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Pertinence of the Graduation Profiles of Engineering Programs in Chile: Analysis of their Consistency with the International Agreements and the National Qualifications Framework for Higher Education

Pertinencia de los perfiles de egreso de las carreras de ingeniería en Chile: análisis de su consistencia con los acuerdos internacionales y el marco nacional de cualificaciones para la educación superior

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Abstract

Chile's higher education system has grown significantly over the last 25 years in a context of very low regulation, which has led to great heterogeneity in the quality of study programs and institutions. The names of the various study programs are also unclear, providing confusing information to future students and employers, a situation that is particularly critical in engineering programs, where, in 2017, there were 1,102 programs registered under the name of "Engineering". A national qualifications framework would make higher education qualifications more coherent and understandable. It is also desirable for the offering of engineering programs to be consistent with current international agreements. In this context, the objective of this study is to analyze the consistency between the graduate profiles of Chilean engineering programs and the international agreements of Washington, Sydney, and Dublin, and the national qualifications framework for higher education (NQF). For this purpose, 115 graduate profiles for both vocational and technical engineering programs were examined in comparison with the international agreements and the NQF. Certain gaps, which occur most frequently at lower educational levels, could thus be identified. Based on the results, we conclude that Chile can move towards subscribing to the international agreements, which would allow greater understanding of the system for students and national and international employers.

Keywords: engineering, higher education, international agreements, framework of qualifications for higher education.

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Resumen

El sistema de educación superior chileno ha crecido significativamente en los últimos 25 años en un escenario de escasa regulación, generando una gran heterogeneidad en la calidad de las carreras e instituciones. Asimismo, las denominaciones de las diferentes carreras son poco claras, ya que entregan información confusa a los futuros estudiantes y empleadores, situación particularmente crítica en las carreras de ingeniería, que en 2017 registraron 1.102 programas con la denominación "Ingeniería". Un marco nacional de cualificaciones permitiría dar coherencia y comprensión a las certificaciones de educación superior. Adicionalmente, en el caso de las ingenierías es deseable que la oferta formativa sea consistente con los acuerdos internacionales vigentes. En este contexto, el objetivo del presente estudio fue analizar la consistencia de los perfiles de egreso de las carreras de ingeniería que se imparten en Chile con los acuerdos internacionales de Washington, Sídney y Dublín y el marco nacional de cualificaciones para la educación superior, para lo cual se analizaron 128 perfiles de egreso de carreras de ingeniería en relación con ambos lineamientos. Los resultados evidencian una alta consistencia entre las tres variables. Asimismo, se identificaron algunas diferencias, las que se verificaron con mayor frecuencia en los niveles formativos más bajos. A partir de los resultados, se concluye que Chile puede avanzar a la adscripción de los acuerdos internacionales, lo que permitiría mejorar la comprensión del sistema para estudiantes y empleadores del país e internacionalmente.

Palabras clave: acuerdos internacionales, educación superior, ingeniería, marco nacional de cualificaciones para la educación superior.

Introduction

In the last few decades Chile's higher education system has undergone a significant transformation, with some of the most important being the increase in enrolment (Servicio de Información de Educación Superior, SIES, 2018b; 2018c) and the rapid growth in the variety of institutions and the range of programs they offer (Organisation for Economic Cooperation and Development, OECD, 2013). Unfortunately, this increase in enrollment has not been accompanied by adequate regulatory mechanisms to provide the system with transparency and comprehensibility. This can be seen, for example, in the existence of programs with similar or identical names, but which involve very different courses, or in discrepancies regarding the duration of programs with the same name, which leads one to wonder whether these courses are equivalent in terms of the learning that they impart to the graduates. This causes a lack of understanding on the part of both students and employers, since it makes it difficult to know what each qualification or degree actually means in terms of the learning achieved at the end of each program (Consejo Nacional de Educación, CNED, 2014; Lemaitre & Durán, 2013). The diversification of the educational offering and the heterogeneity of its quality is particularly evident in the case of engineering. According to data from SIES (2017), there are 1,102 regular undergraduate engineering programs in Chile. Of these, 85% are offered at accredited institutions (937), 452 provide the graduate with a bachelor's degree (equivalent to 42%) and another 191 do not (18%), while 442 involve higher level technical studies (41%). There are also engineering programs that have the same or similar names, but some provide a bachelor's degree and others do not, and they also differ in terms of their duration (SIES, 2017).

With the exception of certain programs (e.g. medicine and pedagogy), in Chile there are no guidelines on what a program consists of, so accreditation processes have been based mainly on internal consistency, that is to say, on verifying whether the training process is in accordance with what is stated in the graduate profile, without there being elements that allow a definition to be made (beyond the experience of the evaluators) regarding the relevance of these profiles[1] (Reglamento Nº 42,538).

This lack of clarity regarding what a qualification actually means is not merely a problem for students and employers, but also makes causes difficulties in coordinating different training levels, and recognizing previous learning and Chilean qualifications in the rest of the world.

Although some initiatives have been carried out in Latin America to address certain regulations of the programs, the results have been limited (Beneitone et al., 2007; Kri et al., 2015; Neves, 2014). For this reason the qualification frameworks would seem to be an essential tool to help resolve these problems, since they establish the different training levels in a country, define the qualifications by level, the expected learning (by level or qualification and not by program) and, in many cases, the typical duration of each qualification. Since the late 1990s, the development of qualification frameworks has been the most important trend in reforms of higher education systems around the world (Skubic & Keep, 2015; Tuck, 2007), and these are key elements in quality assurance systems. This is demonstrated by the fact that, in 2015, the Inventory of Regional and National Qualifications of the United Nations Educational, Scientific and Cultural Organisation (Unesco, 2018) reported around 100 of these instruments around the world and seven regional frameworks, of which the best established are: the European Qualifications Framework (2009), Quality and Qualifications Ireland (2003), Australian Qualifications Framework Council (2013), and the South African Qualifications Authority (2008).

In recent years development of qualification frameworks has also begun in various Latin American countries (Ministerio de Educación Pública Costa Rica, 2018; Sistema Nacional de Educación Terciaria, Colombia, 2017), while in Chile there have been various initiatives in this respect, some of which have been focused on training for work (Comisión del Sistema Nacional de Certificación de Competencias Laborales, ChileValora, 2014), or a certain productive subsector that has established employment qualifications (Consejo de Competencias Mineras, CCM, 2013). However, in the context of this study, the emphasis was placed on formal higher education qualifications. From this perspective, the first Chilean initiative on this topic emerged in 2007 with the Mecesup project[2] "*Diseño de un marco de cualificaciones para el sistema de educación superior chileno*" (Consejo de Rectores de las Universidades Chilenas, CRUCh, 2010), or in English, Design of a qualifications framework for the Chilean higher education system, which identified the elements that should be included in such a national framework, as well as the regulatory aspects that should be addressed in order to develop it. The National Education Council (CNED, 2014) subsequently established the need for Chile to have such an instrument, so, based on this work, the Higher Education Division of the Ministry of Education of Chile, (Mineduc), developed a highly participatory methodology entitled *Marco nacional de cualificaciones para la educación superior* (Mineduc, 2016), or in English, the National qualifications framework for higher education, NQF.

