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Standards for engineering programmes – First draft

Programme Evaluation for Transparency and Recognition of Skills and Qualifications

TLQAA+

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Introduction

The Erasmus+ project "Programme Evaluation for Transparency and Recognition of Skills and Qualifications" sets the elements for the quality assurance and guarantee of relevance of Lebanese Higher Education Programmes. The project is divided into several work packages. The work package 1 (WP1) deals with qualifications framework as a tool that helps, among other things, in guaranteeing the relevance of the academic programmes. The work package 5 (WP5) defines for the evaluation of all programmes, the core set of standards and guidelines. Work package 6, has been dedicated to adapting the core standards to the engineering education and to customise the adopted Lebanese Qualifications Framework (LQF) to the engineering sector. The aim is to use the adapted standards and sectoral QF to evaluate engineering programmes and guarantee their relevance to the societal needs.

For this purpose, a bibliographical study is first conducted and is summarised in the next section. This study that covered several countries allowed us to summarise and compare the expected engineering competencies. It also allowed us to compare the standards used to evaluate the enegineering programmes.

Based on the outcomes of WP1 and WP5 and on the study conducted, the core standards have been adapted to the engineering education and the QF descriptors relative to the engineering sector have been defined as shown the final sections of the present document.

Bibliographical study about engineering competencies

This section summarizes the results of the bibliographical study that was conducted on engineering competencies in different countries and regions. The following section reports the engineering competencies as stated by different engineering education bodies.

Introduction

Globalization has made necessary the recognition of internationally acceptable skills and abilities acquired through the engineering programmes. This has led to the development of internationally recognized framework standards for engineering education.

As a global classification, engineering education standards are derived nowadays based on two International Agreements:

- The Washington Accord[1]
- The EUR-ACE[2] Accord[3]

The Washington Accord

The Washington accord (International Engineering Alliance (IEA), 2014) is "*An agreement that was put in place in year 1989, by a number of international signatories, recognizing their approaches and systems for accrediting engineering programs as comparable.*"

The aim of this agreement was to facilitate the review of academic credentials of an engineer from one country by the licensing/regulatory body of another country.

[1] http://www.ieagreements.org/accords/washington/
[2] European Accreditation for Engineering
[3] https://www.enaee.eu/accredited-engineering-courses-html/eur-ace-accord/

A Brief History

The Washington Accord was originally signed in 1989 by six founding organisations from six countries which are:

- Engineers Australia
- Engineers Canada
- Engineers Ireland
- Institute of Professional Engineers New Zealand[4]
- Engineering Council (UK)
- Accreditation Board for Engineering and Technology[5] (USA)

Noticing the substantial equivalence between their individual processes for granting accreditation to university level engineering programmes, the signatory organisations in 1989 agreed to recommend to registering bodies the recognition of the same rights and privileges to graduates of programmes accredited by other signatories as they grant to their own accredited programmes. Thus, the Washington Accord is primary a recognition accord that makes use of quality assurance mechanisms to guarantee an informed recognition of competencies in engineering.

It is worth noting that the signatories of the Washington Accord have increased since the foundation and include in addition to the founding organisations: The Hong Kong Institution of Engineers (1995), Engineering Council of South Africa (1999), Japan Accreditation Board for Engineering Education (2005), Institution of Engineers Singapore (2006), Institution of Engineering Education Taiwan (2007), Accreditation Board for Engineering Education of Korea (2007), Board of Engineers Malaysia (2009), Association for Evaluation and Accreditation of Engineering Programs (Turkey) (2011), Association of Engineering Education Russia (2012), National Board of Accreditation (India) (2014), Institution of Engineers Sri Lanka (2014), China Association for Science and Technology (2016), Pakistan Engineering Council (2017) and "Instituto de Calidad Y Accreditacion de Programas de Computacion, Ingeneria Y Technologia" (Peru) (2018). In addition five institutions are in the status of provisional signatories.

Besides the Washington Accord two similar accords; the Sydney and Dublin Accords, were established for engineering technologists and engineering technicians in 2001 and 2002, respectively. The three Accords have served as a basis for the establishment of the International Engineering Alliance (IEA) in 2007.

Graduates Attributes and Professional Competencies

In (International Engineering Alliance, 2013), the graduates attributes and the required professional competencies for the three accords are provided. The document and the accords, recognise the dependence of the competence definition on the context of application of this competence. Therefore, it is stated that "*The application of a competency profile may require amplification in different regulatory, disciplinary, occupational or environmental contexts. In interpreting the statements within a particular context, individual statements may be amplified and given particular emphasis but must not be altered in substance or ignored*". Hereafter are summarized the competency profiles according to the Washington Accord.

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[4] Today "Engineering New Zealand"
[5] ABET

Before defining the attributes of the graduates and the professional competencies, the engineering activities are specified as well as what is understood by complex problem solving.

First, (International Engineering Alliance, 2013) classifies the engineering activities into three classes:

- Complex activities
- Broadly defined activities
- Well-defined activities

Each class of activities is defined with a sect of descriptors defining its attributes in terms of:

- Range of resources
- Level of interactions
- Innovation
- Consequences to society and the environment
- Familiarity

Moreover, a range of problem solving is defined and provided in the following table.

