mechanics
CVE1106	Numerical Analysis	3	2	2	MTH1103	Mathematics (3)
CVE1107	Surveying (1)	3	2	2	ENG0101	Engineering Drawing
CPM 1103	Natural Recourses and Its Management	2	2	—		Consult with Instructor
HUM1106	Ethics of Engineering Profession and Its Law	2	2	—		Consult with Instructor
Total		18	14	8		

Table 8.19
Evaluation guidance at level 1, semester 4

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
MTH1103	Mathematics (3)	3	20	30	10	10	100
CPM1102	Construction strategy	2	20	30	10	10	100
CVE1105	Hydraulics (1)	3	20	30	10	10	100
CVE1106	Numerical Analysis	3	20	30	—	50	100
CVE1107	Surveying (1)	3	20	30	10	10	100
CPM 1103	Natural Recourses and Its Management	2	20	20	10	10	100
HUM1106	Ethics of Engineering Profession and Its Law	2	20	20	10	10	100
Total							700

Table 8.20
Guidance table at level 2, semester 5

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CPM2104	Planning and Control of Construction Projects	3	2	2	CPM1101	Introduction to Construction Engineering
CVE2108	Theory of Structures (2)	3	2	2	CVE1103	Theory of Structures (1)
CVE2109	Hydraulics (2)	3	2	2	CVE1105	Hydraulics (1)
CVE2110	Soil Mechanics	3	2	2	MIE1102	Engineering Geology
CVE2111	Reinforced Concrete (1)	3	2	3	CVE1103	Theory of Structures (1)
HUM2107	Writing of Technical Reports	2	2	1		Consult with Instructor
CPM2105	Management Bases	2	2	—		Consult with Instructor
Total		19	14	12		

Table 8.21
Evaluation guidance at level 2, semester 5

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CPM2104	Planning and Control of Construction Projects	3	20	30	10	40	100
CVE2108	Theory of Structures (2)	3	20	30	—	50	100
CVE2109	Hydraulics (2)	3	20	30	10	40	100
CVE2110	Soil Mechanics	3	20	30	10	40	100
CVE2111	Reinforced Concrete (1)	3	20	30	10	40	100
HUM2107	Writing of Technical Reports	2	20	30	10	40	100
CPM2105	Management Bases	2	20	30	10	40	100
Total							**700**

Table 8.22
Guidance table at level 2, semester 6

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CVE2112	Steel Constructions	3	2	2	CVE2108	Theory of Structures (2)
CVE2113	Surveying (2)	3	2	2	CVE1107	Surveying (1)
CVE2114	Properties and Strength of Materials (2)	3	2	2	CVE1104	Properties and strength of materials (1)
CVE2117	Reinforced Concrete (2)	3	2	3	CVE2111	Reinforced Concrete (1)
CPM2106	Construction Technology and Its Management	3	2	2	CVE2111	Reinforced Concrete (1)
HUM20 (01-0**3**)	Elective Course (1)	2	2	—	HUM0104	Engineering Economics
Total		**17**	**12**	**11**		

Table 8.23
Evaluation guidance at level 2, semester 6

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CVE2112	Steel Constructions	3	20	30	10	40	100
CVE2113	Surveying (2)	3	20	30	10	40	100
CVE2114	Properties and Strength of Materials (2)	3	20	30	10	40	100
CVE2117	Reinforced Concrete (2)	3	20	30	10	40	100
CPM2106	Construction Technology and Its Management	2	20	30	10	40	100
HUM20 (01-0**3**)	Elective Course (1)	3	20	30	10	40	100
Total							**600**

Table 8.24
Guidance table at level 3, semester 7

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CPM3107	Protection from Risks Associated to Construction Projects	3	2	2	CPM2104	Planning and Control of Construction Projects
CVE3115	Roads and Traffic Engineering	3	2	2	CVE2107	Surveying (1)
CPM3108	Advanced Construction Technology	3	2	2	CPM2106	Construction Technology and Its Management
CVE3116	Foundations	3	2	2	CVE2110	Soil Mechanics
CVE3118	Irrigation Eng. and Its Structures Design	3	2	2	CVE2109	Hydraulics (2)
CPM30 (01-04)	Elective course (2)	3	2	2	—	Consult with Instructor
Total		18	12	12		

Table 8.25
Evaluation guidance at level 3, semester 7

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CPM3107	Protection from Risks Associated to Construction Projects	3	20	30	10	40	100
CVE3115	Roads and Traffic Engineering	3	20	30	10	40	100
CPM3108	Advanced Construction Technology	3	20	30	10	40	100
CVE3116	Foundations	3	20	30	10	40	100
CVE3118	Irrigation Eng. and Its Structures Design	3	20	30	10	40	100
CPM30 (01-04)	Elective Course (2)	3	20	30	10	40	100
Total							600

Table 8.26
Guidance table at level 3, semester 8

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CVE3119	Theory of Structures (3)	3	2	2	CVE2108	Theory of Structures (2)
CVE3120	Reinforced Concrete (3)	3	2	3	CVE2117	Reinforced Concrete (2)
CPM3109	Quantities and Project Costs Control	3	2	2	CPM1102	Construction strategy
CVE30 (01-04)	Elective Course (3)	3	2	2	CVE3116	Consult with Instructor
HUM4108	Environmental Protection	2	2	—		Consult with Instructor
CPM30 (05-08)	Elective Course (4)	3	2	2		Consult with Instructor
Total		17	12	11		

Table 8.27
Evaluation guidance at level 3, semester 8

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CVE3119	Theory of Structures (3)	3	20	30	—	50	100
CVE3120	Reinforced Concrete (3)	3	20	30	10	40	100
CPM3109	Quantities and Project Costs Control	3	20	30	10	40	100
CVE30 (01-04)	Elective Course (3)	3	20	30	—	50	100
HUM4108	Environmental Protection	2	20	30	10	40	100
CPM30 (05-08)	Elective Course (4)	3	20	30	10	40	100
Total							600

Table 8.28
Guidance table at level 4, semester 9

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CPM4110	Construction Management and Project Control	2	2	—	CPM2106	Construction Technology and Its Management
CPM4111	Management of Energy Resources in Construction Sites	2	2	—		Consult with Instructor
CVE4121	Sanitary and Environmental Eng.	3	2	2	CVE1105	Hydraulics (1)
CPM4112	Contractors and Specifications	3	2	2	CPM3109	Quantities and Project Costs Control
CPM40 (09, 11)	Elective Course (5)	2	2	—	CVE3120	Reinforced Concrete (3)
CPM40 (12, 13)	Elective Course (6)	3	2	2		Consult with Instructor
Total		15	12	6		

Table 8.29
Evaluation guidance at level 4, semester 9

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CPM4110	Construction Management and Project Control	2	20	30	10	40	100
CPM4111	Management of Energy Resources in Construction Sites	2	20	30	10	40	100
CVE4121	Sanitary and Environmental Eng.	3	20	30	10	40	100
CPM4112	Contractors and Specifications	3	20	30	10	40	100
CPM40 (09, 11)	Elective Course (5)	2	20	30	10	40	100
CPM40 (12, 13)	Elective Course (6)	3	20	20	10	40	100
CPM4117	Graduation Project (A)	Discussion	—	50	—	Discussion 50	100
Total							700

Table 8.30
Guidance table at level 4, semester 10

Course Code	Course name	Credit Hours	Study hours per week		Pre-requisite	
			Lecture	Tutorial / Epr.	Course Code	Course name
CPM4113	Quality Control	3	2	2	CVE2114	Properties and strength of materials (2)
CPM4114	Human Factors in Engineering and Management of Construction	2	2	—	CPM3107	Protection from Risks Associated to Construction Projects
CPM4115	Temporary Structures and Frame Work Design	3	2	2	CPM3109	Quantities and Project Costs Control
CPM4116	Tunnels and Networks Engineering	3	2	2	CVE3117	Reinforced Concrete (2)
CPM4117	Risk Management	2	2	—	CVE3117	Reinforced Concrete (2)
CPM40 (14-17)	Elective Course (7)	2	2	—		Consult with Instructor
CPM4118	Graduation Project (B)	3	1	2	CPM4117	Graduation Project (A)
Total		18	13	8		

Table 8.31
Evaluation guidance at level 4, semester 10

Course Code	Course name	Final Exam hrs	Maximum Mark Distributions				
			Mid term Exam	Semester work	Tutorial / Epr.	Final Exam	Total
CPM4113	Quality Control	3	20	30	10	40	100
CPM4114	Human Factors in Engineering and Management of Construction	2	20	30	10	40	100
CPM4115	Temporary Structures and Stiffness Design	3	20	30	10	40	100
CPM4116	Tunnels and Networks Engineering	3	20	30	—	50	100
CPM4117	Risk Management	2	20	30	10	40	100
CPM40 (14-17)	Elective Course (7)	2	20	30	—	50	100
CPM4118	Graduation Project (B)	Discussion	—	50	—	Discussion 50	100
Total							700