On the other hand, at the international level, mechanisms have been created to enable recognition of qualifications between countries, either to allow students to continue their studies, or for graduates from one country to work in other territories. In the case of engineering, the International Engineering Alliance has been working since the late 1980s on the construction of multilateral agreements between groups of jurisdictional bodies responsible for

1. It should be noted that the accreditation processes for undergraduate programs in Chile (with the exception of medicine and pedagogy) were voluntary until 2016 and after the enactment of Law Nº 21,091 (2018) they are no longer part of the national regulations.
2. This involves the projects developed under the auspices of the *Programa de Mejoramiento de la Calidad y la Equidad en la Educación Terciaria* (Program for Improvement of Quality and Equity in Tertiary Education), Mecesup.

the accreditation and recognition of engineering qualifications in higher education (International Engineering Alliance, 2014). Although these are generally known as the Washington Agreement, this includes three different agreements: the Washington Agreement, the Sydney Agreement, and the Dublin Agreement (International Engineering Alliance, 2013), which refer to three different training levels for programs related to engineering: professional engineer, engineering technologist, and engineering technician, respectively.

These international agreements define the expected competencies for training engineers and propose recognitions based on "substantial equivalence" in the accreditation of engineering qualifications, thus allowing adjustments to the situation of each country, region, or higher education institution, at the same time as enabling graduates to practice their profession in affiliated nations (International Engineering Alliance, 2019). A total of 19 countries are currently permanently affiliated to the Washington Agreement and five provisionally, while the Sydney Agreement has 10 countries affiliated on a permanent basis and three provisionally, and, finally, the Dublin Agreement has eight countries adhered permanently and one provisionally. It should be noted that the College of Engineers of Chile was incorporated in 2018 as a provisional member of the Washington Agreement (Colegio de Ingenieros de Chile, 2018).

Furthermore, there have been some international studies that show how engineering programs have adapted to the qualifications framework of a country and how this has favored integration between training levels (De Koker, 2012; Ndambuki & McKune, 2013; Tsirigotis, 2013; Zamtinah, 2018). Similarly, various studies highlight the implications of joining international agreements (Basri, Che Man, Wan Badaruzzaman, & Nor, 2004; Mahmood, Khan, Khan, & Kiani, 2015; Paramasivam, Mutusamy, & Tan, 2013). We found no studies that examined the compatibility between international agreements and qualifications frameworks.

That said, considering that in Chile both instruments—which are intended to promote the standardization and organization of qualifications and the training offering—are in the initial stages of implementation, and given the large diversity of engineering programs and the scant regulation existing in the country, it is interesting to study the evidence that supports the adoption of these instruments to enable greater organization of the field and more frictionless international recognition of the qualifications that the country provides. For this reason, this study asked the following questions:

- Is there consistency between the qualifications defined in the NQF and what is established in international agreements for engineering programs?
- Are Chilean engineering programs consistent with these instruments?

This study is therefore intended to analyze the convergence between the NQF and international agreements in order to assess whether engineering careers in Chile concur with these instruments, based on the review of a sample of graduate profiles.

Methodology

In order to answer the research questions, the NQF and the international agreements were examined in terms of structure, descriptors, and volume of learning. Similarly, the graduate profiles of a sample of programs were studied in comparison with the learning outcomes outlined in the NQF and the international agreements.

The NQF defines five levels of qualification which contain seven qualifications (titles and degrees). In the context of this study, the focus was on the titles defined in the first three levels that correspond to undergraduate training, which will be examined based on the three international agreements and the three different qualifications awarded in Chile, as shown in Table 1.

Table 1
Equivalence between the NQF, international agreements (IA), and Chilean titles used for the analysis

Current programs in Chile	NQF	IA
Técnico de nivel superior[3] (HLT[4])	*Técnico de nivel superior*	Engineering technician (Dublin-IA_D)
Profesional sin licenciatura[5]	*Profesional de aplicación*	Engineering technologist (Sydney-IA_S)
Profesional con licenciatura[6]	*Profesional avanzado*	Professional engineer (Washington-IA_W)

Source: Prepared by the authors.

In order to examine the consistency between the NQF, the international agreements and the graduate profiles, we used the content analysis technique. It should also be considered that performances were defined with different levels of abstraction. Figure 1 shows this graphically: the qualifications framework defines learning outcomes for each qualification without distinguishing between different programs or disciplines; International agreements, meanwhile, define the performance of the different programs related to general engineering, without making any distinction by specialty; and finally, the graduate profile includes the disciplinary overview and also the institutional hallmark. For example, we can thus expect the NQF to refer to "an area or discipline", the international agreements to "natural sciences", and the graduate profiles to "inorganic chemistry".

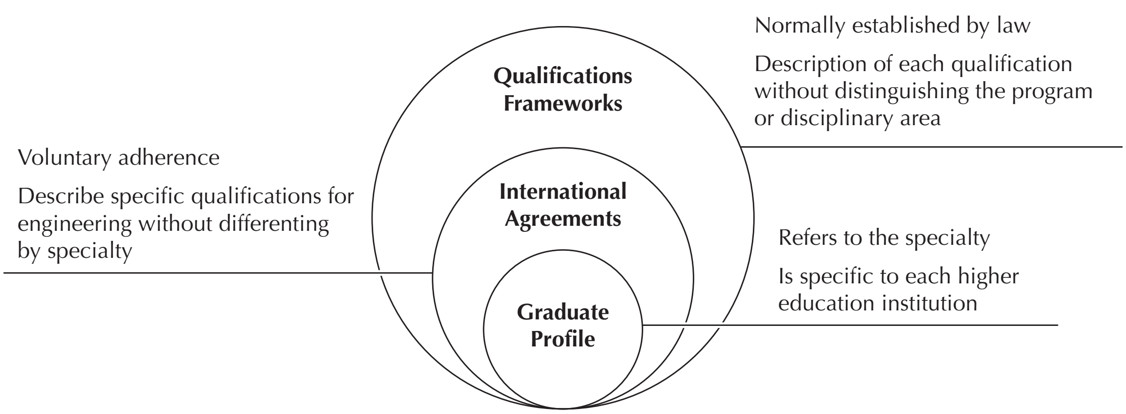

Figure 1. Relationship between a qualifications framework, the international agreements, and graduate profiles.
Source: Prepared by the authors.

3. Equivalent to higher level technician.
4. As the qualification awarded at present in Chile has the same name as that defined in the NQF for level 1, the abbreviation HLT will be used in the case of the current qualification and the full name "higher level technician" in the case of the NQF, in order to facilitate reading.
5. Equivalent to a graduate with an ordinary bachelor degree.
6. Equivalent to a graduate with an honors bachelor degree

There is thus consistency between the instruments analyzed when the performances described are at a similar or equivalent level of qualification, with no contradictions between them. As regards the graduate profiles, it should also be taken into account that they are not always explicit about all the performances involved in the training process, so it is common to find profiles that do not expressly refer to any competency, either because they are defined in the educational model of the institution or because they are understood as being included in the skills. Therefore, where there is an omission, it is not possible to conclude directly that there is a difference in the level of qualification without analyzing the curriculum. Lastly, there will be inconsistencies when the performances described in some of the instruments (NQF, international agreements, or graduate profiles) correspond to another qualification level or when there are contradictions between them.

Description of the sample of graduate profiles and stages

The main objective of this study was to organize the structure and descriptors defined in the NQF and international agreements. The research was descriptive, since we intended to study the main features of the consistency between the content of the two instruments (Bernal, 2008) and because we were unable to find theoretical or empirical evidence in Chile that addresses this problem.

We analyzed 128 graduate profiles of engineering programs with a bachelor degree, engineering programs without a bachelor degree, and for the HLT and the consistency of their content with the corresponding qualifications in the NQF and international agreements. The graduate profiles corresponded to 28 Chilean higher education institutions that have the characteristics shown in Table 2.

