Tuning

Latin America

Higher Education in Latin America: reflections and perspectives on **Civil Engineering**

Alba Maritza Guerrero Spínola (ed.)

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Tuning Latin America Project

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Tuning: past, present and future
An introduction

Major changes have taken place worldwide in higher education over the last 10 years, although this has been a period of intense reflection particularly for Latin America, insofar as the strengthening of existing bonds between nations has been promoted and the region has started to be considered as being increasingly close. These last 10 years also represent the transition time between Tuning starting out as an initiative that arose as a response to European needs and going on to become a worldwide proposal. Tuning Latin America marks the start of the Tuning internationalisation process. The concern with thinking how to progress towards a shared area for universities while respecting traditions and diversity ceased to be an exclusive concern for Europeans and has become a global need.

It is important to provide the reader of this work with some definitions of Tuning. Firstly, we can say that Tuning is **a network of learning communities**. Tuning may be understood as being a network of inter-connected academic and student communities that reflects on issues, engages in debate, designs instruments and compares results. They are experts that have been brought together around a discipline within a spirit of mutual trust. They work in international and intercultural groups and are totally respectful of independence on an institutional, national and regional level, exchanging knowledge and experiences. They develop a common language to problems in higher education to be understood and take part in designing a set of tools that are useful for their work, and which have been devised and produced by other academics. They are able to take part in a platform for reflection and action about higher education - a platform made up of hundreds of communities from different countries. They are responsible for developing reference points for disciplines that represent a system for designing top quality qualifications which are shared by many. They are open to the possibility of creating networks with many regions of the world within their own field and feel that they are responsible for this task.

Tuning is built on each person that forms part of that community and shares ideas, initiatives and doubts. It is global because it has pursued an approach based on worldwide standards while at the same time remaining both local and regional, respecting the specific features and demands of each context. The recent publication: *Communities of Learning: Networks and the Shaping of Intellectual Identity in Europe, 1100-1500* (Crossley Encanto, 2011) takes all the new ideas into consideration which are developed within a community context, whether of an academic, social or religious nature or simply as a network of friends. The challenge facing Tuning communities is to gain an impact on the development of higher education in its regions. Secondly, Tuning is a **methodology** with well-designed steps and a dynamic outlook that enables different contexts to be adapted. The methodology has a clear aim: to build qualifications which are compatible, comparable, are relevant to society and with top levels of both quality and excellence, while preserving the valuable diversity deriving from the traditions of each country involved. These requirements demand a collaborative methodology based on consensus which is developed by experts from different fields who are representatives of their disciplines, and who have the ability to understand local, national and regional situations.

This methodology has been developed around **three core themes**: the first is the **qualification profile**, the second is the **syllabus** and the third refers to the **trajectories of those who learn**.

The qualification profile enjoys a key position in Tuning. After a lengthy period of reflection and debate within Tuning projects in different regions (Latin America, Africa, Russia), the qualifications profile may be defined as being a combination of forces revolving around four core points:

- The region's needs (from local issues to the international context).
- The meta-profile of the area.

- The taking into consideration of future trends in the profession and society.

- The specific mission of the university.

The question of **social relevance** is essential for the design of profiles. Without doubt, any analysis of the relationship existing between university and society lies at the heart of the matter of relevance in higher education. Tuning's aim is to identify and meet the needs of the production sector, the economy, society as a whole and the needs of each student within a particular area of study – measured by specific social and cultural contexts. With a view to achieving a balance between these different needs, goals and aspirations, Tuning has consulted leading people, key local thinkers and experts from industry, both learned and civil society and working parties that include all those interested. An initial period of this phase of the methodology is linked to general competences. Each thematic area involves the preparation of a list of general competences deemed relevant from the standpoint of the region concerned. This task ends when the group has widely discussed and reached consensus about a selection of specific competences, and the task is also performed with specific competences. Once the means of consultation has been agreed and the process completed, the final stage in this practical exercise involving the search for social relevance refers to an analysis of results. This is done jointly by the group, and special care is taken not to lose any contributions from the different cultural perceptions that might illustrate understanding of the specific reality.

Once lists of the general and specific agreed, consulted and analysed competences had been obtained, a new phase got underway over these last two years that is related to the **development of meta-profiles for the area** under consideration. For Tuning methodology, meta-profiles represent the structures of the areas and combinations of competences (general and specific) that lend identity to the disciplinary area concerned. Meta-profiles are mental constructions that categorise competences in recognisable components and illustrate their inter-relations.