Courses for Fulfillment of the NARS Requirements in Programme Subject Areas

Table 8.32
Required percentages of (NARS) specifications of graduate engineers and existing ones in the (CPM) programme

No.	Subject area	Required %	Existing	
			No.	%
1	Humanities	9-12	18.0	10.00
2	Mathematics and Basic Science	20-26	37.0	20.56
3	Basic Engineering Science	20-23	37.0	20.56
4	Applied Engineering	20-22	37.0	20.56
5	Computer Applications	9-11	16.5	9.17
6	Project and Practice	8-10	23.0	12.78
7	Institution Character-Identifying Subjects	6-8	11.5	6.39
	Total	**100**	**180.0**	**100.00**

Chapter 9

Reflections on Student Workload

Karin Jansen Van Rensburg

9.1. Background

A proposal has been developed for the African Credit Transfer System and the Workload Regime (Teferra, 2018). This followed the realisation that Africa had no common and reliable means of measuring and transferring acquired knowledge. Teferra (2018) further notes that "the benefit of a streamlined continental credit system is self-evident for the development of the African higher education space in particular, and the integration of the continent in general". It is also essential in facilitating international mobility, exchanges, and recognition of qualifications. From observation of practices in the various regions, credits are variably weighted and the credit load for various programmes differs among the regions. However, a common credit point per year stands at 60 units across the continent. It is understood that a credit load may be one hour of teaching over a period of 15-16 weeks, or it may be practical classes of two to three hours over a semester made up of 15-16 weeks.

Workload regimes do not appear to differ greatly in the various regimes. It is shown that while in Latin America the number ranges from 1440-1980, the number for Africa stood between 1350 and 1850 (Teferra, 2018). In terms of perception, Whitelock *et al.* (2015) note that student workload is a contentious issue viewed differently in face-to-face institutions where contact time is an agreed metric, while distance universities have chosen study hours as their yardstick.

In our discussion, study hours are considered irrespective of the mode of study. Additional elaboration on workload is available at: www.unideusto.org/tuningen/images/stories/workloads/Student_Workload__last_version.pdf

Students enrol for higher learning at universities all over the world. After the completion of Grade 12 and having met the admission requirements at university, a student starts the journey to his/her future.

Civil Engineering was one of the disciplines for which the current practice in terms of workload was assessed. To explain how workload is determined and what is required for a Civil Engineering qualification, let us start with the difference between the requirements of the school system regarding work load, and what is required from a student at tertiary level. Basically, this was done to explain the component of independent study which forms a significant part of workload at the tertiary level and is considered in addition to the contact time (Whitelock *et al.,* 2015). The South African school and university models will be used as an example; but these models can be applied to other countries as well.

According to the Department of Basic Education in South Africa[1], the aim is to produce learners that are able to:

i. identify and solve problems and make decisions using critical and creative thinking;

ii. work effectively as individuals and with others as members of a team;

iii. organise and manage themselves and their activities responsibly and effectively;

iv. collect, analyse, organise and critically evaluate information;

v. communicate effectively using visual, symbolic and/or language skills in various modes;

[1] https://nationalgovernment.co.za/units/view/7/Department-Basic-Education-DBE

vi. use science and technology effectively and critically showing responsibility towards the environment and the health of others; and

vii. demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

The workload for the scholars in their senior years includes the following subjects:

First language, Second language and then a minimum of any four of the following: Accounting, Information Technology, Agricultural Sciences, Languages, Business Studies, Life Sciences, Consumer Studies, Mathematics, Dramatic Arts, Mathematical Literacy, Economics, Music, Engineering Graphics and Design, Physical Sciences, Geography, Religion Studies, History, Visual Arts.

This indicates that there is a big gap between the requirements and outputs of Grade 12 and the requirements at university level for Civil Engineering. There are quite a number of reasons for this, which will not be discussed here.

The Exit-Level Outcomes (ELOs) for Engineering students in South Africa are as follows:

Exit-Level Outcomes for University Engineering Bachelor's Degrees

(Excerpt from ECSA Document no. PE-61: Standards for Accredited University Bachelor's Degrees, 2001)

- **Exit-level Outcome 1: Problem solving**

  Identify, formulate, analyse and solve complex engineering problems creatively and innovatively.

- **Exit-level Outcome 2: Application of scientific and engineering knowledge**

  Apply knowledge of mathematics, natural sciences, engineering fundamentals and an engineering speciality to solve complex engineering problems.

- **Exit-level Outcome 3: Engineering design**

  Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes.

- **Exit-level Outcome 4: Investigations, experiments and data analysis**

  Demonstrate competence to design and conduct investigations and experiments.

- **Exit-level Outcome 5: Engineering methods, skills and tools, including information technology**

  Demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology.

- **Exit-level Outcome 6: Professional and technical communication**

  Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large.

- **Exit-level Outcome 7: Sustainability and impact of engineering activity**

  Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment.

- **Exit-level Outcome 8: Individual, team and multidisciplinary working**

  Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

- **Exit-level Outcome 9: Independent learning ability**

  Demonstrate competence to engage in independent learning through well developed learning skills.

- **Exit-level Outcome 10: Engineering professionalism**

  Demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.

- **Exit-level Outcome 11: Engineering management**

  Demonstrate knowledge and understanding of engineering management principles and economic decision-making.

The difference between the outcome on school level and at the end of the Bachelor degree is substantial. The major difference between the two is that at school level it is really about mastering the knowledge and not necessarily the way to do it. Academics refer to this as spoon feeding. At university level the student should be able to apply any knowledge; it is about mastering the skills to apply the knowledge. Students unfortunately try to 'force fit' material they learned to new problems.

The Academics thus face challenges while trying to bridge the gap and teaching students to think and apply knowledge, and not just want to take a previous example and use it on a new problem.

9.2. General Student Opinions on Workload

There is a drive from the university to help the student bridge the gap between the high school curriculum outcomes and learning requirements at the university. An extended discussion of the student workload and the expected teaching methods and learning outcomes is available at:

www.unideusto.org/tuningen/images/stories/workloads/Student_Workload__last_version.pdf

For the first and second year students, the following are the issues regarding workload:

- The first major difference is that at school level, the information is more of a general nature and at university level it is specialised for the field of study that was chosen. Students thus struggle with the content and the application thereof.

- Students also need extra help with the mathematics and applied mathematics subjects, as they say the gap is really big between the work they did at school and university. Subjects have been split so that more time is available on doing the work in the curriculum, and under guidance.

The students in the third and fourth year usually complain about the amount of work that they are supposed to do.

According to the study done by Tuning Africa on student workload, the continent was divided into five regions, namely North, West, South, East and Central. The study asked academics (lecturers/staff members) and students to give their opinions on the following issues:

1. Contact time/hours

   This is the amount of time spent on training in contact with the lecturer in the study of a particular course or module. It includes lectures, seminars, clinical practices, labs, project work and supervised field work.

   On average in the Southern region, academics feel that 360 contact hours per semester is sufficient and students felt 307 contact hours is sufficient to complete a module. In all the regions the numbers were in this range.

2. Independent work time/hours

   This is the amount of time a student should work independently, and this includes homework, assignments, preparing for tests and exams.

It is important to highlight the reason why both academics and students were asked to participate in the survey, as it always falls on the academics to determine the contact and independent work time. The drive for student based learning is very important and it shows that universities take the needs of students into account.

9.3. Reflections on Workload at a Bachelor's Degree Level for Civil Engineering

The following paragraph discusses the results from the Tuning Africa – Student Workload study in relation to the Southern region and specific to the Civil Engineering Group.

Table 9.1 shows the amount of time and the breakdown of how the independent work will be done.