Attribute	Complex Engineering Problems
Depth of Knowledge Required	**WP1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of WK3, WK4, WK5, WK6 or WK8 which allows the fundamentals-based, first principles analytical approach
Range of conflicting requirements	**WP2:** Involve wide-ranging or conflicting technical, engineering and other issues
Depth analysis required	**WP3:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
Familiarity of issues	**WP4:** Involve infrequently encountered issues
Extent of applicable codes	**WP5:** Are outside problems encompassed by standards and codes of practice for professional engineering
Extent of stakeholder involvement and conflicting requirements	**WP6:** Involve diverse groups of stakeholders with widely varying needs
Interdependence	**WP7:** Are high level problems including many component parts or sub-problems

Table 1. Descriptors of complex engineering problems reproduced from (International Engineering Alliance, 2013)

In addition to the previous, definitions of complex engineering problems can also be characterised in the context of the professional competencies as shown in Table 2.

Attribute	Complex Engineering Problems
Consequences	**EP1:** Have significant consequences in a range of contexts
Judgement	**EP2:** Require judgement in decision making

Table 2. Descriptors of complex engineering problems in the context of the professional competencies

The Washington Accord defines the profiles of an engineering programme by eight attributes of its knowledge profile and twelve attributes of its graduate profile. According to (International Engineering Alliance, 2013) these are:

Knowledge Profile

WK1 A systematic, theory-based understanding of the **natural sciences** applicable to the discipline

WK2 Conceptually-based **mathematics**, **numerical analysis**, **statistics** and formal aspects of **computer and information science** to support analysis and modelling applicable to the discipline

WK3 A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline

WK4 Engineering **specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5 Knowledge that supports **engineering design** in a practice area

WK6 Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline

WK7 **Comprehension** of the role of engineering in society and identified issues in engineering practice in the discipline: **ethics** and the **professional responsibility** of an engineer to **public safety**; the impacts of engineering activity: economic, social, cultural, environmental and sustainability

WK8 Engagement with selected knowledge in the **research literature** of the discipline

Graduate Attribute Profile

WA1 **Engineering Knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to the solution of complex engineering problems.

WA2 **Problem Analysis:** Identify, formulate, research literature and analyse *complex* engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (WK1 to WK4)

WA3 **Design:** Design solutions for *complex* engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)

WA4 **Investigation:** Conduct investigations of *complex* problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

WA5 **Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *complex* engineering problems, with an understanding of the limitations. (WK6)

WA6 **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7)

WA7 **Environment and Sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)

WA8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (WK7)

WA9 **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

WA10 **Communication:** Communicate effectively on *complex* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

WA11 **Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

WA12 **Lifelong Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

The previous descriptors appear to be an adaptation of the general descriptors of level 7 in the LQF as adopted in Erasmus+ TLQAA+ WP1 (TLQAA+ WP1, 2018) to the engineering sector.

The EUR-ACE Accord

The EUR-ACE Accord[6] (European Network for Accreditation of Engineering Education) is an agreement that was established by the European Network for Accreditation of Engineering Education (ENAEE), between 13 agencies in Europe to award EUR-ACE Label in addition to national accreditation. Similarly to the Washington Accord, the EUR-ACE Accord is a recognition agreement whereby the signatories accept each other's accreditation decisions about Bachelor and Master degree programmes.

Presently, 15 agencies have signed the EUR-ACE Accord. These are: ASIIN[7] (Germany), CTI[8] (France), Engineering Council (UK), Engineering Ireland (Ireland), Ordem dos Engenheiros (Portugal), AEER[9] (Russia), Müdek[10] (Turkey), ARACIS[11] (Romania), QUACING[12] (Italy), KAUT[13] (Poland), AAQ[14] (Switzerland), ANECA[15] (Spain), FINEEC[16] (Finland), ZSVTS[17] (Slovakia), KazSEE[18] (Kazakhstan).

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[6] First signed in 2014
[7] Fachakkreditierungsagentur für Studiengänge der Ingenieurwissenschaften, der Informatik, der Naturwissenschaften, und der Mathematik
[8] Commission des Titres d'Ingénieur
[9] Association for Engineering Education of Russia
[10] Association for Evaluation and Accreditation of Engineering Programs
[11] The Romanian Agency for Quality Assurance in Higher Education
[12] Agenzia per la Certificazione di Qualità e l'Accreditamento EUR-ACE dei Corsi di Studio in Ingegneria
[13] Komisja Akredytacyjna Uczelni Technicznych
[14] Schweizerische Agentur für Akkreditierung und Qualitätssicherung

It is worth noting that four organizations are members in both Washington Accord and EUR-ACE Accord. Actually, mutual understanding between IEA and ENAEE is considered in a formal mechanism between both institutions.

EUR-ACE Framework Standards

The EUR-ACE Framework Standards and Guidelines (EAFS) are published by the ENAEE (European Network for Accreditation of Engineering Education, 2015). An accreditation and quality assurance agency can award the EUR-ACE label if the agency satisfies the standards defined in the EAFS.

The EAFS defines the framework of the programme outcomes that shall be respected in order to allow the award of the EUR-ACE label. The framework requires the Programme Outcomes:

- To be expressed under knowledge, understanding, skills and abilities
- To be used in both the design of an engineering programme by the higher education institution and its evaluation by an agency

The Programme Outcomes are described separately for both Bachelor and Master Degree programmes with reference to the following eight learning areas:

1- Knowledge and understanding;
2- Engineering Analysis;
3- Engineering Design;
4- Investigations;
5- Engineering Practice;
6- Making Judgements;
7- Communication and Team-working;
8- Lifelong Learning.