Table 2
Characteristics of the sample of graduate profiles

Classification	Category	Number of institutions
Type of institution by degrees and titles	University	24
	Professional Institute (PI)	2
	Technical training center (TTC)	2
Type of institution by funding	CRUCh state university (CSU)	10
	CRUCh private university (CPU)	6
	Private university (PU)	8
	Private professional institute (PI)	2
	Technical training center (TTC)	2
Type of institution by accreditation	Accredited	27
	Not accredited	1[7]
Type of institution by geographic area	North	4
	Center	13
	South	6
	Presence in Metropolitan Region and other regions	5

Source: Prepared by the authors.

7. The institution was accredited at the time of the study, but it subsequently lost it and is currently in the process of closing.

The profiles were selected in accredited institutions and programs, with non-probabilistic sampling for convenience, considering the feasibility of accessing the information and ensuring diversity in the types of institutions, since it was not an objective of the research to generalize the results for all engineering programs taught in the country (Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2010). Of the 128 graduate profiles, 30 of them corresponded to PIs and TTCs, while the rest of the institutions were universities belonging to CRUCh and private universities. A total of 13 graduate profiles were also for HLT, 20 for engineering with an ordinary bachelor's degree, and 95 for engineering with an honors bachelor's degree.

The analysis of the information was carried out in two stages:

Stage 1. We carried out a documentary analysis of the international agreements, and specifically how the competencies of a professional engineer, engineering technologist, and engineering technician are organized, as well as a review of the NQF. Then both tools were compared in terms of:

- Structure: We conducted a comparative analysis of the dimensions and sub-dimensions defined in the NQF and the international agreements.
- We carried out a comparative analysis of the dimensions and sub-dimensions defined in the NQF and the international agreements.
- Descriptors: We carried out a comparative analysis of the descriptors defined in the qualifications in the NQF and international agreements.
- Volume of learning: We conducted a comparative analysis of the duration of each qualification in the NQF and that defined in the international agreements.

Stage 2. We carried out a content analysis on the sample of engineering program graduate profiles, verifying the convergence between the content of the descriptors defined in the NQF and the international agreements by using information classification categories established previously based on the dimensions and sub-dimensions of the NQF (because they are the most general and in stage 1 equivalence was observed between these and those used in the international agreements). Then the content of each graduate profile was classified according to the dimensions and sub-dimensions, before later grouping the content identified and analyzing to what extent the content of the graduate profiles converged with or diverged from what was proposed by the international agreements and the NQF.

Limitations

In light of the fact that the analyses were carried out on the graduate profiles, it was only possible to establish the consistency between those and the NQF and international agreements, so it is not possible to draw conclusions regarding the training processes, since even when the graduate profiles represent the commitment acquired by the institution, it is necessary to analyze the curricula and how they are implemented in order to find out whether they are fulfilled, which should be verified during the quality assurance processes. Moreover, as explained above, in the case that the graduate profiles do not refer to an expected performance, it is not possible to establish whether this is an omission in the preparation of the profile or whether it actually corresponds to a performance that is not considered in the training process, for which analysis of the study plan is also required.

Results

The results of the analyses carried out in both stages are shown below. At first, the results are presented in terms of the structure and volume of learning between the NQF and the international agreements and, then, the results of the analysis of the descriptors from the NQF, the international agreements, and the graduate profiles are presented together for each level.

Structural comparison

The NQF organizes its descriptors in three dimensions (knowledge, skills, and competencies) and nine sub-dimensions. International agreements, meanwhile, consider 12 sub-dimensions, of which 11 coincide with elements that are considered in the sub-dimensions of the NQF. Table 3 shows the comparison between the sub-dimensions of the NQF and the sub-dimensions of the international agreements, where the former are more general in their nomenclature than the latter. However, when the descriptors that define them are analyzed, we can observe great equivalence between the two instruments, since the descriptors contain the elements that the sub-dimensions of the international agreements consider on their behalf. For example, the NQF establishes cognitive, technical, and communication skills: in the cognitive skills, the descriptors of the NQF mention "diagnosis or detection of problems", "design of solutions", and "problem solving", which are the names of some of the sub-dimensions of the international agreements, such as "problem analysis" and "design/development of solutions". At the level of technical skills, the descriptors in the NQF also state "use of material resources of their profession or discipline" and "execution of projects or research", which refer to the sub-dimensions of "research" and "use of tools" in the international agreements. The same is true at the level of the sub-dimension of communication skills, which converges with the "communication" sub-dimension of the international agreements.

Table 3
Convergence between the structure of the NQF and the international agreements

Dimension	NQF Sub-dimension	International Agreements: Washington Sub-dimension	Sydney Sub-dimension	Dublin Sub-dimension
Knowledge	C1: Type C2: Scope C3: Depth	WA1: Knowledge of Engineering	SA1: Knowledge of Engineering	DA1: Knowledge of Engineering
Skills	H1: Cognitive H2: Technical H3: Communicational	WA2: Problem Analysis WA3: Design/ development of solutions WA4: Research WA5: Use of tools WA10: Communication	SA2: Problem Analysis SA3: Design/ development of solutions SA4: Research SA5: Use of tools SA10: Communication	DA2: Problem Analysis DA3: Design/ development of solutions DA4: Research DA5: Use of tools DA10: Communication
Competency (Application in context)	CO1: Ethics and Responsibility CO2: Autonomy CO3: Work with others	WA8: Ethics WA6: The engineer and society WA7: Environment and sustainability WA12: Continuous learning WA9: Individual and team work	SA8: Ethics SA6: The engineer and society SA7: Environment and sustainability SA12: Continuous learning SA9: Individual and team work	DA8: Ethics DA6: The engineer and society DA7: Environment and sustainability DA12: Continuous learning DA9: Individual and team work

Source: Prepared by the authors.

Comparison of learning volume. In the NQF, the volume of learning is defined by the Academic Credit Transfer System (SCT-Chile), which is based on the fact that 60 credits correspond to a full-time year. In the case of the international agreements, the duration of each qualification is defined in terms of the number of years of the training process.

Analysis of the comparison of the duration of the qualifications shows total consistency between what the NQF suggests and the international agreements for the qualifications of engineers, as shown in Table 4. This is very important in the Chilean context, since the country has no standards or agreements regarding the duration that the different training programs should have (Pey, Durán, & Jorquera, 2012). Therefore, the durations indicated in the NQF and the international agreements could be used as a reference for the institutions, always bearing in mind that when the international agreements indicate years of duration, they consider full-time students, so the equivalence should be calculated for part-time programs.

Table 4
Volume of learning in the NQF and international agreements

Qualification	NQF	International Agreements
Técnico de nivel superior engineering technician	120 SCT-Chile, equivalent to two years of full-time study	2 years
Profesional de aplicación engineering technologist	180 SCT-Chile, equivalent to three years of full-time study	3 to 4 years
Profesional avanzado professional engineer	300 SCT-Chile, equivalent to five years of full-time study	4 to 5 years

Source: Prepared by the authors.

Comparison of descriptors. The analysis of the descriptors is presented for each sub-dimension of the NQF, considering that it is the most general and allows the analysis of the NQF, the international agreements, and the graduate profiles. The analysis is shown for each level of qualification (see Table 1).

One transversal finding at all levels is the fact that the NQF encourages respect for diversity, decision-making, and the autonomous performance of tasks, which is not considered in the international agreements or in the graduate profiles.