Table 9.1
Independent work for all Subject Area Groups (SAG)

	INDEPENDENT WORK															
	Reading texts or literature		Fieldwork (site visits, etc. not supervised)		Laboratory work (not supervised)		Preparation and execution/ presentation of written work		Working with Internet sources		Preparing for interim assessment, final exam		Other		TOTAL	
	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students	Academics	Students
Agricultural Sciences	93,50	116,73	33,67	22,54	29,50	22,77	47,67	68,16	53,83	41,97	75,17	211,30	9,00	4,58	342,33	488,05
Applied geology	89,92	79,71	50,92	57,26	45,58	44,41	61,58	78,64	65,17	42,91	62,17	137,16	2,83	1,19	378,17	441,28
Civil Engineering	183,50	161,86	59,67	27,98	53,50	34,43	141,90	120,70	130,58	92,24	161,33	200,36	13,25	24,82	743,73	662,40
Economics	106,17	111,36	11,67	11,83	9,50	2,46	50,44	58,09	75,83	68,06	114,41	131,53	1,56	12,60	369,57	395,92
Higher Educ. Manag.	99,21	120,17	14,08	15,88	1,00	3,91	70,63	79,88	35,42	72,53	85,71	134,04	18,75	20,12	324,79	446,53
Mechanical Eng.	186,53	117,92	17,44	9,22	51,14	47,57	113,53	96,78	22,78	34,93	122,33	124,29	0,00	3,31	513,75	434,01
Medicine	140,98	121,67	46,08	40,31	61,67	41,33	43,34	31,50	114,22	61,34	81,81	101,72	0,00	1,57	488,10	399,43
Teacher Education	167,50	170,59	22,70	32,85	22,48	23,79	92,84	127,33	80,81	90,73	112,85	243,79	12,43	6,18	511,62	695,26

Figure 9.1 below shows the breakdown of independent work according to the teaching staff.

Figure 9.2 shows the breakdown according to the students.

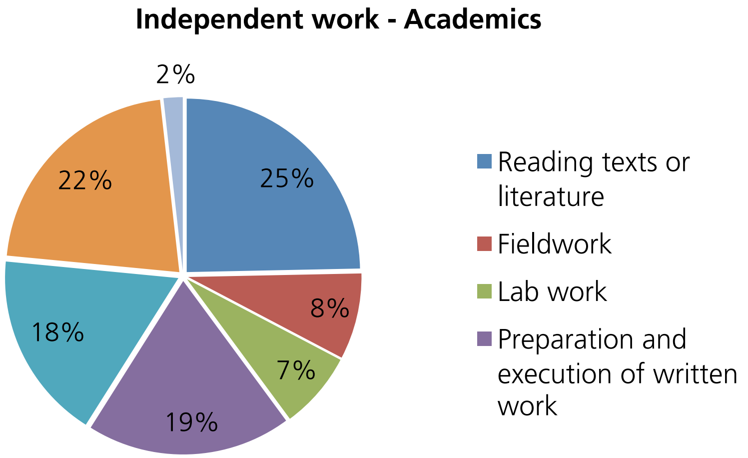

Figure 9.1
Civil Engineering Independent works – Academics

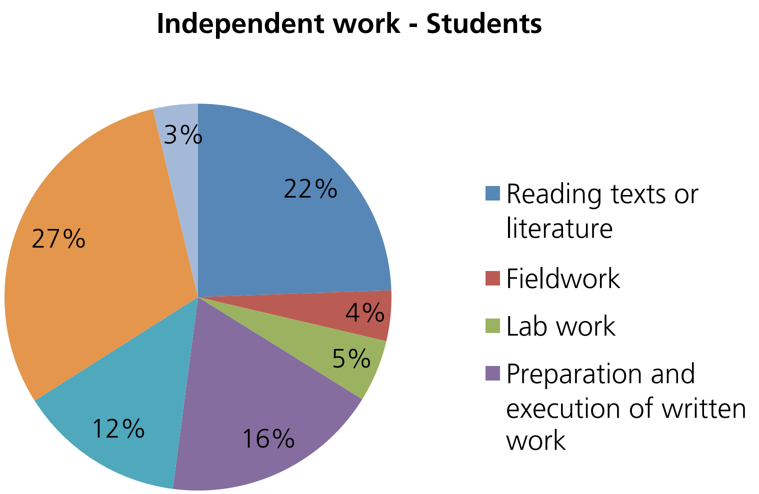

Figure 9.2
Civil Engineering Independent work – Students

The major differences between Figure 9.1 and 9.2 regard the amount of field work that should be included in the semester and the students' opinion that they need more time preparing for assessments and exams.

According to Figure 9.3, it can be seen that although academics and students do not agree wholly on how the independent work time should be spent, there is consensus on the amount of time spent on contact hours and independent work.

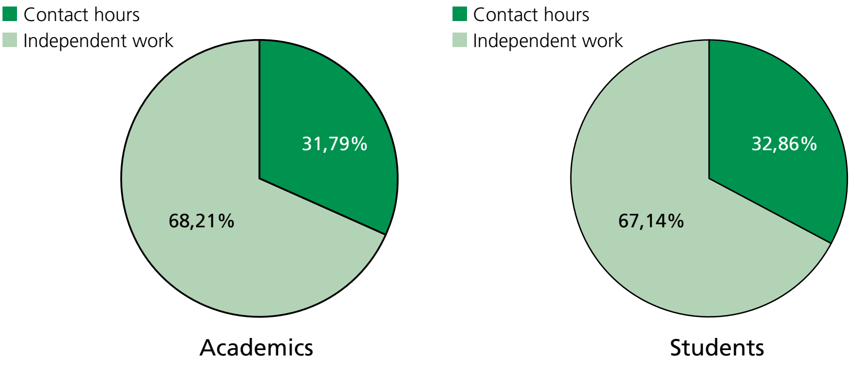

Figure 9.3
Percentage Contact hours vs. Independent work

Depending on different universities, and the credit systems they use, the credits are used to calculate the notional hours (contact time plus independent work) per semester. At the University of Pretoria, the minimum credits per semester are 64 credits. This means a student should spend 640 hours per semester on between 4 and 5 subjects.[2] The total number of hours per semester as the result of the contact hours and independent work hours can be seen in Table 9.2 below:

[2] At the University of Pretoria, notional hours refer to the time that the average student would need to attend all classes, study for tests and do assignments and homework. Each credit equals 10 notional hours. If, for example, 120 credits are required per year to get a degree, then the number of notional hours is 1200 per year. Divide this number by 28 weeks, which is the number of academic lecture weeks in a year. This gives you approximately 40 hours that you should spend on your studies per week, which is 8 hours per day from Monday to Friday.

Table 9.2
Total number of hours per semester

	Total CONTACT HOURS to study this unit/course/module along the SEMESTER (1)		Total INDEPENDENT WORK to learn this unit/course/module along the SEMESTER (2)		TOTAL (1)+(2)	
	Academics	Students	Academics	Students	Academics	Students
Agricultural Sciences	231,00	346,30	342,33	488,05	573,33	834,35
Applied geology	365,25	413,05	378,17	441,28	743,42	854,33
Civil Engineering	346,67	324,21	743,73	662,40	1090,40	986,61
Economics	271,78	301,16	369,57	395,92	641,34	697,08
Higher Educ. Manag.	126,17	183,26	324,79	446,53	450,96	629,78
Mechanical Eng.	313,72	320,56	513,75	434,01	827,47	754,57
Medicine	389,08	337,06	488,10	399,43	877,18	736,50
Teacher Education	323,08	254,01	511,62	695,26	834,70	949,27

For Civil Engineering, the total numbers estimated by the Academics are 1,090.40 and by the Students 986.61. This is substantially higher than in the other Subject Area Groups.

9.4. Conclusion

Thus, in conclusion, it can be seen from the Tuning Africa Workload study that the current systems are in line with what the universities in Africa are currently using. The bigger challenge is to bridge the gap between school and university for a lot of students, and making sure that they spend their time on independent work properly.

Total credits × 10 = notional hours; 120 credits × 10 = 1,200 notional hours; 1,200 notional hours/28 weeks = ± 40 hours per week = ±8 hours per day.

Chapter 10

Quality Assurance/Monitoring Mechanisms

Hassan Ibrahim Mohamed Mohamed

10.1. Introduction

Since the beginning of the 1990s, the concept of "quality" began to appear frequently in the field of engineering education practice, the principles of quality assurance also began to be introduced into the field of engineering education (Li and Lei, 2017). Universities can be very different, not only from one country to the next, but also among different scientific sectors within the same country. This means that evaluation of objectives and criteria which are very diversified but share common requirements requires formulating a final judgment on each programme based on a very narrow final set of key quality aspects. The latter must be selected so that, in a clear and readily recognisable manner, they address the very "heart" of the quality of educational activities, which is not limited to the quality of individual teachers, but rather refers to the overall quality of an organised collective effort encompassing several fronts.

The four key "aspects" or "dimensions" of evaluation:

- Requirements and objectives.
- Teaching and learning.
- Learning resources.
- Monitoring, analysis, review.