	Bachelor Degree	**Master Degree**
Knowledge and understanding	• knowledge and understanding of the mathematics and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes; • knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront; • awareness of the wider multidisciplinary context of engineering.	• **<u>in-depth</u>** knowledge and understanding of mathematics and sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes; • **<u>in-depth</u>** knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes; • **<u>critical awareness of the forefront of their specialisation</u>**; • **<u>critical</u>** awareness of the wider multidisciplinary context of engineering **<u>and of knowledge issues at the interface between different fields</u>**.
Engineering Analysis	• ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and	• ability to analyse **<u>new and</u>** complex engineering products, processes and systems **<u>within broader or multidisciplinary contexts</u>**; to select and apply **<u>the most appropriate</u>** and relevant

[15] National Agency for Quality Assessment and Accreditation of Spain
[16] Korkeakoulujen arviointineuvosto KKA
[17] Zväz slovenských vedeckotechnických spoločností
[18] Kazakhstan Society for Engineering Education

	experimental methods; to correctly interpret the outcomes of such analyses; • ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical–societal, health and safety, environmental, economic and industrial - constraints.	methods from established analytical, computational and experimental methods <u>or new and innovative methods</u>; to <u>critically</u> interpret the outcomes of such analyses; • <u>ability to conceptualise engineering products, processes and systems</u>; • ability to identify, formulate and solve <u>unfamiliar complex</u> engineering problems <u>that are incompletely defined, have competing specifications, may involve considerations from outside their field of study and</u> non-technical – societal, health and safety, environmental, economic and industrial – constraints; <u>to select and apply the most appropriate and relevant methods from established analytical, computational and experimental methods or new and innovative methods in problem solving</u>; • <u>ability to identify, formulate and solve complex problems in new and emerging areas of their specialisation</u>.
Engineering Design	• ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical – societal, health and safety, environmental, economic and industrial– considerations; to select and apply relevant design methodologies; • ability to design using some awareness of the forefront of their engineering specialisation.	• ability to develop, to design <u>new</u> and complex products (devices, artefacts, etc.), processes and systems, <u>with specifications incompletely defined and/or competing, that require integration of knowledge from different fields</u> and non-technical – societal, health and safety, environmental, economic and industrial commercial – constraints; to select and apply <u>the most appropriate</u> and relevant design methodologies <u>or to use creativity to develop new and original design methodologies</u>. • ability to design using <u>knowledge and understanding</u> at the forefront of their engineering specialisation.
Investigations	• ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues <u>in their field of study</u>; • ability to consult and apply codes of practice and safety regulations <u>in their field of study</u>; • laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions <u>in their field of study</u>.	• <u>ability to identify, locate and obtain required data</u>; • ability to conduct searches of literature, to consult and critically use databases and other sources of information, to carry out simulation in order to pursue detailed investigations and research of <u>complex</u> technical issues; • <u>ability to consult and apply codes of practice and safety regulations</u>; • <u>advanced</u> laboratory/workshop skills and ability to design and conduct experimental investigations, <u>critically evaluate</u> data and draw conclusions; • <u>ability to investigate the application of new and emerging technologies at the forefront of their engineering specialisation</u>.

Engineering Practice	• understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study; • practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study; • understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study; • ability to apply norms of engineering practice in their field of study; • awareness of non-technical -societal, health and safety, environmental, economic and industrial - implications of engineering practice; • awareness of economic, organisational and managerial issues (such as project management, risk and change management) in the industrial and business context.	• **comprehensive** understanding of applicable techniques and methods of analysis, design and investigation and of their limitations; • practical skills, **including the use of computer tools**, for solving complex problems, realising complex engineering design, **designing** and conducting complex investigations; • **comprehensive** understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations; • ability to apply norms of engineering practice; • **knowledge and understanding** of the non-technical – societal, health and safety, environmental, economic and industrial – implications of engineering practice; • **critical** awareness of economic, organisational and managerial issues (such as project management, risk and change management)
Making Judgements	• ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues; • ability to manage complex technical or professional activities or projects in their field of study, taking responsibility for decision making.	• **ability to integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgement**; • ability to manage complex technical or professional activities or projects **that can require new strategic approaches**, taking responsibility for decision making.
Communication and Team-working	• ability to communicate effectively information, ideas, problems and solutions with engineering community and society at large; • ability to function effectively in a national and international context, as an individual and as a member of a team and to cooperate effectively with engineers and non-engineers.	• ability **to use diverse methods** to communicate **clearly and unambiguously their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences in national and international contexts**; • ability to function effectively in national and international contexts, as a member or **leader of a team**, that may be **composed of different disciplines and levels, and that may use virtual communication tools**.
Lifelong Learning	• ability to recognise the need for and to engage in independent life-long learning; • ability to follow developments in science and technology.	• ability to **engage** in independent life-long learning; • **ability to undertake further study autonomously.**

Table 3. Descriptors of Engineering Programme Outcomes as defined in EAFS (European Network for Accreditation of Engineering Education, 2015) for both Bachelor and Master levels. The words marking the differences between the two levels are marked.

ABET Student Outcomes

The Accreditation Board of Engineering and Technology (ABET) (ABET Engineering Accreditation Committee) is an engineering professional body responsible of the education, accreditation, regulation and professional development of engineering in the United States. ABET is a founding signatory organization of the Washington Accord and is a non-governmental organization recognized by the Council for Higher Education Accreditation (CHEA).

Similarly to the graduate attribute Profile of the Washington Accord and the Outcomes of an engineering programme of EUR-ACE, ABET defines the attribute profile of a graduate from an engineering programme as Student Outcomes. The ABET Student Outcomes are discipline independent for the Bachelor level. These Outcomes become discipline dependent at the Master level where scientific and professional communities take part in the definition of those outcomes.

At the Bachelor level, ABET Student outcomes are commonly known as outcomes (a) through (k). ABET welcomes any additional outcomes that may be articulated by a program. It is supposed that the attainment of these outcomes prepares graduates to enter the professional practice of engineering. The Student Outcomes for a Bachelor Programme are provided in Table 4.