As regards the analysis of the graduate profiles, the number of mentions identified (summarized in Table 5) and certain representative citations taken from the graduate profiles analyzed are shown. Each citation is identified by indicating the type of institution (in accordance with the nomenclature indicated in Table 2) and whether it operates in Santiago (S), other regions (R), or in Santiago and other regions (S&R).

Table 5
Number of mentions identified in the graduate profiles

Dimensions	Graduate profile *Profesional avanzado* *n* = 95	Graduate profile *Profesional de aplicación* *n* = 20	Graduate profile *Técnico de nivel superior* *n* = 13
C: Knowledge (C1, C2, C3)	145	14	12
H: Skills (H1, H2, H3)	657	251	132
CO: Competency (CO1, CO2, CO3)	308	21	72

Source: Prepared by the authors.

Técnico de nivel superior - engineering technician – HLT. The results show that there is convergence between the NQF and the IA_D in terms of knowledge. The NQF states that an HLT demonstrates general theoretical knowledge and specialized practical knowledge of a specific area of work. Meanwhile, the IA_D states that an engineering technician must be able to apply knowledge of mathematics, natural sciences, fundamentals of engineering, and an engineering specialization. In the graduate profiles, 12 mentions of knowledge were identified that refer to the ability of the HLT to apply basic knowledge in their work, for example, knowledge of administration, statistics, or concepts of physics, biology, and mathematics, among others, which is consistent with what is proposed in the IA_D and the NQF. However, most graduate profiles do not explicitly refer to practical knowledge or application of knowledge, which is stated in the NQF and the IA_D.

> Demonstrating knowledge of basic descriptive statistical methods and contribution rates associated with risk prevention (PI_S&R).
>
> Demonstrating basic knowledge of general administration and risk management, with comprehension of the purposes, structure, and operation of a company (PI_S&R).
>
> Operating with basic physical, biological, chemical, and mathematical concepts involved in occupational accidents and diseases (IP_SyR).

In terms of skills, the IA_D and NQF converge in four descriptors of a total of five, which can be observed mostly in technical and communication skills. Both the NQF and the IA_D state that the engineering technician applies appropriate techniques to certain procedures, using resources from a specific area of work and they are capable of effectively communicating their duties. With respect to technical skills, we observe that the IA_D establishes a higher level of qualification than the NQF regarding management or administrative ability. We identified a total of 132 mentions of skills in the graduate profiles, the techniques being those mentioned most frequently (81 mentions). These skills are particular and depend on the specialty of the HLT and highlight the ability of the technician to prepare products (reports, manuals, and plans, among other things) and carry out procedures using resources or technologies specific to their area of work. In this regard, the graduate profiles are consistent with what is proposed by the descriptors of the NQF, but they are divergent from the IA_D, since the latter defines that an engineering technician is capable of managing or administering part or all of a well-defined activity; however, we found only one mention in the graduate profiles examined that refers to this field.

> Prepare reports with recommendations to prevent accidents and/or occupational diseases caused by technological, physical, chemical, and biological factors (PI_S&R).
>
> Plan, administer, and manage the means and resources necessary to carry out a project (PI_S&R).
>
> Document the solution of IT projects, demonstrating the ability to create basic and technical user manuals (PI_S&R).
>
> Draw plans for electrical projects … applying drawing software and technology (PI_S&R).

We found a total of 11 mentions of communication skills in the graduate profiles, which refer to the HLT's ability to communicate effectively orally, in writing, or visually, which is consistent with what is proposed by the NQF and the IA_D. However, the latter agreement is more specific, as it mentions the ability to communicate with the engineering community and general society. This could be understood as an aspect that is included in the more general description used in the graduate profiles.

> Effectively communicate ideas orally or in written Spanish (PI_S&R).
>
> Communicate effectively, demonstrating the ability to select, organize, and present information using computer support (PI_S&R).
>
> Communicate by expressing ideas clearly and consistently, both orally and in writing (TTC_S&R).

Meanwhile, when it comes to cognitive skills, the results show that both the NQF and the IA_D promote the ability to analyze and identify well-defined problems, but the international agreement stipulates that the engineering technician must have the cognitive skills to design solutions to well-defined engineering problems, while in the NQF this level of required qualification is lower, since it mentions the identification and selection of known solutions to solve problems. Furthermore, the IA_D defines that an engineering technician is capable of analyzing or investigating engineering problems, which is not mentioned in the NQF for this level of qualification. In this regard, what is required by the IA_D clearly corresponds to a higher level of qualification than that indicated in the NQF, because it defines that the HLT identifies and selects solutions, but does not design or propose them. Meanwhile, in the graduate profiles we found 40 mentions of cognitive skills, which refer to the HLT's ability to interpret diverse information, diagnose failures or problems, and propose or design innovative and relevant solutions to a problem. In this respect, the graduate profiles are consistent with what is proposed in the IA_D and are superior to what is indicated in the NQF.

> Interpret statistical reports on occupational accidents (PI_S&R).
>
> Interpret plans using the CAD platform (PI_S&R).
>
> Diagnose faults in the electrical and/or electronic systems of light vehicles (PI_S&R).
>
> Ability to propose innovative and pertinent solutions to problems in their area of work and/or professional field, as required in their technical duties in a company (PI_S&R).

In these competencies, we can observe convergence between the descriptors of the NQF and the IA_D, since both promote ethical behavior and respect for the regulations, as well as assuming the responsibilities of the job, recognizing the need for constant improvement, and working effectively in work teams.

We found 72 mentions of the dimension of competency in the graduate profiles, with the competency of ethics and responsibility being that mentioned most frequently (51 mentions). In this case, they essentially refer to acting responsibly and ethically, respecting current regulations, and the protocols or procedures of the company or organization. The graduate profiles are consistent with the NQF and the IA_D, but the profiles omit elements that are considered in both documents, such as the ability to assess and assume the implications of the results of their work.

> Operate according to fundamental economic, administrative, and ethical criteria in human organizations (PI_S&R).
>
> Comply with the work procedures according to the organization's policies and current regulations (PI_S&R).
>
> Demonstrate ethical behavior and social responsibility, respecting human dignity in personal relationships and in different areas of work and professional action (TTC_S&R).

We identified five mentions of the competency of autonomy, three referring to the HLT's ability to perform or act autonomously and the remaining two to demonstrating a proactive attitude towards their professional development. These five mentions are consistent with what is suggested by the NQF and the IA_D, but the graduate profiles omit the ability to constantly assess their work to improve their professional performance, which is suggested in the NQF.

> Acting autonomously (TTC_S&R).
>
> Use self-learning, constant and continuous training, and critical and self-critical ability as tools to improve professional development (TTC_S&R).

Lastly, we found 16 mentions of work with others, which mainly refer to the ability to work collaboratively in work teams. This converges with what is proposed in the NQF and the IA_D, but some graduate profiles also mentioned that the HLT shows leadership, which goes beyond the qualifications defined in the IA_D and NQF for this level. The graduate profiles also omit the ability to respect the roles and functions of the people who make up their work area, which is stated in the NQF.

> Working collaboratively (TTC_S&R).
>
> Demonstrating organization and ability to work collaboratively (TTC_S&R).
>
> Demonstrating leadership (TTC_S&R).

The competency of leadership is at a higher level of qualification than that established by both the NQF and the IA_D (however, this would refer to a specific situation). In the other cases, the differences found between the NQF, the IA_D, and the graduate profiles may be due to omissions in the drafting of the profiles, or because they are understood as being included in others, but they do not clearly show inconsistency.