An appropriate quality assurance mechanism will be present if these four aspects are kept under control in effective manner by the programme. Course is an important carrier of engineering education, and course quality is the core element of the engineering education quality. Therefore, the course assessment is an important aspect of the quality assurance in engineering education.

10.2. Example: Quality Assurance Faculty of Engineering- Assiut University, Egypt

The Faculty of Engineering, Assiut University, started its activities for quality assurance through student feedback about the performance of courses taught besides the available facilities for teaching under the supervision of University Performance Evaluation and Development Unit since the academic year 1997/1998. The Faculty of Engineering with cooperation of the Association of African Universities carried out a self-evaluation study for quality assurance in 2001 and the faculty received a positive validation report in September 2002. The Faculty has participated in the project financed by Ford Foundation, with five other faculties in three universities, to make a pilot self-evaluation of the Faculty.

The study was carried out from December 2002 to June 2003. Later the Faculty was one among the six leading faculties in three universities starting the implementation of internal quality assurance system in September 2004 in light of the guidelines published later in "The Quality Assurance and Accreditation Handbook for Higher Education in Egypt". The Faculty prepared the required documents such as Faculty annual report, specifications and reports of the nine programmes running in the Faculty, and specifications and reports on course units. In the following example, we show the course specification which must be prepared at the beginning of academic year by the staff member teaching the course. The Faculty received national accreditation in 2011 as the first engineering college accredited in Egypt. As shown in Table (10.1), the course specification includes a section about the course basic information such as the title, course code and number of hours. The second section in the course specification explains the course aims, the outcomes which covers the course in the programme, the course contents and ILOs.

Table 10.1
Course specification

1. Basic Information

<table>
<tr><td>Code</td><td colspan="4" rowspan="2">Hydraulics (1)</td><td>Bylaw</td></tr>
<tr><td>C226</td><td>2004</td></tr>
<tr><td>Department</td><td colspan="3">Civil Engineering</td><td>Programme</td><td>Civil Engineering</td></tr>
<tr><td>Competent Dept.</td><td colspan="3">Civil Engineering</td><td>Prerequisite</td><td>—</td></tr>
<tr><td rowspan="4">Course units</td><td>Theoretical</td><td>4</td><td>h</td><td>System</td><td>Semesters</td></tr>
<tr><td>Tutorials</td><td>1</td><td>h</td><td>Level</td><td>2nd year</td></tr>
<tr><td>Experiments</td><td>1</td><td>h</td><td>Semester</td><td>1st</td></tr>
<tr><td>Total</td><td>6</td><td>h</td><td>Academic year</td><td>2017-2018</td></tr>
<tr><td rowspan="4">Confirmation date</td><td rowspan="2">Programme</td><td colspan="3">FOE council</td><td>No. (-) – 16-11-2017</td></tr>
<tr><td colspan="3">Dept council</td><td>No. (-) – 2-11-2017</td></tr>
<tr><td rowspan="2">Course</td><td colspan="3">FOE council</td><td>No. (1041) – 16-11-2017</td></tr>
<tr><td colspan="3">Dept council</td><td>No. (-) – 5-10-2017</td></tr>
</table>

2. Course Aim

Main Aim	The course is designed to give all Civil Engineering students the ability to understand the principles of hydraulics engineering and to apply it appropriately in designing and evaluating civil engineering projects. The course seeks to provide basics in fluid static, steady uniform and non-uniform incompressible flow in pipelines, flow measurements, and hydraulics simulation.
Sub-Aims	1.1. Apply knowledge of mathematics and hydraulics to the solution of water supply networks. 1.2. Apply knowledge of mathematics and hydraulics to the solution of open channel flow (sanitary networks, canals and drains). 2. Design a system of water supply networks, sanitary networks, canals and drains. 3. Design and conduct hydraulics experiments as well as analyze and interpret the data. 4. Identify, formulate and solve fundamental hydraulics problems. 5. Use the hydraulic measurements techniques and tools necessary for engineering practice and project management. 6. Work and communicate effectively in multi-disciplinary teams. 7. Engage in self- and life- long learning. 8. Act professionally in design and supervision of hydraulic structures. 9. Select and design adequate water control structures, irrigation and water networks, sewerage systems and pumping stations. 10. Design and construct structures for protection against dangers of unexpected natural events such as floods and storms. 11. Lead and supervise a group of designers and site or lab technicians.

3. Relationship between course and the programme

Field	National Academic Reference Standards (NARS)			
	Knowledge & Understanding	Intellectual Skills	Professional Skills	General Skills
Academic standards that the course contribute in achieving it	a4, a5, a10 and a13	b1. b2, b4 and b14	c1, c2, c5, c12, c13 and c14	d1,d2 and d7

4. Course Subject Area

A	B	C	D	E	F	G	Total
Humanities and Social Sciences	Mathematics and Basic Sciences	Basic Engineering Sciences	Applied Engineering and Design	Computer Applications and ICT	Projects and Practice	Discretionary subjects	
—	16.67	33.33%	16.67%	16.67	16.66	—	100%

5. Intended Learning Outcomes (ILOs)

Field	Programme ILOs that the course contribute in achieving it (P-ILOs)	Course ILOs in detail (C-ILOs)
	By the end of the programme, graduate can:	By the end of the course, student can:
Knowledge & Understanding	a4) List Principles of design including elements design, process and/or a system related to Civil Engineering.	a4-1) List the design gates and walls subjected to hydrostatic forces. a4-2) List the design pipe flow through the pipe networks.
	a5) Recognise methodologies of solving engineering problems, data collection and interpretation.	a5) Know how to analyse the experimental results using the dimensional analysis and similarity.
	a10) Know technical language and report writing.	a10) Know technical language and report writing.
	a13) Know engineering principles in the fields of reinforced concrete and metallic structures' analysis and design, geotechnics and foundations, hydraulics and hydrology, water resources, environmental and sanitary engineering, roadways and traffic systems, surveying and photogrammetry.	a13) Know engineering principles in the fields of hydraulics and hydrology, water resources, environmental and sanitary engineering.

Field	Programme ILOs that the course contribute in achieving it (P-ILOs)	Course ILOs in detail (C-ILOs)
	By the end of the programme, graduate can:	**By the end of the course, student can:**
Intellectual Skills	b1) Select appropriate mathematical and computer-based methods for modelling and analysing problems.	b1) Use computer programme for solving problems regarding pipe networks.
	b2) Select appropriate solutions for engineering problems based on analytical thinking.	b2-1) Select an appropriate method to calculate the hydrostatic force for designing the gates and walls subjected to it. b2-2) Apply the Bernoulli's equation to different flow situations.
	b4) Combine, exchange, and assess different ideas, views, and knowledge from a range of sources.	b4) Combine, exchange, and assess different ideas for flow measurement devices.
	b14) Select and design adequate water control structures, irrigation and water networks, sewerage systems and pumping stations.	b14-1) Select the method of design and analyse the pipe flow through pipe networks. b14-2) Select a pumping system and its capacity.

Field	Programme ILOs that the course contribute in achieving it (P-ILOs)	Course ILOs in detail (C-ILOs)
	By the end of the programme, graduate can:	By the end of the course, student can:
Professional Skills	c1) Apply knowledge of mathematics, science, information technology, design, business context and engineering practice integrally to solve engineering problems.	c1) Apply knowledge of hydraulic properties of different liquids integrally to solve hydraulic problems.
	c2) Professionally merge engineering knowledge, understanding, and feedback to improve design, products and/or services.	c2) Professionally merge hydraulic knowledge, understanding, and feedback to improve pipe networks planning and design.
	c5) Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design experiments, collect, analyse and interpret results.	c5-1) Use dimensional analysis and similarity in the analysis of experimental results. c5-2) Use computational facilities for solving pipe network problems. c5-3) Conduct laboratory experiments to determine fluid properties, hydrostatic forces, shear stresses head losses and pressure.
	c12) Prepare and present technical reports.	c12) Prepare and present technical reports on hydraulic problems.
	c.13) Use laboratory and field equipment competently and safely.	c13) Prepare well laboratory experiments, their procedures and measurements.
	c14) Observe, record and analise data in laboratory and in the field.	c14-1) Record data measurements. c14-2) Analyse data on the bases of dimensional analysis.
General Skills	d.1) Collaborate effectively in a multidisciplinary team.	d1) Able to join in team work to design pipe networks using the computer facilities and undertake simple stability analyses of small gravity dams, weirs and regulators.

Field	Programme ILOs that the course contribute in achieving it (P-ILOs)	Course ILOs in detail (C-ILOs)
	By the end of the programme, graduate can:	By the end of the course, student can:
	d2) Work in stressful environment and within constraints.	d2) Work in a stressful environment and within constraints.
	d7) Search for information and engage in life-long self learning.	d7) Search for information and engage in life-long self learning.