Furthermore, thinking about education means becoming involved in the present, while above all also looking towards the future – thinking about social needs, and anticipating political, economic and cultural changes. This means also taking into account and trying to foresee the challenges that those future professionals will have to face and the impact that certain profiles of qualifications is likely to have, as designing profiles is basically an exercise that involves looking to the future. Within the present context, designing degree courses takes time in order for them to be planned and developed and their approval obtained. Students need years to achieve results and mature in terms of their learning. Then, once they have finished their degree, they will need to serve, be prepared to act, innovate and transform future societies in which they will find new challenges. Qualification profiles will in turn need to look more to the future than the present. For this reason, it is important to take an element into consideration that should always be taken into account, which are future trends both in terms of the specific field and society in general. This is a sign of quality in design. Tuning Latin America embarked on a methodology so as to incorporate an **analysis of future trends into the design of profiles**. The first step therefore involved the search for a methodology to devise future scenarios following an analysis of the most relevant studies in education by focusing on the changing role of higher educational establishments and trends in educational policies. A methodology was chosen based on in-depth interviews with a dual focus: on the one hand, there were questions that led to the construction of future scenarios on a general society level, their changes and impact. This part needed to serve as a basis for the second part, which dealt specifically with the features of the area in itself, their transformation in general terms in addition to any possible changes in the degree courses themselves that might have tended to disappear, re-emerge or be transformed. The final part sought to anticipate the possible impact on competences based on present coordinates and the driving forces behind change.

There is a final element that has to be taken into account when constructing the profiles, which is linked to the **relationship with the university where the qualification is taught**. The mark and mission of the university must be reflected in the profile of the qualification that is being designed.

The second core theme of the methodology is linked to **syllabuses**, and this is where two very important Tuning components come into play: on the one hand, students' work volume, which has been reflected in an agreement to establish the Latin American Reference Credit (CLAR), and all studies are based on this and, on the other, the intense reflection process into how to learn, teach and assess competences. Both aspects have been covered in Tuning Latin America.

Lastly, an important area is opened up for future reflection about the **trajectories of those who learn** – a system that proposes focusing on the student leads one to consider how to position oneself from that standpoint so as to be able to interpret and improve the reality in which we find ourselves.

Finally, Tuning is a **project** and as such came into existence with a set of objectives and results and within a particular context. It arose from the needs of the Europe of 1999, and as a result of the challenge laid down by the 1999 Bologna Declaration. Since 2003, Tuning has become a project that goes beyond European borders, in so doing embarking on intense work in Latin America. Two very specific problems faced by the university as a global entity were pinpointed: on the one hand, the need to modernise, reformulate and make syllabuses more flexible in the light of new trends, society's requirements and changing results in a vertiginous world and, on the other, which is linked closely to the first problem, the importance of transcending limits imposed by staff in terms of learning, by providing training that would enable what has been learnt to be recognised beyond institutional local, national and regional borders. The Tuning Latin America project thus emerged which, in its first phase (2004-2007), sought to engage in a debate whose goal was to identify and exchange information and improve collaboration between higher educational establishments, with a view to developing the quality, effectiveness and transparency of qualifications and syllabuses.

This new phase of **Tuning Latin America (2011-2013)** started life on already-fertile terrain – the fruits of the previous phase and in view of the current demand on the part of Latin American universities and governments to facilitate the continuation of the process that had already been embarked on. The aim of the new Tuning phase in the region was to help build a Higher Education Area in Latin America. This challenge takes the form of four very specific central working themes: a deeper understanding of agreements involving **designing meta-profiles and profiles in the 15 thematic areas** included in the project (Administration, Agronomy, Architecture, Law, Education, Nursing, Physics, Geology, History, Information Technology, Civil Engineering, Mathematics, Medicine, Psychology and Chemistry); contributing to **reflections on future scenarios for new professions**; promoting the joint construction of **methodological strategies in order to develop and assess the training of competences**; and designing **a system of academic reference credits (CLAR-Latin American Reference Credit)** to facilitate recognition of studies in Latin America as a region that can be articulated with systems from other regions.

The Tuning door to the world was Latin America, although this internationalisation of the process wouldn't have gone far if it hadn't been for a group of prestigious academics (230 representatives of Latin American universities), who not only believed in the project, but also used their time and creativity to make it possible from north to south and west to east across the extensive, diverse continent that is Latin America. This was a group of experts in different thematic areas that would go on to study in depth and gain weight in terms of their scope and educational force, and in their commitment to a joint task that history had placed in their hands. Their ideas, experiences and determination paved the way and enabled the results which are embodied in this publication to be achieved.