It can thus be established that, for this level, the differences that imply different levels of qualifications occur in management or administration skills and in design of solutions.

Profesional de aplicación - engineering technologist – profesional sin licenciatura. In the dimension knowledge there is a high degree of consistency between the NQF and the IA_S. The NQF states that a *Profesional de aplicación* is capable of demonstrating general theoretical knowledge, advanced practical knowledge of a profession, and general knowledge of related disciplines. Meanwhile, the IA_S states that the engineering technologist is capable of applying knowledge of mathematics, natural sciences, engineering principles, and an engineering specialization to procedures, processes, systems, or defined and applied engineering methodologies. In the graduate profiles, seven mentions were made that refer to knowledge, where the use of the word 'basic' is predominant; for example, in law, administration, and project methodology, etc., which depends on the specialty. Most graduate profiles do not specify whether the knowledge should be practical or applied, as is stated in the NQF and the IA_S.

> Demonstrating knowledge of current Chilean legislation and international recommendations regarding the prevention of occupational risks (PI_S&R).
>
> Applying knowledge in logistics (PI_S&R).
>
> Demonstrating theoretical and practical knowledge in installing and updating software and hardware (PI_S&R).

In relation to skills, the NQF and the IA_S are consistent on the descriptors of technical and communication skills, where both emphasize the use of appropriate techniques and resources for procedures and effective communication of essential aspects of professional duties. On the other hand, we found 187 mentions of technical skills in the graduate profiles, which emphasize the engineer's ability to develop projects, investment portfolios, marketing strategies, etc. (depending on the type of specialty), carrying out different processes (for example administrative) and operations (e.g., logistics), through the use of instruments and machinery, among others. They also refer to the ability to formulate, plan, execute, and assess projects (business, audiovisual products, etc.). This is consistent with what is proposed by the IA_S, where it underlines the engineer's ability to manage or administer activities.

> Develop construction projects according to the client's needs (PI_S&R).
>
> Develop IT systems using tools that are standardized in the market (PI_S&R).
>
> Execute logistics operations in the transportation and distribution area, in accordance with customer requirements and current legal regulations (PI_S&R).

The number of mentions of communication skills found was much lower than for cognitive and technical skills, since we only identified 14 mentions in the graduate profiles. Most of them involved the ability to effectively communicate ideas orally or in writing in Spanish. This is consistent with what is suggested by the IA_S, but with regard to the NQF, the graduate profiles do not refer to the engineer's ability to communicate essential aspects of their profession visually through different media and aids. In addition, only one mention refers to preparing reports and presentations and one to the ability to communicate in academic contexts.

> Effectively communicate ideas orally or in writing in Spanish (PI_S&R).
>
> Prepare reports and presentations to provide information corresponding to projects or works, using application software (PI_S&R).
>
> Communicate orally or in writing, applying linguistic-pragmatic tools that allow the solution of communicative problems in academic contexts, in accordance with the common framework of reference for languages (PI_S&R).

Both the NQF and IA_S mention the ability to analyze problems or information, but the IA_S promotes a higher level of qualification for this professional than the NQF. In this respect, an engineering technologist is expected to design solutions to broadly-defined engineering problems and not just adapt solutions to solve problems, as defined by the NQF. In addition, the ability to investigate engineering problems, design experiments, and obtain valid conclusions is stated in the IA_S, which is not considered in the NQF. In the graduate profiles, there are 50 mentions of cognitive skills, which refer to the ability to detect problems, such as faults in the electrical systems of a vehicle; and the ability to make a diagnosis and solve problems in the working context of their specialty, in some cases proposing recommendations or lines of action to solve them. Only four graduate profiles include mentions referring to the analytical capacity promoted in the NQF descriptors for this level of qualification. We found no mentions that indicate the design of solutions to broadly-defined engineering problems as suggested by the IA_S.

> Diagnose faults in the electrical and/or electronic systems of light vehicles in accordance with standards defined by the manufacturer (PI_S&R).
>
> Detect problems arising from lighting and the use of electricity, their installations, machinery, and equipment that can cause accidents or professional diseases and make recommendations to correct them (PI_S&R).
>
> Diagnose and set up acoustic spaces observing requirements of intelligibility and environmental standards in accordance with the sound production requirements of the site (PI_S&R).

In terms of competencies, there is a high degree of consistency between the IA_S and NQF, since in both cases they promote ethical and responsible professional practice, respect for regulations, assuming the implications of the work, and recognizing the need for constant professional development. The leadership capacity of this professional is noted in particular. In the NQF a *profesional de aplicación* is expected to supervise work teams, and in the IA_S an engineering technologist is expected to effectively lead diverse work groups.

As regards the dimension of competencies, the graduate profiles contain only one mention that corresponds to the competency of ethics and responsibility and that refers to the ability of the engineering graduate to be socially and ethically responsible. Compared with the NQF and the IA_S, this component is excluded from the graduate profiles examined.

> Being socially and ethically responsible, in accordance with the requirements of the company and the market (PI_S&R).

In the competency of autonomy, we found four mentions in the graduate profiles analyzed, which highlight the ability to carry out an action or operation according to the instructions of management or procedures defined by the company. No mentions were found referring to the demonstration of a proactive and responsible attitude towards updating knowledge and developing skills, which is divergent from what is proposed in the NQF.

> Carry out operational actions in the area of Recruitment and Selection of personnel in accordance with the needs of the organization and instructions of the management (PI_S&R).
>
> Carry out operations associated with the maintenance plan for light vehicles in accordance with the manufacturers' manual and the procedures defined in the company (PI_S&R).

In terms of working with others, we identified 16 mentions in the graduate profiles, which involve the ability to lead work teams and supervise activities that involve working with others, such as building works, development of management systems or a business unit team. This is consistent with what is proposed in the IA_S, but in the profiles analyzed one element is omitted that is included in the NQF, which refers to respect for the roles and functions of the people who make up the work area.

> Demonstrating leadership skills and work in multidisciplinary teams within the organization (PI_S&R).
>
> Lead work teams, negotiating with various actors to meet the objectives, in accordance with institutional policies, situational characteristics of the organization, and current regulations (PI_S&R).
>
> Supervise the performance of the people in their business unit in accordance with company policies (PI_S&R).

From the previous analysis we observe that there are differences in the levels of qualifications in the skills related to the design of solutions and the ability to investigate, conduct experiments, and draw valid conclusions, as well as in the competency of autonomy.

Profesional avanzado - professional engineer – profesional con licenciatura. As in the case of the two previous international agreements, there is a high degree of convergence between the NQF and the IA_W in the knowledge dimension. Indeed, while the NQF proposes that an *profesional avanzado* is capable of demonstrating advanced theoretical and practical knowledge of a discipline or disciplinary area that is the foundation of a profession and fundamental knowledge of related disciplines, the IA_W states that a professional engineer is able to apply knowledge of mathematics, natural sciences, engineering principles, and an engineering specialization to the solution of complex engineering problems. On the other hand, in the graduate profiles there are 145 mentions that refer to knowledge and provide sufficient information about this dimension; for example, they specify knowledge of basic sciences, engineering, and the specialty, as suggested by the IA_W. They also refer to knowledge in related areas or disciplines depending on the type of engineering (administration, construction, finance, management, chemistry, mathematics, among others), as proposed by the descriptors of the NQF.