6. Course Content

Properties of fluids – Fluid pressure measurements – Forces in static fluids – Hydrostatic pressure - Forces on Surfaces – Buoyancy and Flotation – applications of dimensional analysis - Dynamic similitude – Kinematics of fluid motion – pressure intensity and velocity changes in moving fluids – Energy equation – Newton's second law–Introduction to hydrodynamics – Flow in pipes and closed conduits – Pipe networks - Computer applications.

7. Course Topics

Topic No.	Topics	No. of hours	Week No.
1st topic	Fluids and their properties	6	1, 2
2nd topic	Fluid pressure and its applications	6	2, 3
3rd topic	Static forces on surfaces	8	4, 5
4th topic	Buoyancy and flotation	—	—
5th topic	Dimensional analysis and similarity	6	6, 7
6th topic	Bernoulli equation and its applications	8	7, 8, 9
7th topic	Pipes flow	8	10, 11
8th topic	Momentum equation and its application	4	12

8. ILOs /Topics Matrix

Course Intended Learning Outcomes (ILOs)			1st topic	2nd topic	3rd topic	5th topic	7th topic	9th topic	10th topic
Knowledge & Understanding	a4-1)	List the design gates and walls subjected to hydrostatic forces.			X				
	a4-2)	List the design and analyse the pipe flow through pipe networks.							X
	a5)	Know how to analyse the experimental results using dimensional analysis and similarity.				X			
	a10)	Know technical language and report writing.	X	X	X	X	X	X	X
	a13)	Know engineering principles in the fields of hydraulics and hydrology, water resources, environmental and sanitary engineering.					X		X
Intellectual Skills	b1)	Use computer programmes for solving pipe network problems.							X
	b2-1)	Select an appropriate method to calculate the hydrostatic force for designing the gates and walls subjected to it.			X				
	b2-2)	Apply the Bernoulli's equation to different flow situations.					X		
	b4)	Combine, exchange, and assess different ideas for flow measurement devices.		X			X		
	b14-1)	Can design and analyse the pipe flow through pipe networks.						X	X
	b14-2)	Select the pumping system and its capacity.					X		X

Course Intended Learning Outcomes (ILOs)			1st topic	2nd topic	3rd topic	5th topic	7th topic	9th topic	10th topic
Professional Skills General Skills	c1)	Apply knowledge of hydraulic properties of different liquid integrally to solve hydraulic problems.	X						
	c2)	Professionally merge hydraulic knowledge, understanding, and feedback to improve pipe network~~s~~ planning and design.							X
	c5-1)	Use the dimensional analysis and similarity in the analysis of experimental results.				X			
	c5-2)	Use computational facilities for solving pipe network issues.							X
	c5-3)	Conduct laboratory experiments to determine fluid properties, hydrostatic forces, shear stresses head losses and pressure.	X				X	X	X
	c12)	Prepare and present technical reports on a hydraulic problem~~s~~.	X	X	X	X	X	X	X
	c13)	Prepare well the laboratory experiments, their procedures and measurements.		X			X		X
	c14-1)	Record data measurements.		X			X		X
	c14-2)	Analyse data on the bases of dimensional analysis.				X			
	d1)	Be able to join ~~a~~ team to design pipe networks using the computer facilities and undertake simple stability analysis of small gravity dams, weirs and regulators.					X		X
	d2)	Work in a stressful environment and within constraints.	X						
	d7)	Search for information and engage in life-long self learning.					X		X

9. Teaching & Learning Methods

Course Intended Learning Outcomes (ILOs)		Teaching & Learning Methods									
		Lecture (T1)	Presentation and Movies	Discussions(T3)	Tutorials(T4)	Problem solving(T5)	Brain storming(T6)	Experimental Work	Site visits(T8)	Self-learning(T9)	Cooperative(T10)
Knowledge and Understanding	a.4.1	X			X			X			
	a.4.2	X	X		X			X	X		
	a.5	X			X			X			
	a.10		X							X	X
	a.13	X			X	X	X		X		
Intellectual Skills	b1	X			X					X	
	b2.1	X		X	X			X			
	b2.2	X			X			X			
	b4			X					X		X
	b14.1	X			X			X			
	b14.2	X			X				X		
Professional Skills	c1	X			X						
	c2	X	X								
	c5.1	X						X			
	c5.2	X			X					X	
	c5.3				X			X			
	c12		X							X	
	c13							X			
	c14.1							X	X		
	c14.2	X			X						
General Skills	d1	X	X							X	X
	d2			X	X						
	d7									X	

10. Teaching and learning methods for low capacity and outstanding students

For low capacity students	* Such students are given an extra time from the office hours to discuss their problems and observe their level continuously. ** They are given some extra time to teach them what they can't understand.
For outstanding students	* Such students are given an extra time from the office hours to observe their level continuously. ** They are given some extra exercises.

11. Assesment

11.1. *Assesment Methods*

Course Intended Learning Outcomes (ILOs)		Assesment Methods						
		Written Exam (S1)	Oral Exam(S2)	Tutorial assessment (S3)	Report assessment (S6)	Quiz assessment (S7)	Presentation assessment (S8)	Laboratory test (S10)
Knowledge and Understanding	a.4.1	X	X	X				
	a.4.2	X	X	X				
	a.5	X						X
	a.10				X		X	
	a.13	X						
Intellectual Skills	b1	X		X				
	b2.1	X						
	b2.2	X						
	b4	X	X	X	X	X	X	X
	b14.1	X	X	X				
	b14.2	X	X	X				

Course Intended Learning Outcomes (ILOs)		Assesment Methods						
		Written Exam (S1)	Oral Exam(S2)	Tutorial assessment (S3)	Report assessment (S6)	Quiz assessment (S7)	Presentation assessment (S8)	Laboratory test (S10)
Professional Skills	c1	X	X	X	X	X	X	X
	c2	X	X	X	X	X	X	X
	c5.1		X					X
	c5.2	X		X				X
	c5.3	X		X				X
	c12				X		X	
	c13		X					X
	c14.1	X	X					X
	c14.2	X	X					X
General Skills	d1							X
	d2	X				X		
	d7			X	X			

Grades Distribution

Assessment Methods	Value (degrees)	Percentage	Time
Final Exam	100	66.67%	By the end of semester
(Oral + Lab.) Final Exam	20	13.33%	Week No. 15
Semester assessments	30	20.00%	Continuous during the semester
Total	**150**	**100.00%**	

11.2. *Semester Assessments*

Semester Assessments	Value (degrees)	Percentage of total (100%)	Time
Written Exam	15	10%	Week No. 13
Tutorial assessment	6	4%	Each week
Report assessment	3	2%	Week No. 10
Quiz assessment	3	2%	Each month
Presentation assessment	3	2%	Week No. 12
Total	**30**	**20%**	

11.3. *Grading system*

Grade	from	to	Comments
Excellent	85%	100%	
Very Good	75%	85%>	
Good	65%	>75%	
Pass	50%	>65%	
Poor	30%	> 50%	
Very Poor	Less than 30%		

List of References

Course notes	Nashaat A. Ali, "Fundamentals of engineering fluid mechanics and hydraulics" Theory and problems, 1997.
Required books	1- Kurmi, R.S, "Elements of hydraulics", New Delhi, 1970. 2- Vennard, J.K.," Elementary fluid mechanics", Jon Willey & Sons, London, 1961.
Recommended books	1- Kurmi, R.S, "Elements of hydraulics", New Delhi, 1970. 2- Vennard, J.K.," Elementary fluid mechanics", Jon Willey & Sons, London, 1961.
Periodicals, web sites... etc.	Journal of Hydraulic Engineering. Journal of Hydraulic Division. Journal of Engineering Science, Assiut University, Egypt. - Web Sites related to hydraulics and water resources.

At the end of semester, a course report is written by the staff member which includes the students' feedback on the course and statistics for the students results in exams. The following table (10-2) is an example of the course report. Also, the course report includes sections for the suggested improvement and the difficulties which are faced during teaching the course. The course specification and course report are folded in the course file.