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyse and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Table 4. The Student Outcomes as defined by ABET for the accreditation of Engineering Programmes at the Bachelor level (ABET, 2017).

ABET student outcomes are regularly reviewed and updated. In 2018, the (a) through (k) student outcomes have been updated and are now (1) to (7) outcomes (ABET, 2017). The table below illustrates the mapping between the (a) through (k) outcomes and the (1) to (7) outcomes, that will be applicable for the 2019-2020 cycle of engineering programme evaluation.

(a) an ability to apply knowledge of mathematics, science, and engineering (e) an ability to identify, formulate, and solve engineering problems	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(b) an ability to design and conduct experiments, as well as to analyse and interpret data	6. an ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(d) an ability to function on multidisciplinary teams	5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (j) a knowledge of contemporary issues	4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(g) an ability to communicate effectively	3. an ability to communicate effectively with a range of audiences
(i) a recognition of the need for, and an ability to engage in life-long learning	7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	Implied in 1, 2, and 6

Table 5: Mapping between the (a) through (k) outcomes and the (1) to (7) outcomes, updated by ABET

CTI engineering outcomes

The "Commission des Titres d'Ingénieurs" (CTI), is a French national agency evaluating all engineering programmes. CTI has been established since 1931, and it has accumulated through the years a large experience in evaluating engineering programmes. The standards and procedures of CTI are regularly updated like in the case of ABET and other agencies. A major specificity of CTI is its attachment to significantly consider the expectations of the professional fields for engineering graduates. One can read in the introduction to the expected engineering competencies by CTI (CTI, 2016):

"*The expectations of the professional world, the society and the individuals, expressed in terms of the skills required for the practice of engineering have evolved over time. Initially focused on scientific and technical aspects, they have gradually expanded to meet the needs of companies and engineers.*"[19]

According to CTI "*Engineers need to have a broad view of their field, be both operational and able to stay that way. They must be able to change their specialty and their cultural and technical environment and evolve within the hierarchy of the company or any other company, while remaining concerned about their personal balance and the well-being of the society.*"[20]

The CTI makes use of programme learning outcomes to designate the prfile attribute of a graduate. A set of learning outcomes have been defined and constitute a generic repository of competencies for any engineering programme. These learning outcomes are called "Réferentiel de base de compétences" or Basic Competences Standards. This generic repository consists of a set of learning outcomes related to knowledge, skills and attitudes. It is therefore conformant to the qualifications framework division of the competences. As stated earlier, the learning outcomes are regularly updated by the CTI.

The actual outcomes have been extended from previously nine to fourteen learning outcomes that are regrouped in 3 main categories as follow (CTI, 2016)[21]:

The Acquisition of Scientific and Technical Knowledge and the Ability of their implementation:

1- Knowledge and understanding of a broad range of basic sciences and the related analytical and synthesis skills
2- Aptitude to mobilise the resources of a specific scientific and technical field
3- Proficiency of engineering methods and tools: identification, modelling and problem solving, even those that are not familiar and not fully defined, the use of computing tools, the analysis and design of systems
4- Ability to design, implement, test and validate innovative solutions, methods, products, systems and services
5- Ability to carry out research activities, fundamental or applied, and to set up experimentations, and to open up to the practice of collaborative work
6- Ability to find, evaluate and use relevant information

The Adaptation to the Specific Requirements of an Enterprise or the Society

7- Aptitude to consider business issues: economic dimension, respect for quality procedures, competitiveness and productivity, commercial requirements, economic intelligence

[19] Translated from French
[20] Translated from French
[21] Translated from French

8- Aptitude to consider the issues of work relations, ethics, responsibility, work safety and health
9- Aptitude to consider environmental issues, particularly through the application of the principles of sustainable development
10- Aptitude to consider the societal issues and needs

Taking into Account the Organizational, Personal and Cultural Dimension

11- Ability to integrate a professional life, to integrate into an organization, to animate and drive it forward: self-awareness, team spirit, commitment and leadership, project management, communication capacity with specialists and non-specialists
12- Ability to undertake and innovate, as part of personal projects or through initiative and involvement within the enterprise in entrepreneurial projects
13- Aptitude to work in an international context: mastering of one or more foreign languages and associated cultural openness, ability to adapt to international contexts
14- Ability to self-identify, self-assess, and manage self skills (especially in a lifelong learning perspective), to make professional choices

In order to evaluate the evolution of the CTI engineering learning outcomes, the ones relative to 2009 (CTI, 2010) are recalled hereafter:

1- **Knowledge and understanding of a broad range of basic sciences** and the related capacity to summarize and perform analysis,
2- **Aptitude to use the scientific and technical resources related to a specialty,**
3- **Understanding of engineering methods and tools**: identification and resolution of problems, even those that are not familiar and not fully defined, possibly using experimentation, innovation and research, the collection and interpretation of data, the use of computing tools, the analysis and design of systems,
4- **Capacity to join an organization, to lead it and drive it forward**: self-awareness, team spirit, commitment and leadership, project management, project coordination, communication with specialists and non-specialists alike,
5- **Aptitude to take on board professional issues**: corporate spirit, competitiveness and productivity, innovation, intellectual and industrial property, respect for quality procedures, security, health and safety in the workplace,
6- **Aptitude to work in an international context**: command of one or more foreign languages, cultural open-mindedness, international experience, business intelligence,
7- **Aptitude to put sustainable development principles into practice**: environment, economy, labor and corporate governance,
8- **Aptitude to consider and foster societal values**: endorsing social values, responsibility, ethics, health and safety,
9- **Capacity to follow through on their professional choices** and fit into a professional context.