> Ability to apply knowledge of basic sciences, engineering, and the specialty in the different areas of their profession (CSU_S).
>
> The engineer is a professional with solid training in basic sciences, engineering sciences, engineering applied to construction, and administrative sciences, these being complemented by aspects related to finance and legislation (CPU_R).
>
> The engineer masters up-to-date knowledge of basic sciences, engineering sciences, applied engineering, and management (CPU_R).

In terms of skills, we observed a high degree of consistency in the three sub-dimensions: cognitive, technical, and communicational. In cognitive skills, the IA_W and the NQF state that for this level of qualification a professional engineer is capable of reflecting on and analyzing information, but is also capable of designing solutions to solve complex engineering problems, issuing well-founded conclusions or judgments. In technical skills, there is emphasis on participation in research and the use and application of appropriate techniques. We identified 218 mentions of skills in the graduate profiles. The mentions of cognitive skills refer to the ability of analysis and critical thinking, and the ability to diagnose and solve complex engineering problems and to develop solutions, while the ability to make judgments is also stated, albeit less frequently, as suggested by the NQF

> Ability to formulate and solve engineering problems from a systemic perspective at the operational level (CSU_S).
>
> Analyze the overall reality of an industrial sector and determine the competitive position of a company within the sector (PU_S).
>
> Investigate, identify, and define problems, and then prepare and propose possible solutions (CPU_S&R).

We found 370 mentions of technical skills in the graduate profiles. These refer to the ability of the engineer to formulate, carry out, and control engineering projects in their specialty, as well as to implement processes using tools and equipment. This is consistent with what is proposed in the NQF and the IAW. These profiles also emphasize the ability to design, develop, and assess specialty projects, while the ability to apply scientific method to carry out engineering research is also mentioned, but to a lesser extent. On this point, the graduate profiles differ from the IAW, where there is more promotion of the development of research on the part of the professional engineer.

> Ability to manage and administer projects or companies related to their profession (CSU_S).
>
> Ability to implement and integrate processes (CSU_S).
>
> Research new scientific and technological developments and related to the organizational processes and structures (PU_S).
>
> Apply scientific method to design, conduct, and carry out research in engineering (CPU_R).

Finally, as regards communication skills, both the NQF and the IA_W agree on the ability of this professional to effectively communicate their work to specialized audiences and to general society. Meanwhile, in the graduate profiles we found 69 mentions referring to the engineer's ability to communicate effectively in Spanish orally, in writing, and graphically (or symbolically), as well as their ability to communicate in technical language and adapt to the characteristics of the audience, which is consistent with the descriptor in the NQF and IA_W.

> Comprehensively communicate technical information in Spanish, orally, in writing, and graphically, at an advanced level (CPU_R).
>
> Use oral, written, and technical language to communicate effectively and achieve a good work performance (CPU_R).

> Communicate ideas, arguments, and knowledge clearly and effectively, both orally and in writing, using the media appropriately and adapting to the characteristics of the situation and the audience (CSU_R).

The comparison of the descriptors on the competencies shows high consistency between the IA_W and the NQF, as in the case of the other two international agreements. Both instruments promote ethical and responsible professional practice, respect for regulations, assuming the implications of the work, and recognizing the need for constant professional development. In particular, they agree on the leadership ability of this professional, which is suggested in the NQF and the IA_W, emphasizing the professional engineer's ability to lead multidisciplinary work teams.

We identified a total of 98 mentions of the competency of ethics and responsibility in the graduate profiles, which refer to the ability to act ethically and with social and professional responsibility, as well as with awareness of the impacts of their professional work on the social, environmental, and economic spheres. In this regard, these profiles are consistent with the IA_W and NQF. To a lesser extent, it refers to the ability to act according to current legal regulations, respecting people, society, and the environment.

> Act ethically and with social and professional responsibility (CSU_S).
>
> Comprehension of professional, social, and ethical responsibility in every context in which they operate (CSU_S).
>
> Awareness of the impacts of their professional work on the social, environmental, and economic spheres (CSU_S).
>
> Practice the profession applying ethical and regulatory codes that are typical of engineering, with environmental concern and social responsibility as the framework of their professional work (CSU_R).

In terms of the competency of autonomy, we found 70 mentions, which refer to the engineer's ability to learn autonomously and constantly update him or herself, which is consistent with what the NQF and the IA_W propose. However, we only identified one mention of the ability to function independently in the graduate profiles, an element that is considered in the NQF descriptors.

> Learning by oneself to be constantly up-to-date (CSU_S).
>
> Apply autonomous learning tools as a strategy to continue learning (CSU_R).
>
> Recognize the need to maintain conduct of constant improvement and development of personal and professional knowledge over time (PU_S&R).
>
> Act autonomously, flexibly, and with initiative in their work (CPU_S&R).

Lastly, in the graduate profiles we found 140 mentions that refer to the competency of working with others, where the ability of the engineer to form multidisciplinary work teams, and lead and supervise them is highlighted. To a lesser extent, the graduate profiles state that the engineer has the ability to enhance the abilities of individuals and/or groups to achieve the objectives desired. These profiles are generally consistent with what is suggested by the NQF and the IA_W.

> Form multidisciplinary work teams (CPU_R).
>
> Ability to supervise staff and productive processes (CSU_S).
>
> Lead and function effectively in technical teams (CSU_R).

Have extensive preparation in leading multidisciplinary teams (CSU_R).

Exercise their leadership, enhancing the abilities of individuals and/or groups to achieve desired objectives (CSU_R).

We can see that there are no differences in the rankings of qualification at this level. On the other hand, there are certain skills and competencies that are not included in all graduate profiles, although, in many cases, this may be due to the fact that they are considered to be included in other skills or competencies.

Discussion

International recognition of qualifications is essential in the current globalized world, where many professionals work in countries other than those in which they studied (Lucena, Downey, Jesiek, & Elber, 2008). Nevertheless, although each country has its own mechanisms to recognize qualifications, this is often a complicated process, although various initiatives have emerged in recent decades to facilitate this recognition. In the Bologna Process, for example, one of the critical elements was the recognition of the qualifications in the different countries of the European Community, thus promoting the movement of students and professionals between the member nations.

However, a key element in order to make these equivalences are the NQFs and their correspondence with the European framework. International agreements, such as those studied in this paper, are also aimed at complementing the efforts towards this objective. It is thus possible to observe how different countries have strived to adhere to these international agreements (Hodgson & Williams, 2007) or to the Bologna Process (Chuchalin, Boev, & Kriushova, 2007; King, 2007).

In this regard, adherence to the international agreements has involved reviewing the quality assurance systems in each country (Anwar & Richards, 2018) or redesigning education plans (Basri, 2009; Hodgson & Williams, 2007; Klassen & Sá, 2020). There is no doubt that this must also take place in Chile, although the particularity of the Chilean case creates additional difficulties to meet this challenge. For example, the deregulation of the higher education offering in Chile (Amestoy, 2013; Brunner, 2008) has led to high levels of heterogeneity in the quantity and quality of programs in general and in engineering in particular (SIES, 2018a), where each institution defines the graduate profiles according to their own criteria. For this reason, when the Mineduc designed the NQF it started analyzing the current graduate profiles, since although the NQF is intended to organize the qualifications, this means that it must address the current diversity. In this respect, the analysis carried out in this study shows that, despite the evident complexity of the graduate profiles, it is possible to advance towards adherence to the international agreements. Indeed, in other countries where there are greater guidelines on what graduate profiles should contain (whether by means of accreditation mechanisms, qualification frameworks, or professional associations), the question that has arisen is specifically what the country should do to adhere to these agreements (Basri, 2009). In the case of Chile, it is still necessary to examine the situations of the different higher education institutions.