Yet the Tuning Latin America project was also designed, coordinated and administered by Latin Americans from the region itself, via the committed work carried out by Maida Marty Maleta, Margarethe Macke and Paulina Sierra. This also established a type of *modus operandi*, conduct, appropriation of the idea and of deep respect for how this was going to take shape in the region. When other regions decided to join Tuning, there would henceforth be a local team that would be responsible for considering what to emphasize - specific features, the new elements that would need to be created to meet needs which, even though many of them might have common characteristics within a globalised world, involve dimensions specific to the region, are worthy of major respect and are, in many cases, of major scope and importance.

There is another pillar on this path which should be mentioned: the coordinators of the thematic areas (César Esquetini Cáceres-Coordinator of the Area of Administration; Jovita Antonieta Miranda Barrios-Coordinator of the Area of Agronomy; Samuel Ricardo Vélez González-Coordinator of the Area of Architecture; Loussia Musse Felix-Coordinator of the Area of Law; Ana María Montaño López-Coordinator of the Area of Education; Luz Angélica Muñoz González-Coordinator of the Area of Nursing; Armando Fernández Guillermet-Coordinator of the Area of Physics; Iván Soto-Coordinator of the

Area of Geology; Darío Campos Rodríguez-Coordinator of the Area of History; José Lino Contreras Véliz-Coordinator of the Area of Information Technology; Alba Maritza Guerrero Spínola-Coordinator of the Area of Civil Engineering; María José Arroyo Paniagua-Coordinator of the Area of Mathematics; Christel Hanne-Coordinator of the Area of Medicine; Diego Efrén Rodríguez Cárdenas-Coordinator of the Area of Psychology; and Gustavo Pedraza Aboytes-Coordinator of the Area of Chemistry). These academics, chosen according to the thematic groups to which they belonged, were the driving forces behind the building of bridges and strengthening of links between the project's Management Committee of which they formed a part and their thematic groups which they always held in high regard, respected and felt proud to represent. Likewise, they enabled there to be valuable articulation between the different areas, showing great ability to admire and listen to the specific elements attached to each discipline in order to incorporate, take on board, learn and develop each contribution – the bridges between the dream and the reality. Because they had to carve new paths in many cases to make the ideas possible, design new approaches in the actual language of the area and the considerations proposed, and to ensure that the group would think about them from the standpoint of the specific nature of each discipline. Following group construction, the process always requires a solid framework based on generosity and rigour. In this respect, the coordinators were able to ensure that the project would achieve specific successful results.

Apart from the contribution made by the 15 thematic areas, Tuning Latin America has also been accompanied by a further two transversal groups: the Social Innovation group (coordinated by Aurelio Villa) and the 18 National Tuning Centres. The former created new dimensions that enabled debates to be enriched and an area for future reflection on thematic areas to be opened up. Without doubt, this new area of work will give rise to innovative perspectives to enable those involved to continue thinking about top quality higher education that is connected to the social needs of any given context.

The second transversal group about which one should recognise the major role played comprises the National Tuning Centres – an area of representatives from the highest authorities of university policies from each of the 18 countries in the region. These centres accompanied the project right from the outset, supported and opened up the reality of their national contexts to the needs or possibilities developed by Tuning, understood them, engaged in dialogue with others, disseminated them and constituted reference points when seeking genuine anchors and possible goals. The National Centres have been a contribution from Latin America to the Tuning project, insofar as they have contextualised debates by assuming and adapting the results to local times and needs.

We find ourselves coming to the end of a phase of intense work. The results envisaged over the course of the project have succeeded all expectations. The fruits of this effort and commitment take the form of the reflections on the area of Civil Engineering that will be provided below. This process comes to an end in view of the challenge faced in continuing to make our educational structures more dynamic, encouraging mobility and meeting points within Latin America, while at the same time building the bridges required with other regions on the planet.

This is the challenge facing Tuning in Latin America.

July 2013

Pablo Beneitone, Julia González and *Robert Wagenaar*

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Meta-profile of the civil engineer

1.1. Introduction

In phase 1 of the 2004-2007 Tuning project, the working party comprised 21 universities and higher educational establishments from 18 countries as follows: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, the Dominican Republic and Venezuela. 10 generic competences related directly to the civil engineering profession were deemed to be the most relevant during the professional team process (Beneitone et al., 2007, p. 217), and these are shown in Table 1 below.