Considering the CTI learning outcomes and their evolution the following comments can be formulated:

- Going from nine to fourteen learning outcomes shows that CTI wants to focus on very specific aspects. An example is the ability to work in international context.
- The entrepreneurial ability is more highlighted in the recent version of the learning outcomes.
- The reflexive approach is a distinctive learning outcome and is clearly identified in the learning outcome 14.

Mapping between the ABET and CTI Programme Learning Outcomes

Another important aspect is related to the compare the ABET Programme Outcomes to the CTI Learning Outcomes. A mapping is provided in the following table.

ABET	CTI
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1- Knowledge and understanding of a broad range of basic sciences and the related capacity to summarize and perform analysis, 2- Aptitude to use the scientific and technical resources related to a specialty,
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	4- The ability to design, implement, test and validate innovative solutions, methods, products, systems and services, 7- Aptitude to take on board business issues: economic dimension, respect for quality procedures, competitiveness and productivity, commercial requirements, business intelligence, 8- Aptitude to take on board the issues of work relations, endorsing ethics, responsibility, safety and health at work, 9- Aptitude to take on board environmental issues, particularly through the application of the principles of sustainable development, 10- Aptitude to take on board the issues and needs of the society.
3. an ability to communicate effectively with a range of audiences	11- The ability to integrate into professional life, to integrate into an organization, to animate and drive it forward: self-awareness, team spirit, commitment and leadership, project management, communication capacity with specialists as well as with non-specialists,
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,	8- Aptitude to take on board the issues of work relations, endorsing ethics, responsibility, safety and health at work,

which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	9- Aptitude to take on board environmental issues, particularly through the application of the principles of sustainable development, 10- Aptitude to take on board the issues and needs of the society.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	11- The ability to integrate into professional life, to integrate into an organization, to animate and drive it forward: self-awareness, team spirit, commitment and leadership, project management, communication capacity with specialists as well as with non-specialists,
6. an ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions	3- The ability or proficiency (la maitrise) to use engineering methods and tools: identification, modelling and problem solving, even those that are not familiar and not fully defined, the use of computing tools, the analysis and design of systems, 5- the ability to carry out research activities, fundamental or applied, and to set up experimentations, and to open up to the practice of collaborative work,
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	14- The ability to self-identify, self-assess, and self-manage skills (especially in a lifelong learning perspective), to make professional choices (Reflexive approach).
	6- The ability to find, evaluate and use relevant information.
	12- The ability to undertake and innovate, as part of personal projects or through initiative and involvement within the company in entrepreneurial projects,
	13- Aptitude to work in an international context: command of one or more foreign languages and associated cultural openness, ability to adapt to international contexts,

Table 6. Mapping between the ABET Programme Outcomes and the CTI Learning Outcomes

Based on Table 6, the following comments can be formulated:

- The ABET Programme Outcomes and the CTI Learning Outcomes are comparable
- CTI Learning Outcomes are slightly more specific, while ABET groups together several programme outcomes

- CTI learning outcomes stress more on entrepreneurship, research activities and internationalisation

Proposed Lebanese Engineering Competencies

In Table 7, a set of competencies for the Lebanese engineers is suggested and compared to the ABET and CTI list of required competencies. These competencies need to be discussed and validated in a national roundtable that shall be organised within the Erasmus+ TLQAA+ project.

ABET	CTI	Lebanese Engineers
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1- Knowledge and understanding of a broad range of basic sciences and the related capacity to summarize and perform analysis, 2- Aptitude to use the scientific and technical resources related to a specialty,	1. Assimilate and use scientific and technical engineering resources 2. Solve engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	5- The ability to design, implement, test and validate innovative solutions, methods, products, systems and services, 12- Aptitude to take on board business issues: economic dimension, respect for quality procedures, competitiveness and productivity, commercial requirements, business intelligence, 13- Aptitude to take on board the issues of work relations, endorsing ethics, responsibility, safety and health at work, 14- Aptitude to take on board environmental issues, particularly through the application of the principles of sustainable development, 15- Aptitude to take on board the issues and needs of the society.	3. Design, implement and test engineering solutions, systems and services 4. Respect economic/commercial dimension, quality, competitiveness, productivity, safety, and sustainability in the design and implementation of an engineering solution
3. an ability to communicate effectively with a range of audiences	1. The ability to integrate into professional life, to integrate into an organization, to animate and drive it forward:	5. Communicate clearly and effectively

	self-awareness, team spirit, commitment and leadership, project management, communication capacity with specialists as well as with non-specialists,	
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	11- Aptitude to take on board the issues of work relations, endorsing ethics, responsibility, safety and health at work, 12- Aptitude to take on board environmental issues, particularly through the application of the principles of sustainable development, 13- Aptitude to take on board the issues and needs of the society.	6. Apply professional codes and respect ethical and professional values while exercising engineering
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	12- The ability to integrate into professional life, to integrate into an organization, to animate and drive it forward: self-awareness, team spirit, commitment and leadership, project management, communication capacity with specialists as well as with non-specialists,	7. Work in a team and lead the development of engineering practices and processes 8. Advance engineering knowledge, practices, processes and systems
6. an ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions	5- The ability or proficiency (la maitrise) to use engineering methods and tools: identification, modelling and problem solving, even those that are not familiar and not fully defined, the use of computing tools, the analysis and design of systems, 7- the ability to carry out research activities, fundamental or applied, and to set up experimentations, and to open up to the practice of collaborative work,	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	15- The ability to self-identify, self-assess, and self-manage skills (especially in a lifelong learning perspective), to make professional choices (Reflexive approach).	9. Apply enquiry competences and search for new engineering solutions and systems 10. Adapt to new working

		contexts
	13- The ability to undertake and innovate, as part of personal projects or through initiative and involvement within the company in entrepreneurial projects,	
	14- Aptitude to work in an international context: command of one or more foreign languages and associated cultural openness, ability to adapt to international contexts,	11. Work in an international context showing good linguistic skills and cultural knowledge
	6- The ability to find, evaluate and use relevant information.	