In Chile, there is currently discussion of the possibility of simultaneously having an NQF and subscribing to international agreements, which creates the importance of analyzing the consistency between both instruments. Having an NQF that is fully aligned with the agreements described would have the benefit of allowing higher education institutions to consider both guidelines simultaneously in their processes of curricular innovation, thus facilitating greater comprehensibility both nationally and internationally.

According to the analysis carried out in this research, it can be observed that international agreements and the NQF are consistent in their structure and in terms of the volume of learning (duration of programs). As regards the descriptors, although there is a high degree of agreement, there are certain differences that should be addressed in order to align the documents more fully.

In the analysis of the graduation profiles, we observed a high degree of correspondence with the agreements and with the NQF, while the discrepancies identified can easily be resolved in the processes of curricular innovation for the study programs. This finding is not uncommon, as there are various experiences in the literature that show how the programs have had to adapt their curricula to respond to the requirements of the agreements (Klassen & Sá, 2020; Kolmos, Hadgraft, & Holgaard, 2016), to the different NQFs (Handayani, Putro, Rakhman, & Jo-Ching, 2018), or other requirements of the Bologna Process (Uhomoibhi, 2009). Similarly, in spite of the differences found and because of the high levels of consistency, it seems possible that the educational offering of programs related to engineering in Chile can be organized according to the international agreements, which would also be consistent with the NQF. This would allow progress in producing qualifications that are more understandable for students and employers, both inside and outside the country.

Conclusions

The analyses carried out enable us to conclude that Chile has an NQF proposal for higher education that broadly converges with international engineering agreements in terms of structure, descriptors, and the typical volume of learning for each qualification.

The greatest consistency was seen in the qualification of the *profesional advanzado*, since the NQF, the agreements, and the graduate profiles outline similar levels of qualification for the engineer. On the other hand, the largest discrepancies were observed in the qualifications of the HLT and *profesional de aplication*, since the Dublin and Sydney agreements both establish that a higher level of qualification is expected in some skills, specifically in cognitive and technical skills. Internationally, design skills for solutions to engineering problems are required for these levels of qualification, which are not included in the NQF or the graduate profiles. As a consequence, it is necessary to examine other programs in order to determine whether these differences also appear and, if so, it could be a good idea to make adjustments to in the NQF in order to expand the skills that are deficient in comparison with the agreements.

As stated previously, despite the differences found, it seems possible that the educational offering of engineering-related careers in Chile can be organized based on the agreements, in consonance with the NQF, in order to progress towards comprehensible qualifications for a broad target audience.

Finally, with respect to the omissions identified in some graduate profiles, adherence to the international agreements and the NQF will undoubtedly lead them to be more explicit and thus contribute to the transparency and structuring of the national education system in these areas.

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References

Anwar, A. & Richards, D. (2018). Comparison of EC and ABET accreditation criteria. *Journal of Professional Issues in Engineering Education and Practice, 144*(3), 06018001. https://doi.org/10.1061/(asce)ei.1943-5541.0000364

Basri, H., Che Man, A., Wan Badaruzzaman, W., & Nor, M. (2004). Malaysia and the Washington accord: What it takes for full membership. *International Journal of Engineering and Technology*, 1(1), 64-73. Retrieved from http://www.ijet.feiic.org/journals/J-2004-V1008.pdf

Basri, H. (2009). International benchmarking in higher education: A case study for engineering education in Malaysia. *International Journal of Organizational Innovation, 1*(3), 2-18. Retrieved from https://search-proquest-com.ezproxy.usach.cl/docview/194697671?accountid=45394

Beneitone, P., Esquetini, C., González, J., Maletá, M., Siufi, G., & Wagenaar, R. (2007). *Reflexiones y perspectivas de la educación superior en América Latina. Informe Final-Proyecto Tuning América Latina desde 2004 a 2007.* Bilbao: Universidad de Deusto.

Bernal, C. (2008). *Metodología de la investigación* (tercera edición). Bogotá: Pearson Educación. Retrieved from http://abacoenred.com/wp-content/uploads/2019/02/El-proyecto-de-investigaci%C3%B3n-F.G.-Arias-2012-pdf.pdf

Brunner, J. J. (2008). El sistema de educación superior en Chile: un enfoque de economía política comparada. *Avaliação: Revista da Avaliação da Educação Superior (Campinas), 13*(2), 451-486. https://doi.org/10.1590/s1414-40772008000200010

Comisión del Sistema Nacional de Certificación de Competencias Laborales, ChileValora. (2014). *Marco de cualificaciones para la formación y certificación laboral.* Retrieved from https://www.oitcinterfor.org/sites/default/files/file_publicacion/ChileValora_MarcoCualificaciones_2014.pdf

Chuchalin, A., Boev, O., & Kriushova, A. (2007). The Russian system of higher education in view of the Bologna process. *International Journal of Electrical Engineering & Education, 44*(2), 109-117. https://doi.org/10.7227/ijeee.44.2.4

Consejo de Competencias Mineras, CCM. (2013). *Marco de cualificaciones para la minería.* Retrieved from http://www.ccm.cl/marco-de-cualificaciones-para-la-mineria-mcm/

Consejo Nacional de Educación, CNED. (2014). *Hacia un marco nacional de cualificaciones para Chile.* Retrieved from https://www.cned.cl/sites/default/files/marco_nacional_cualificaciones_chile.pdf

Colegio de Ingenieros de Chile. (2018). *Colegio de Ingenieros de Chile por medio de su Agencia Acreditadora se incorporó como miembro provisional del Washington Accord*. Retrieved from https://www.ingenieros.cl/colegio-de-ingenieros-de-chile-por-medio-de-su-agencia-acreditadora-se-incorporo-como-miembro-provisional-del-washington-accord/

Consejo de Rectores de las Universidades Chilenas, CRUCh. (2010). *Diseño de un marco de cualificaciones para el sistema de educación superior chileno.* Santiago de Chile: Autor.

European Union (2009). *The European Qualifications Framework for lifelong learning (EQF)*. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/2402bbf8-a06a-4bbb-969f-029849635417

de Koker, J. (2012). Engineering technology education under the new higher education qualification framework. *Civil Engineering: Magazine of the South African Institution of Civil Engineering, 20*(5), 2-5. Retrieved from https://saice.org.za/civil-engineering-magazine/civil-engineering-magazine-archives/

Handayani, P., Putro, T. Y., Rakhman, E., & Jo-Ching, S. (2018). Learning outcomes mapping of the three year-electronic engineering diploma in level-5 professional expertise of the national qualification framework. *Jurnal Pendidikan Teknologi Dan Kejuruan, 24*(1), 102-115. https://doi.org/10.21831/jptk.v24i1.18186

Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, P. (2010). *Metodología de la investigación*. México, DF.: McGraw-Hill.