Table 10.2
Course Report

1. Basic information

Code	C226			By law	2004
Department	Civil Eng. Dept.			Programme	
Responsible Dept.	Civil Eng. Dept.			Prerequisite	—
Course units	Lectures	4	h	System	Semesters
	Tutorials	2	h	Level	2
	Practical	—	h	Semester	1
	Total	6	h	Academic year	2015/2016

2. Statistics of passing the course

Students	**Registered**	**Examined**	**Excused absence**	**Forbidden**	**Absent**	**Total**
	No.	248	0	0	1	249
	%	99.60%	0.00%	0.00%	0.40%	100%
Exam statistics	**Examined**	**Succeeded**		**Failed**		**Total**
	No.	227		21		248
	%	91.53%		8.47%		100%
Passed Students statistics	**Grade**	**Excellent**	**Very good**	**Good**	**Pass**	**Total**
	No.	6	43	71	107	227
	%	2.64%	18.94%	31.28%	47.14%	100%

3. Course content and topics

3.1. *Coverage of course content*

% Taught from the specified course content	100%					
% Covered from specified course topics		< 60%		60-84 %	√	> 85%

3.2. *Topics that have not been taught from or have been added to those stated in course specification*

No.	Topics (State whether deleted/added)	Impact on Learning Outcomes	Reasons for deletion or addition
1			
2			
…			

4. Teaching and learning methods

4.1. *Teaching and learning methods used*

Course Intended Learning Outcomes (ILOs)		Lecture (T1)	Presentations and Movies	Discussions(T3)	Tutorials(T4)	Problem solving(T5)	Brain storming(T6)	Experimental Work	Site visits(T8)	Self learning(T9)	Cooperative(T10)
Knowledge and Understanding	a.4.1	X			X			X			
	a.4.2	X	X		X			X	X		
	a.5	X			X			X			
	a.13	X			X	X	X		X		
Intellectual Skills	b2.1	X		X	X			X			
	b2.2	X			X			X			
Professional Skills	c1	X			X						
	c14.1							X	X		
	c14.2	X			X						
General Skills	d2			X	X						
Activate methods		x			x						

4.2. *Difficulties faced in applying teaching and learning methods (if any)*

....

....

4.3. *Applied teaching and learning methods for slow learning and outstanding students*

Category	Method	Timing
Slow learning students		
Outstanding students		

5. Assessment methods

5.1. *Assessment methods used*

Course Intended Learning Outcomes (ILOs)		Assesment Methods							
		Written Exam (S1)	Oral Exam(S2)	Tutorial assessment (S3)		Report assessment (S6)	Quiz assessment (S7)	Presentation assessment (S8)	Laboratory test (S10)
Knowledge and Understanding	a.4.1	X	X	X					
	a.4.2	X	X	X					
	a.5	X							X
Intellectual Skills	b2.1	X							
	b2.2	X							
Professional Skills	c1	X	X	X		X	X	X	X
	c14.1	X	X						X
	c14.2	X	X						X
General Skills	d2	X					X		
Activate Methods		x			x				

5.2. *Difficulties faced in applying assessment methods (if any)*

....
....

6. Achieved learning outcomes

6.1. *% Students achieving learning outcomes*

Course learning outcomes		No. of achieving students	%
Knowledge and Understanding	a4-1) List the design gates and walls subjected to hydrostatic forces. a4-2) List the design pipe flow through pipe networks.		
	a5) Know how to analyse the experimental results using dimensional analysis and similarity.		
	a10) Know technical language and report writing.		
	a13) Know engineering principles in the fields of hydraulics and hydrology, water resources, environmental and sanitary engineering.		
Intellectual Skills	b1) Use computer programme for solving pipe network problems.		
	b2-1) Select appropriate method to calculate the hydrostatic force for designing the gates and walls subjected to it. b2-2) Apply Bernoulli's equation to different flow situations.		
	b4) Combine, exchange, and assess different ideas for flow measurement devices.		
	b14-1) Select the method of design and analyse pipe flow through pipe networks. b14-2) Select the pumping system and its capacity.		

Course learning outcomes		No. of achieving students	%
Professional Skills	c1) Apply knowledge of hydraulic properties of different liquids integrally to solve hydraulic problems.		
	c2) Professionally merge hydraulic knowledge, understanding, and feedback to improve pipe networks planning and design.		
	c5-1) Use dimensional analysis and similarity in the analysis of experimental results. c5-2) Use computational facilities for solving pipe network issues. c5-3) Conduct laboratory experiments to determine fluid properties, hydrostatic forces, shear stresses head losses and pressure.		
	c12) Prepare and present technical reports on one of the hydraulic problems.		
	c13) Prepare well the laboratory experiments, their procedures and measurements.		
	c14-1) Record data measurements. c14-2) Analyse data on the bases of dimensional analysis.		
General Skills	d1) Be able to join a team to design pipe networks using the computer facilities and undertake simple stability analysis of small gravity dams, weirs and regulators.		
	d2) Work in stressful environment and within constrains.		
	d7) Search for information and engage in life-long self learning discipline.		

6.2. *Comments on rate of achieving course ILOs*

....
....

7. Student assessment of course

7.1. *Results of students' course assessment (Average %)*

General items		ILOs		Lecture		Tutorial		Assessment system		Staff		Assistants		halls	
P.	N.	P.	N.	P.	N.	P.	N.	P.	N.	P.	N.	P.	N.	P.	N.
65	35	52	48	74	26	73	27	73	27	77	23	30	70	68	32

P = Positive – N = Negative.

7.2. *The most important points in free views of students*

....

....

7.3. *Comments on students' course assessment result*

....

....

8. Facilities for teaching

References		Available	√	Limited		not available
Aids	√	Available		Limited		not available
Supplies and raw materials		Available		Limited	√	not available

9. Constrains and administrative restrictions (if any)

....

....

10. Course development

10.1. *Development suggestions achieved (refer to the previous year course report)*

Development aspects	Item	date	Responsible person
Course content and topics			Staff
Halls/classes			Dept. head

10.2. *Development suggestions not achieved (refer to the previous course report)*

Development aspects	Item	Reasons	Responsible person
Teaching aids			Dept. head

10.3. *Long-term development suggestions*

....
....

10.4. *Development plan for the next year/cycle*

Development aspects	Description	date	Responsible person
Course ILOs			Staff
Course content and topics			Staff
Teaching aids			Dept. head
Halls/classes			Dept. head

10.3. Conclusion

This chapter contributes on quality assurance/monitoring mechanisms, using as an example the Faculty of Engineering, Assiut University, Egypt. The Faculty started its quality assurance activities through student feedback about the performance of courses taught. Documents such as the Faculty annual report, specifications and reports of the programmes running in the Faculty, and specifications and reports of courses were prepared. Course specifications must be prepared by academic staff teaching the courses at the beginning of academic year. All these are presented in the chapter.

Chapter 11

Approaches to Teaching and Learning and Reflection on Staff Development: Needs and Possibilities at SAG Level

Stanley Muse Shitote

11.1. Background

Discussions in the Civil Engineering Subject Area Group showed that the traditional approach to teaching Civil Engineering is practised in the majority of African universities. The approach is characterised by "what I am told I need to know" (Holmes and Beagon, 2015) and, commonly, teaching is through face to face lectures. Other teaching and learning activities include tutorials, laboratory work, field work, field visits, attachments and reading assignments. All these teaching and learning activities are mainly lecturer-centred and lecturer-controlled so that the lecturer is typically the "giver". The activities are generally practised as described below.

Tutorial Learning

Tutorials are normally led by a tutor or tutorial fellow as an interactive method of transferring knowledge and may be used as a part of a learning process. It seeks to teach by example and supply the information to complete a certain task. Some universities use the word supervision to refer to the tutorial method. A tutorial can be taken in many forms, ranging from a set of instructions to complete a task to an interactive problem-solving session. Computer tutorials that are online or downloadable are available for learners' use. They include a method of review that reinforces or tests understanding of the content in the related module or section. Webb (2006), has discussed some problems and suggested solutions related to the tutorial method and argues that often the tutorial method does not fulfil the role intended for it within a learning strategy.

Practical Work

Laboratory work is used to instil the practical aspects of the knowledge gained in the lectures. A laboratory technician takes the learners through the practical work complete with warning on safety requirements in the laboratory or for the particular exercise. The learners are then allowed to practise and complete given practical assignments. Understanding of content is tested through successfully completed tasks and the written reports. As noted by Davies (2008), laboratory work can account for up to 50% contact time in some courses. Additionally, practical and project reports associated with the practical work may account for 20-30% of marks awarded for the course. Overall, the role and benefits of practical work in engineering curriculum are to:

- Motivate students and stimulate their interest in the subject.
- Help them to deepen their understanding through relating theory to practise.
- Provide opportunities for students to work together on analysing and solving engineering problems.
- Develop skills and attributes that will enable graduates to effectively and professionally in an engineering workplace.

Davies (2008) also discusses the challenges of incorporating practical work in learning and strategies to achieve learning outcomes.