Table 7. Comparison of engineering competencies between ABET, CTI and the suggested ones in Erasmus+ TLQAA+

Bibliographical study about standards for engineering programmes

Most of the quality assurance agencies dealing with programme evaluation have set standards for the evaluation of the programmes against. Traditionally, most of the engineering programmes in Lebanon are linked to either similar French or American programmes. Thus, both the ABET and CTI programmes are overviewed in this section.

ABET

Regularly, ABET's Board of Directors updates the set of criteria. This makes the set of criteria used for the evaluation living and responding to the rapid change in the engineering knowledge and technological development. The review of the ABET criteria is often done on a yearly basis.

The ABET criteria are separated into two sets (ABET, 2017): general criteria and programme-specific criteria. The general criteria are separated into subsets depending of the level of the programme: bachelor level, integrated bachelor-master, and master level. It is also to be noted that the programme-specific criteria are jointly defined with professional societies representing the professional and scientific communities operating in the field of engineering.

According to (ABET, 2017) the bachelor's level general criteria are:

Criterion 1: Students

Criterion 2: Program Educational Objectives

Criterion 3: Student Outcomes

Criterion 4: Continuous Improvement

Criterion 5: Curriculum

Criterion 6: Faculty

Criterion 7: Facilities

Criterion 8: Institutional Support

The Master's level general criteria are:

- Students and Curriculum
- Program Quality
- Faculty
- Facilities
- Institutional Support

CTI

CTI regularly updates its standards. The standards are set respecting the evolution of the engineering profession and required skills and competences. The process of defining the standards involves the major stakeholders. The standards are centred on the programme itself but also on its sustainable quality. The CTI standards are in conformance with the European requirements. The standards cover:

A. Mission and organisation of the programme
B. Partnership and openness
C. Engineering programme
D. Enrolment of students
E. Employment of graduates
F. Quality process and continuous improvement

Comparison

Table 8 provides a correspondence between ABET (Bachelor's and Master's levels), CTI and Erasmus+ TLQAA+ core standards for engineering programmes. While there is a clear overlap between these standards, it is worth noting that CTI standards stress more on the enrolment and employability of the graduates as well as on the openness and international dimension of the programme. The Erasmus+ TLQAA+ core standards put forward the services offered to the students and the budget allocated to the programme.

<table>
<tr><th colspan="2">ABET</th><th rowspan="2">CTI</th><th rowspan="2">TLQAA+ Core Standards</th></tr>
<tr><th>Bachelor’s</th><th>Master’s</th></tr>
<tr><td rowspan="2">Students</td><td rowspan="5">Students and Curriculum</td><td>Enrolment of students</td><td rowspan="3">Assessment and Student Success</td></tr>
<tr><td>Employment of graduates</td></tr>
<tr><td>Student’s Outcomes</td><td rowspan="3">Engineering programme</td></tr>
<tr><td>Program Educational Objectives</td><td rowspan="2">Curriculum</td></tr>
<tr><td>Curriculum</td></tr>
<tr><td>Continuous Improvement</td><td>Program quality</td><td>Quality process and continuous improvement</td><td>Continuous Improvement</td></tr>
<tr><td>Faculty</td><td>Faculty</td><td rowspan="3">Engineering programme</td><td>Faculty</td></tr>
<tr><td rowspan="2">Facilities</td><td rowspan="2">Facilities</td><td>Student Services</td></tr>
<tr><td>Budget, Resources and Facilities</td></tr>
<tr><td>Institutional Support</td><td>Institutional Support</td><td rowspan="2">Mission and organisation of the programme</td><td rowspan="2">Mission, Goals and Governance</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td>Partnership and openness</td><td></td></tr>
</table>

Table 8. Correspondence between ABET (ABET, 2017), CTI (CTI, 2016) and Erasmus+ TLQAA+ core standards.

Mapping the Lebanese Engineering Competencies to the LQF

The Lebanese Qualifications Framework (LQF) adopted in the Erasmus+ TLQAA+ project (work package 1) is the one defined in the frame of the ETF project. It is good to recall the recommendations that were stated for using of the LQF.

1- Add the following set of criteria to be satisfied when registering a qualification at a given level of the LQF:
  a. More than 70% of the courses LOs are at the requested LQF level
  b. More than 70% of the credits are at the requested LQF level
  c. All the credits are at two levels below the requested LQF level or above
  d. The programme and courses learning outcomes match at 80% or more the descriptor of the requested sectorial LQF level if defined
  e. The entry requirements need to be well defined and assure that the student has acquired competences relative to the previous levels of the targeted LQF level.
  f. If learners with non-NQF registered qualifications are

to be admitted to the programme, the procedures for assuring the equivalent of criterion *e* need to be provided.

2- Define a structure for managing the LQF
3- Translate the generic LQF to sectorial LQF where this is possible.

Therefore, it is mandatory to adapt the LQF for the case of engineering programme. While having an observation on the Engineering competencies/outcomes presented in the previous sections and the proposed LQF in WP1, we can identify that 80% of the engineering competencies (Table 7) can be mapped to the descriptors of Qualifications of Level 6 and Level 7.