Hodgson, R. M. & Williams, B. R. (2007). Engineering education, accreditation and the Bologna declaration: A New Zealand view. *International Journal of Electrical Engineering & Education, 44*(2), 124-128. https://doi.org/10.7227/ijeee.44.2.6

International Engineering Alliance. (2013). *Graduate attributes and professional competencies.* Retrieved from https://www.ieagreements.org/assets/Uploads/Documents/Policy/Graduate-Attributes-and-Professional-Competencies.pdf

International Engineering Alliance. (2014). *25 years Washington Accord.* Retrieved from https://www.ieagreements.org/assets/Uploads/Documents/History/25YearsWashingtonAccord-A5booklet-FINAL.pdf

International Engineering Alliance. (2019). *Rules and procedures.* Retrieved from https://www.ieagreements.org/assets/Uploads/Documents/Policy/Accord-Rules-and-Procedures-July-2018-version-2019.1.pdf

King, R. W. (2007). The Bologna process and its potential influence on Australian engineering education. *International Journal of Electrical Engineering & Education, 44*(2), 118-123. https://doi.org/10.7227/ijeee.44.2.5

Klassen, M. & Sá, C. (2020). Do global norms matter? The new logics of engineering accreditation in Canadian universities. *Higher Education, 79*(1), 159-174. https://doi.org/10.1007/s10734-019-00403-6

Kolmos, A., Hadgraft, R. G., & Holgaard, J. E. (2016). Response strategies for curriculum change in engineering. *International Journal of Technology and Design Education, 26*(3), 391-411. https://doi.org/10.1007/s10798-015-9319-y

Kri, F., Marchant, E., del Valle, R., Sánchez, T., Altieri, E., Ibarra, P., ..., Segovia, N. (2015). *Manual para la implementación del Sistema de Créditos Académicos Transferibles* (tercera edición). Santiago de Chile: Consejo de Rectores de Universidades Chilenas, CRUCh.

Ley N° 21.091 sobre Educación Superior del Ministerio de Educación de Chile. *Diario Oficial de la República de Chile*, Santiago, Chile, 11 de mayo de 2018. Retrieved from https://www.leychile.cl/navegar?idNorma=1118991

Lemaitre, M. J. & Durán, F. (2013). *Hacia una nueva arquitectura del sistema de educación superior en Chile: el régimen de lo público.* Santiago de Chile: Aequalis.

Lucena, J., Downey, G., Jesiek, B., & Elber, S. (2008). Competencies beyond countries: The re-organization of engineering education in the United States, Europe, and Latin America. *Journal of Engineering Education, 97*(4), 433-447. https://doi.org/10.1002/j.2168-9830.2008.tb00991.x

Mahmood, K., Khan, K. M., Khan, K., & Kiani, S. (2015). *Implementation of outcome based education in Pakistan: A step towards Washington Accord*. Trabajo presentado en IEEE 7th International Conference on Engineering Education (ICEED), Kanazawa, Japón. http://doi.org/10.1109/ICEED.2015.7451513

Ministerio de Educación de Chile, Mineduc. (2016). *Marco nacional de cualificaciones para la educación superior.* Santiago de Chile: Autor.

Ministerio de Educación Pública Costa Rica. (2018). *Marco nacional de cualificaciones.* Retrieved from http://www.detce.mep.go.cr/sites/all/files/detce_mep_go_cr/adjuntos/marco_nacional_cualificaciones_.pdf

Ndambuki, J. & McKune, T. (2013). Implications of the new higher education qualification sub-framework on the training of civil engineering professionals. *Magazine of the South African Institution of Civil Engineering, 10*, 75-76. Retrieved from https://saice.org.za/civil-engineering-magazine/civil-engineering-magazine-archives/

Neves, M. (2014). The Bologna Process and higher education in Mercosur: Regionalization or Europeanization? *International Journal of Lifelong Education, 33*(3), 411-427. https://doi.org/10.1080/02601370.2014.891884

Organización para la Cooperación y el Desarrollo Económicos, OCDE. (2013). *Revisión de Políticas Nacionales de Educación: El aseguramiento de la calidad en la Educación Superior en Chile 2013.* Paris: OECD Publishing. https://doi.org/10.1787/9789264191693-es

Palma Amestoy, C. (2013). La privatización de la educación superior en Chile: procesos de masificación y reproducción social. *Sociedad Hoy*, *24*, 119-140. Retrieved from http://revistasacademicas.udec.cl/index.php/sociedad_hoy/article/view/796

Paramasivam, S., Mutusamy, K., & Tan, K. (2013). Study of the effectiveness of the implementation of Washington accord in Malaysia's engineering undergraduate programme using SEM. *Procedia-Social and Behavioral Sciences*, *90,* 803-812. https://doi.org/10.1016/j.sbspro.2013.07.155

Pey, R., Durán, F., & Jorquera, P. (2012). *Duración de las carreras de pregrado en el CRUCh.* Santiago de Chile: Consejo de Rectores de las Universidades Chilenas, CRUCh.

Qualifications Framework Council. (2013). *Australian qualifications framework.* Retrieved from https://www.aqf.edu.au/

Quality and Qualifications Ireland. (2003). *National framework of qualifications (NQF)*. Retrieved from https://www.qqi.ie/Articles/Pages/National-Framework-of-Qualifications-(NFQ).aspx

Reglamento N° 42.538. *Diario Oficial de la República de Chile*, Santiago, Chile, 27 de diciembre de 2019. Retrieved from https://www.cnachile.cl/SiteAssets/Paginas/Acreditacion-institucional/DO_APRE.pdf

Servicio de Información de Educación Superior, SIES. (2017). *Base de oferta académica 2017.* Retrieved from https://www.mifuturo.cl/bases-de-datos-de-oferta-academica/

Servicio de Información de Educación Superior, SIES. (2018a). *Base de oferta académica 2019.* Retrieved from https://www.mifuturo.cl/bases-de-datos-de-oferta-academica/

Servicio de Información de Educación Superior, SIES. (2018b). *Informe matrícula 2018 en educación superior en Chile.* Retrieved from https://www.mifuturo.cl/informes-de-matricula/

Servicio de Información de Educación Superior, SIES. (2018c). *Instituciones de educación superior vigentes, 31 de diciembre 2018.* Retrieved from https://www.mifuturo.cl/instituciones-de-educacion-superior-en-chile/

Skubic, E. & Keep, E. (2015). Implementing national qualifications frameworks across five continents. *Journal of Education and Work*, *28*(1), 106-115. https://doi.org/10.1080/13639080.2014.934790

Sistema Nacional de Educación Terciaria, Colombia. (2017). *Marco nacional de cualificaciones-Colombia*. Retrieved from http://www.oei.org.co/uploads/files/microsites/16/66/mnc-introduccion-al-mnc.pdf

South African Qualifications Authority. (2008). *South African Qualifications Authority*. Retrieved from http://www.saqa.org.za/list.php?e=NQF

Tsirigotis, G. A. (2013). *Accreditation proposal for control systems in electrical engineering for 6th level in European qualification framework (EQF).* Trabajo presentado en 24th EAEEIE Annual Conference (EAEEIE), Chania, Grece.

Tuck, R. (2007). *An introductory guide to national qualifications frameworks: Conceptual and practical issues.* Ginevra: International Labor Organization.

Uhomoibhi, J. O. (2009). The bologna process, globalisation and engineering education developments. *Multicultural Education & Technology Journal, 3*(4), 248-255. http://dx.doi.org.ezproxy.usach.cl/10.1108/17504970911004255

United Nations Educational, Scientific and Cultural Organization, Unesco. (2017). *Global inventory of regional and national qualifications frameworks, Volume II.* Retrieved from https://uil.unesco.org/lifelong-learning/qualification-frameworks/global-inventory-regional-and-national-qualifications-1

Zamtinah, E. S. (2018). Developing the Indonesian Qualifications Framework's descriptors for electrical engineering as the basis of the recognition of prior learning (RPL). *Journal of Physics: Conference Series, 1140,* 012025. https://doi.org/10.1088/1742-6596/1140/1/012025