Field Work

This is similar to laboratory work but done outside the laboratory structure. It is key for earth science learning, for practical hands on training in skills such as the setting-out of structures, surveying, collection of samples, hydrological observations and data collection. Students' competences are evaluated based on tasks completed and reports submitted.

Field Visits

These are planned visits to companies either involved in the production of construction materials or providing engineering-related services. Field visits aim at enabling students to relate theoretical instruction to real life practice in the discipline.

Industrial Attachments

Industrial attachments are normally offered in the second half of the degree programme. In this respect, learners are posted in the companies that deal in the provision of goods and services in their line of training. Attachments aim at exposing the learners to the actual working environment hence enabling them to put into practice the knowledge gained in class. Attachments are also key in helping the students to develop personal skills and competences necessary to succeed in their career. Benefits of industrial attachment are discussed by Matamande *et al.* (2013).

Reading Assignments

These are necessary to help learners to gain an in-depth understanding of the content taught in class or even to cover the content that is yet to be taught in class.

11.2. Emerging Trends

As explained by Holmes and Beagon (2015), engaging learners in the traditional approach entails dealing with "what I am told I need to know". Quite often, assessment significantly relies on students reporting on the content covered out of class (or practical work) as individuals or in a group. However, the majority of the students do not show responsibility and, instead may plagarise another learners' work. They may also perform some assessments without reflecting on the skills that need to be acquired for proper career development in the field. These challenges have led to the need to depart from the traditional "what I am told I need to know" to "what I need to know to solve the problem", thereby promoting self-directed learning (Holmes and Beagon, 2015).

Civil Engineering is a demanding discipline that aims at equipping learners with key skills in the areas of design and analysis, management, communication, leadership, adherence to the law and relevant regulations, quality management, creativity and sustainability. As observed in Chapter 4 above, engineering education still falls short of the goal of preparing students adequately for professional practice. Typically, studies indicate that engineering graduates have deficiencies for crucial job skills (Business Council of Australia, 2006). Hence the need to rethink the teaching and learning methods.

The Tuning Africa Project has guided the effort towards hamonisation of higher education in Africa. The agreed framework is the development of continental generic competences as well as subject-specific competences in the respective pilot disciplines. The overall process has been guided by the Tuning Methodology (Teklemariam *et al.,* 2014). A key feature is the promotion of student-centred learning. Success of the project entails design of new curricula with features different from the current traditional curricula.

The Concept of Competences

Competence-based learning as a suitable modern approach in teaching and learning has been addressed in Chapters 2 and 3 above. It aims at achieving quality and fitness in learners to perform specific desired professional tasks. The student must demonstrate having obtained the desired learning outcomes set out in the curricula and needed for effective performance in a profession. An overview of the potential and characteristics of competence-based learning can be found at:

> https://www.pearsoned.com/wp-content/uploads/584G245_CBE_playbook_WP_lr_f.pdf (Pearson, 2015)

Other authors have written on the subject, including:

> http://www.managementstudyguide.com/what-are-competencies.html, González and Yarosh (2014); and Heijke (2003).

Using the concept of competences, the quality of learning is measurable and demonstrable. Therefore, shortcomings observed in the traditional approach in engineering training can be addressed. Further, it is possible to apply a standard for measuring quality of learning, hence to compare degrees across the continent and the globe at large. Learners who demonstrate the desired competences can easily adapt to their future working situations.

Implementation of the New Approaches in Teaching

The desire to have graduates with a greater impact in the work environment has led to the implementation of new approaches in teaching and learning. The competence-based approach has been practised or piloted in several countries around the globe (Holmes and Beagon, 2015). Student-centred learning methods have been implemented with the teacher providing the necessary guidance. The processes are essentially student-centred and show increased responsibility and control on the part of the student.

Challenges in Applying the New Approaches in Africa

Substantial capacity has been developed through the Tuning Africa Project for implementation of the new approaches in Africa. Besides activities in the SAG, staff in some of the universities is engaged in various online courses as part of staff development. However, some of the challenges that are likely to be faced in the introduction of competence-based learning in Africa are:

- Acquisition and reorganisation of physical and human resources.
- Review of curricula to define and apply competences; challenge to ensure all activities required to instil and test the achievement of competences are undertaken.

- Determination of curriculum goals; desirable skills at every level of learning.

11.3. Characteristics of the New Curricula

A major goal of the Tuning Africa process is to reform the curricula, to enhance the quality of higher education and to increase the mobility of students in Africa in light of the overarching objective of regional integration and sustainable development. The process has been developed involving Universities in Africa with groups in various subject areas, including the field of Civil Engineering.

It is recognised that the Civil Engineering profession is becoming increasingly important in the context of Africa's rapid urbanisation, demographic growth and regional integration. The construction sector is one of the fastest growing economic sectors in Africa. The *African Statistical Yearbook (*2009) highlights twenty-two African countries with an annual growth rate of above 10 per cent in the construction sector. In some countries, the growth rate is substantially higher. In contrast, current manpower development in the discipline is still very low. The new curricula provide new approaches that will supply manpower consistent with the observed demand.

The broad nature of the discipline of Civil Engineering is another characteristic that needs consideration in the staff development initiatives to address the new curricula. Civil engineers are responsible for developing, designing and building good-quality infrastructures, buildings and facilities and improving and maintaining them. Civil engineers supply energy and clean water, including the networks of pipes to handle municipal water supplies, sanitation services, wells, sewage and desalination plants and industrial waste treatment systems. They are also responsible for creating, maintaining and upgrading transportation and traffic systems like highways, bridges, tunnels, underground systems, airports, railway lines and seaports. A civil engineer is concerned with planning, determining the right design for these structures and managing the construction process to assure the longevity and sustainability of these structures after completion. One recent and increasingly important facet of Civil Engineering is Environmental Engineering. In this sub-speciality, civil engineers are concerned with applications of various methods of environmental protection, such as the purification of contaminated air, water and soil. It is clear that a diversity of approaches are needed in developing competences across the curriculum.

The new curricula will capture current trends in Civil Engineering which include the application of new materials, composite materials and in particular local materials. Rapid urbanisation throughout the continent has highlighted the importance of low-cost building. Another contemporary focus is improving the capabilities of standard materials. Increased attention is given to controlling the effects of natural disasters such as floods and earthquakes and to conducting environmental impact studies of new constructions. A major objective is to prevent cycles of disasters and to control the impacts of climate change in Africa. A relatively recent specialisation of Civil Engineering in Africa is Environmental Engineering. This specialisation covers solid waste management, environmental impact assessment and mitigation, water supply and treatment, waste-water treatment and air pollution management amongst other specialisations. Another recent emphasis is the application of specialised software programmes in the Civil Engineering industry as part of preparing civil engineers for the tasks emerging in the twenty-first century.

In listing the competences, it will also be remembered that the Civil Engineering sector is mainly divided into (1) consultants, (2) contractors and (3) project managers. Typically, the options for a new Civil Engineering graduate are consulting or contracting. Usually a high level of professional experience is required to become a project manager.

In determining approaches to the new curricula, it is also noted that the Civil Engineering profession is highly regulated in most African countries. Thus regulations, standards and quality assurance are of vital interest. It must be realised that within the profession that a registered or licensed professional engineer may prepare, sign and seal, and submit engineering plans and drawings to public authorities for approval or seal engineering works for public and private clients.

The unique situation in Africa demands creativity in curriculum implementation to overcome several bottlenecks and hurdles. In many countries, universities often cannot provide state-of-the-art teaching and research infrastructure and facilities like laboratories, seminar rooms and lecture halls, staff offices, a variety of well-equipped and maintained workshops, recreation facilities, libraries and studios for practical work. Other frequent gaps are the availability of computer labs and educational software, internet access and even e-mail addresses for staff and students. The provision of postgraduate training programmes and research resources is likewise limited.

11.4. Staff Development Needs

To implement the new curricula, there is the need to develop requisite capacity in terms of staff and relevant learning materials. The staff must be trained to embrace new teaching methods, learning activities and assessment techniques. Individual institutions must systematically engage the staff in the change process, offer the necessary training and ensure transformation to the new approaches. Institutional networks must also be established in the various subject areas to encourage peer review of activities using mutually developed instruments to achieve the desired harmonisation. The staff development programme must achieve the following outcomes, among others:

i. Further develop their experience of and skills in conducting focussed familiarization workshops and presentations on student-centred learning.

ii. National and international African bodies having larger visible pool of experts on which to draw for further developmental work related to the harmonisation process. The expertise will span the teaching, learning and assessment aspects.

iii. Engagement in and reflection on a wide variety of learning-centred activities that can be used in their work.

iv. Co-designing and co-facilitation of workshops by participants thereby supporting them in the role of staff developers or mentors for other academics.

v. Participation at all levels in single and multi-disciplinary groups.