NQF levels	Knowledge	Know-how	Social skills
level 6	Has in-depth knowledge in a sphere of work or study requiring a critical understanding of theories and principles applicable to a range of professional situations and diverse studies.	Can devise technical, methodological and conceptual solutions and demonstrate expertise and innovative ability to resolve complex and unpredictable problems in a specialist sphere of work or study, using advanced skills.	Can implement unpredictable complex technical or professional activities or projects, including responsibilities in terms of taking decisions in professional or study contexts requiring one to adapt/adaptation to new technologies and methods and to new forms of organisation. Can take on responsibilities in connection with individual and collective professional development.
	1. Assimilate and use scientific and technical engineering resources	2. Solve engineering problems by applying principles of engineering, science and mathematics 3. Design, implement and test engineering solutions, systems and services	5. Communicate clearly and effectively 7. Work in a team and lead the development of engineering practices and processes
level 7	Has highly specialised knowledge, some of which are in the vanguard of knowledge in a sphere of work or	Can solve problems relating to research and innovation, to develop new knowledge and new procedures by	Can act on complex, unpredictable professional or study contexts that require new strategic

	study, based on original ideas and/or research. Has critical awareness of knowledge in a certain field and at the interface of several fields.	mobilising highly-specialised skills. Can integrate knowledge from different areas and communicate the knowledge and the results of activities with specialists and non-specialists.	approaches. Can make judgements and exercise responsibilities, considering the social and ethical aspects associated with the decisions. Can take on responsibilities to contribute to knowledge and professional practices and/or to revise the strategic performance of teams.
	4. Respect economic/ commercial dimension, quality, competitiveness, productivity, safety, and sustainability in the design and implementation of an engineering solution	8. Advance engineering knowledge, practices, processes and systems 9. Apply enquiry competences and search for new engineering solutions and systems	6. Apply professional codes and respect ethical and professional values while exercising engineering 10. Adapt to new working contexts 11. Work in an international context showing good linguistic skills and cultural knowledge

Table 9. Mapping of the engineering competencies on the core standards defined within the Erasmus+ TLQAA+ project

Standards and guidelines from WP5 related to core standards and Adaptation to WP6

Based on the review presented in the previous section, the proposed academic standards for work package 6 as depicted in TLQAA+ project are defined in the following.

i. Mission, Goals and Governance

   a. The programme has clearly defined, comprehensive mission that include measurable programme goals.

   b. The programme's mission and goals are consistent with mission of the faculty and the University including, where applicable, contribution to strategic initiatives.

   c. The programme has an organizational structure that supports the achievement of its mission, and the success of its students, faculty and staff.

ii. Curriculum

a. Programme provides broad, well-integrated knowledge of the discipline, is responsive to changes in the field, and exhibits a curricular design that ensures graduates demonstrate disciplinary knowledge appropriate to their degree.

b. The academic programme has specific learning outcomes that are designed to meet the programme's intended purpose.

  - Learning outcomes are appropriate for the degree designation (i.e., associate degree vs. bachelor's degree vs. master's degree vs. doctoral degree or the level in the LQF when applicable).
  - Course requirements and delivery mechanisms provide sufficient opportunities for students to meet learning outcomes.
  - *Course should be organised into:*
    - *Basic and fundamental sciences*
    - *Engineering topics*
    - *General education*
  - The programme learning outcomes address the major issues and concerns in the discipline or professional area.
  - *The learning outcomes of the programme must include elements relative to problem solving, engineering design and enquiry competences.*

c. The learning outcomes defined for the courses build together the programme learning outcomes.

d. The programme curriculum shall be aligned with the Lebanese Qualifications Framework when applicable.

e. The programme learning outcomes address the major issues and concerns in the engineering discipline or professional area.

f. *The delivery mechanisms for each course are defined. The engineering programmes should have sufficient learning activities with appropriate delivery/teaching and learning mechanisms, such as:*

  - *Practicum*
  - *Individual Collective Project*
  - *Internship*

iii. Student Academic and Support Services

a. The institution provides student administrative services according to established and publicly declared policies in the following areas: Recruitment, Admission, Financial aid, Scholarship applications, Transfer credit and prior learning evaluation, and Student records management.

b. The process for the evaluation and recognition of prior learning shall be documented and public.

c. The institution provides student support services, including:

  i. Advising and assessment as needed

ii. Advising and assessment for credit transfer and recognition of prior learning
iii. Academic support for students with disabilities and other learning needs
iv. Physical or mental health counselling
v. Orientation services
vi. Career services.

d. The programme has in place remedies, where necessary, to ensure student progression and completion.
e. The programme routinely evaluates the effectiveness of its support services including advising.
f. Based on the evaluation results, the Programme makes appropriate adjustments necessary to support student achievement.

iv. Assessment and Student Success

a. The programme has an appropriate number of students to ensure viability.
b. The retention rate is sufficiently high to ensure viable completion numbers.
c. The programme assesses and evaluates student achievement of the Programme learning outcomes rigorously through direct and indirect methods.
d. Formative and summative assessments inform faculty members and students of student progress in the programme. Assessment results are communicated in ways that enable improvements.

v. Faculty

a. The number, qualifications, and credentials of faculty members are adequate.
b. Faculty resources are sufficient to meet the teaching, scholarship, service, and advising needs of the programme.
c. Faculty development is assured as appropriate to the teaching in the discipline and advancing disciplinary knowledge.
d. The programme regularly evaluates the effectiveness of faculty with respect to departmental, college, and institutional criteria. The evaluation includes teaching effectiveness, evidence of research, and service to the institution. The evaluation also includes scholarly activity, grants and awards.

vi. Budget, Resources, and Facilities

a. The programme's allocated resources are sufficient to support its goals and objectives. The resources include:
    - Financial resources

- Human resourcesPhysical facilities (e.g., classrooms, laboratories) under the disposal of the student population and the programmes offered. Library resources and services supportTechnology resources (e.g., hardware, software and professional development) to advance teaching and learning

b. Policies are in place to ensure the safety and security of students, faculty and staff.

vii. Continuous Improvement

a. The programme engages in periodic self-review, has established evaluation procedures, and shows evidence of improvements based on these processes.

b. Multiple direct and indirect assessments are used to inform continuous programme improvement.