The whole concept of student-centred learning is new to the profession in Africa. It entails an entire paradigm shift in the teaching of Civil Engineering on the continent. The situation is further complicated by low staff capacity and other challenges in resources as explained above.

As part of the staff development initiatives, the idea of Teaching, Learning and Assessment (TLA) approaches will be to allow students reach the Intended Learning Outcomes (ILOs) in a course of study, described as "alignment" of TLA with ILOs of a course of study (Biggs, 2002). The approach must make transparent the relationship between university education and core or transferable skills. The training must address the questions:

> Which are appropriate modes of teaching?
>
> Which learning activities might best foster competences in terms of knowledge, understanding and skills?
>
> And how do we assess these competences?

The training will expand TLA to cover the activities listed in Table 11.1. A discussion of the activities can be found at http://www.unideusto.org/tuningeu/teaching-learning-a-assessment.html. It is noted that the lists are indicative only. For instance, how each teaching technique is undertaken may vary widely not only between academics but within the everyday practice of any one academic. Learning activities are the activities students are required to undertake in a programme or part of a programme of study while the assessment list gives a range of modes of assessment.

There is need for extensive consultation for a better overview of possible teaching, learning and assessment strategies. The staff must answer the questions:

- What does this competence mean for the students?
- How do you help students to achieve this competence in your teaching methods?
- What learning activities do your students engage with in order to develop this competence?
- How do you assess whether, or to what degree, they have achieved this competence?
- How do your students know whether or to what degree they have achieved this competence, and if not, why have they not achieved it?

Table 11.1
Teaching, Learning and Assessment Techniques

Teaching Techniques	
a.	Seminar (small group teaching)
b.	Tutorials
c.	Research seminar
d.	Exercise classes or courses
e.	Workshops (classroom based practical classes)
f.	Problem-solving sessions
g.	Laboratory teaching
h.	Demonstration classes
i.	Placement (internship/traineeship)
j.	Work based practice
k.	Fieldwork
l.	Online / Distance or e-learning: which may be paper based or ICT based
Learning Activities	
a.	Conduct searches for relevant materials in libraries and on-line
b.	Survey literature
c.	Summarise those readings which seem to be most relevant to their current needs.
d.	Learn to pose problems as well as solve those set by the lecturer
e.	Conduct increasingly complex even if small scale, research
f.	Practise technical or laboratory skills
g.	Practise professional skills (e.g. in Nursing, Medicine, Teaching)
h.	Research and write papers, reports, dissertations of increasing difficulty (in terms of size and complexity of the material)
i.	Work with other students to co-produce a report/design/answer to a problem
j.	Prepare and make oral presentations, either in groups or individually
k.	Make constructive criticism of the work and others, and use the criticism of others productively
l.	Chair and participate usefully in meetings (of seminar groups, for example)
m.	Lead or be useful members of teams
n.	Work under time constraint to meet deadlines
o.	Communicate questions and findings with others using a variety of media
p.	Learn to criticise their own work
Assessment Methods	
a.	Tests of knowledge or skill
b.	Oral presentations
c.	Laboratory reports
d.	Analyses, e.g. of texts, data
e.	Performance of skills while being observed e.g. in work placements, laboratories
f.	Work placement reports or diaries
g.	Professional portfolios
h.	Fieldwork reports
i.	Written essays or reports or parts of these, e.g. a written review of relevant literature; a critique of contrasting research papers

11.5. Development of Courses for Staff Development

The Civil Engineering Subject Area Group will use the experience of the Tuning Africa Project to start and grow the staff development programme. Initial capacity will be through access to the suite of on-line courses developed by the Tuning Academy as part of its resources provision. Three courses are available:

1. Course 1: Course Design for Outcomes-Based Learning in Higher Education.

2. Course 2: Practical Assessment for Learning.

3. Course 3: Teaching for Active Learning in Higher Education.

The Group has also built capacity through various workshops organised at various General Meetings and between General Meetings of the Tuning Africa Project. Group members have tasks to write and implement workshops on the Project at their respective universities. These will be shared and there will be networking in the implementation.

Chapter 12

Conclusions

Kabir Bala

The Tuning Africa Project has made tremendous contribution towards aligning African Higher Education to contribute to the African vision of integration by enhancing the quality of the degrees and improving mobility and employability of the graduates. Following the success of the pilot project, which was completed in 2013, Phase II of the Tuning Africa Project was aimed at scaling up the Harmonisation and Tuning initiative to cover more universities and subject areas. This was achieved through the creation of new degree programmes, teaching, learning, assessment methods, and then defining joint agreements in the subject areas. This phase has achieved the design of degrees based on the expected competences to be developed, their implementation and formulation of the appropriate credits and workloads for the students to achieve the required learning outcomes.

The Civil Engineering Subject Area Group has presented in this book the results of its work and reflections, including those on the consultation process and concludes as follows: The respondents' perception of the importance of some competences and the extent to which they are currently achieved revealed some gaps that need to be addressed. The Civil Engineering Subject Area Group has proffered solutions by addressing the discrepancies in the current achievement of these generic and subject-specific competences and by filling the gaps identified between the level of importance assigned to the competences and their level of achievement. The suggested solutions include:

- The use of ''course-practical attachment, the 'industrial attachment'' or the work integrated learning' approaches such as the ones used in South Africa. The gaps can also be addressed through 'qualified internship under academic mentorship', as practised in Ethiopia's Engineering Capacity Building Programme.

- The "Service learning" model, being practised in South Africa, which encourages students' participation by allowing them to earn certain notional hours can also be adopted.

- The use of multidisciplinary teams with experts in health and safety giving additional lectures and gaining practical experience through case studies on regulations, safety and project management can also be useful.

It is the belief of the Civil Engineering group that gaps and discrepancies in curricula can easily be bridged by the incorporation of the meta-profile in curriculum review processes across Africa.

The SAG has also stressed the need for improving the Civil Engineering curriculum in Africa, in order to address challenges posed by ongoing technological developments, changes in labour market demand for various skills and the impact of the economic crisis in the various African countries. The reforms should be able to significantly contribute to the goals of making the national economies more efficient, competitive and responsive to disparate needs of the countries and the region in general. It was, however, found that some African countries are fostering curriculum reform and modernisation as part of their national development strategies.

Despite some differences between competences for Latin America and Africa, members of the Civil Engineering working group believe that there is a prospect for the integration of qualifications across the two continents. This is because the elements of cognitive, social and interpersonal skills as well as technological and international dimensions captured in the Latin American experience, can also be identified in the African meta-profile.

After comparing the Meta-profile of Civil Engineering in the curricula of the participating African Universities, the Tuning Africa Working Group in Civil Engineering found it to be well aligned with the requirements of the Professional Engineering Institutions in their respective countries. The working group also espoused the need to distinguish between knowledge and competences to be developed in the Civil Engineering field since some of the competences cannot be applied if students have not gained the relevant knowledge.

The Civil Engineering curriculum in Africa was compared to other existing Tuning models in Latin America, Europe and Russia. The results revealed some areas of improvement in the African Civil Engineering curriculum in, among other areas, providing for hands-on internship training during the study period and broadly defining competencies according to study years. Moreover, the Latin America competences were systematised in advance into social, cognitive, technological and ethical categories and groupings, while those of Africa were clustered as a step following the identification of generic and subject-specific competences.

The group also examined how workload is determined and what is required for a Civil Engineering qualification in African Universities using the South African school and university models as examples. Academics and Students do not agree wholly on how the independent work time should be spent, but there is a consensus on the amount of time spent on contact hours and independent work. There is a challenge of making sure that students properly use their time on independent work because of the importance attached to student-based learning.

In this phase of the project, efforts have been made to successfully arrive at agreements on student workload, credits transfer and mobility across the African countries offering Civil Engineering. Meta-profiles have been agreed upon by the members of the subject area, following the established quality control measures.

The successes recorded in the Tuning Africa II Project generally, and especially in the Civil Engineering Subject Area, will be effectively consolidated by ensuring broader institutional and political backing. The establishment of the regional Tuning centres, and the continuous involvement of professional and regulatory institutions will ensure a more holistic implementation and dissemination. The Tuning centres will play a vital role in ensuring the implementation of the harmonisation and alignment process at the national, regional, and continental levels. This will engender seamless integration, through the Tuning Methodology of the Civil Engineering curricula in Africa.

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