- Assessments are linked to the programme's mission and goals
- Assessments include student performance in courses, labs and clinical experiences, and alumni performance in the workforce
- Faculty members are involved in defining the expected outcomes and in determining whether these outcomes are achieved
- Assessments provide faculty with the opportunity to examine student performance in the context of progressively more challenging problems, projects, and standards for performance

c. The programme engages in periodic self-evaluation, has established evaluation procedures, and shows evidence of improvements based on these processes

d. Faculty and administrators regularly review the effectiveness of the assessment system

e. Assessment results are available to stakeholders, including faculty members and students

Conclusions

The present document summarises the work conducted in work package 6 of the Erasmus+ project TLQAA+ aiming at shaping standards for the evaluation of engineering programmes in Lebanon and at customising the levels 6 and 7 of the adopted Lebanese qualifications framework for the engineering field. A bibliographical study showed the competences required in a graduate of an engineering programme. A comparison of these competences has been performed and a specific set is deduced for the Lebanese case. Those competences are mapped onto the adopted Lebanese Qualifications Framework.

The second part of the study is relative to the engineering quality standards. The standards from ABET and CTI are listed and compared. Finally, the core standards defined in the project have been updated by adding few specific criteria relative to engineering education.

Bibliography

AACSB. (2017). *Elligibility Procedures and Accreditation Standards for Business Accreditation.*

ABET. (2016). *Accreditation Policy and Procedure Manual.* ABET.

ABET. (2016). *Criteria for Accrediting Engineering Programs - 2017-2018 Accreditation cycle.*

ABET. (2016). *Criteria for Accrediting Engineering Programs.* ABET.

ABET. (2017). *Criteria for Accrediting Engineering Programs 2018-2019.* Baltimore: ABET.

ABET Engineering Accreditation Committee. (n.d.). Retrieved 6 28, 2018, from http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2018-2019/

Accreditation Board of Engineering and Technology. (n.d.). *ABET History*. (ABET) Retrieved 7 18, 2018, from http://www.abet.org/about-abet/history/

Accreditation Council. (2013). *Rules for the Accreditation of Study Programmes and for System Accreditation.* Germany.

AEQES. (2015). *Référentiel d'évaluation AEQES et Guide d'accompagnement.*

ANECA. (2017). *Accreditation of Recognized Bachelor, Master and Doctorate Degree Programmes - Evaluation Model, Criteria and Guidelines.*

ANECA. (2016). *Guide to Official Bachelor's Degree and Master's Degree programme follow-up processes - Monitor Procedure.*

APQN. (2009). *Higher Education Quality Assurance Principles for the Asia Pacific Region.* Retrieved from http://www.apqn.org/media/library/publications/higher_education_quality_assurance_principles_for_the_asia_pacific_region_chiba_principles.pdf

CHEA. (2015). *International Quality Principles.*

CTI. (2015). *Référence et orientation - Références et critères majeurs d'accréditation.*

CTI. (2010). *References and Guidelines – Adapted English version of the 'Références et Orientations 2009'.* Commission des Titres d'Ingénieur.

CTI. (2016). *Références et orientations de la Commission des Titres d'Ingénieur: Références et Critères Majeurs d'Accréditation.* Commission des Titres d'Ingénieur.

ENAEE. (2015). *EUR-ACE Standards and Guidelines.* ENAEE.

ESG. (2015). *Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).* Brussels, Belgium.

European Network for Accreditation of Engineering Education. (n.d.). Retrieved 7 17, 2018, from http://www.enaee.eu/engineering-accreditation/engineering-education-accreditation-html/

European Network for Accreditation of Engineering Education. (2015). *EUR-ACE® Framework Standards and Guidelines.* ENAEE.

Hamalainen, K. (2003). Common Standards for Programme Evaluations and Accreditation. *European Journal of Education , 30* (3), 291-300.

HCERES. (2016). *Référentiel pour l'évaluation externe d'une formation.*

International Engineering Alliance (IEA). (2014). *25 Years of the Washington Accords.* IEA.

International Engineering Alliance. (2009). *Graduate Attributes and Professional Competencies.* IEA.

International Engineering Alliance. (2013). *Graduate Attributes and Professional Competencies.* International Engineering Alliance.

NVAO. (2015). *Programme Accreditation - Flanders 2015-2021- Framework.*

QAA. (2017). *The Quality Code for Higher Education.* Retrieved 2017, from QAA: http://www.qaa.ac.uk/assuring-standards-and-quality/the-quality-code

QQI. (2016). *Statutory Quality Assurance Guidelines.*

Références et orientations de la Commission des titres d'ingénieur. (Version 2016). Retrieved 6 28, 2018, from https://api.cti-commission.fr/uploads/documents/backend/document_15_fr_references-et-orientations-livre-1_30-11-2015.pdf

Tempus TLQAA. (2012). *The Lebanese Higher Education System – A Short Description.*

TLQAA+ WP1. (2018). *Lebanese Qualifications Framework – Indicators, Structure and Recommendations.* Beirut: Erasmus+ TLQAA+.