Table 1
Most directly-relevant generic competences in the first stage of the Tuning project

- Capacity for abstraction, analysis and synthesis.
- Ability to apply knowledge in practice.
- Knowledge about the area of study and profession.
- Ability to identify, consider and deal with problems.
- Skills in the use of information and communications technologies.
- Capacity for decision-making.
- Capacity for teamwork.
- Ability to formulate and administer projects.
- Ethical commitment.
- Commitment to quality.

Source: put together by the 2013 Civil Engineering team.

From 2007 to November 2012, the changes that took place in each of the milieus required a review of already-defined generic competences and, as a result, it was suggested that six generic competences be included among the most important ones as listed in Table 2.

Table 2
Generic competences incorporated in the second stage of the Tuning project

• Ability to work within international contexts. • Ability to communicate in a second language. • Capacity for oral and written communication. • Social responsibility and citizenship. • Ability to learn and constantly keep up-to-date. • Ability to innovate and undertake business ventures (new).

Source: put together by the 2013 Civil Engineering team.

1.2. Map of the discipline

In Latin America, the civil engineer is defined as a professional with a broad command of basic engineering science to enable them to develop engineering solutions for infrastructure-related problems, whether roads, housing, hydraulics or sanitation. The civil engineer must have the ability to design, plan, manage and administer projects involving the implementation of such solutions.

The most commonly-awarded qualification is that of civil engineer. This qualification entitles graduates to exercise professionally in several Latin American countries, although in most cases registration with the relevant professional association is also required. An examination also needs to be passed in some cases (Mexico). The degree course is of 5 years' duration in most (15) countries, exceptions being Mexico (from 3.5 to 5 years), the Dominican Republic (from 3.5 to 4.5 years) and Chile (6 years).

In some countries, the title of engineer-builder or construction engineer is also awarded as a qualification which is to a large extent equivalent to that of civil engineer. In addition, other related qualifications are awarded in some civil engineering faculties or departments such as those of environmental engineer, hydraulic engineer and agricultural engineer, among others, which imply a level of specialization within the field of civil engineering. However, work involving the identification of specific competences carried out by the working party focused exclusively on civil engineering and construction engineering qualifications.

Civil engineering training includes the following aspects:

- *Basic science*: including the acquisition of knowledge in mathematics, physics and chemistry, among other subjects.

- *Basic vocational training,* covering subjects such as: mechanics, fluid mechanics, resistance and material science, thermodynamics, soil mechanics, geomatics, geology, drawing and graphic communication, computing and environmental science, among others.

- *Vocational training:* a stage in which knowledge is acquired and skills developed for: analysis and design of structures (concrete, wooden, metal and masonry); the conception and design of projects involving the exploitation of hydraulic resources, water supply systems and sanitation; road design and planning (streets, paths and roads); the management of construction teams; and the supervision and control of projects and building work.

- *Socio-humanistic and complementary training:* takes into consideration comprehensive graduate education, including ethics and values, and also aspects involved in the management and administering of human, material and financial resources, economic engineering and entrepreneurship, among others.

Civil engineers are able to perform their duties in any public or private company involved in the management, design, construction, operation, maintenance or supervision of infrastructure building projects, whether in urban or rural areas (Beneitone et al., 2007, p. 215).

In the first phase of the Tuning project, the working party identified 19 specific competences as being essential in the training of the civil engineer (Beneitone et al., 2007, p. 217), which are listed below in Table 3.

Table 3

Specific competences of the civil engineer

1. Apply knowledge of basic science and civil engineering science.
2. Identify, assess and implement suitable technologies according to their context.
3. Create, innovate and undertake business ventures in order to contribute towards technological development.
4. Devise, analyse, plan and design civil engineering work.
5. Plan and schedule civil engineering work and services.
6. Build, supervise, inspect and assess civil engineering work.
7. Operate, maintain and renovate civil engineering work.
8. Assess and alleviate the environmental and social impact of building work.
9. Shape and simulate civil engineering systems and processes.
10. Manage and supervise human resources.
11. Administer material resources and equipment.
12. Understand and associate legal, economic and financial concepts with decision-making, project management and civil engineering work.
13. Use spatial abstraction and graphic representation.
14. Propose solutions that may contribute towards sustainable development.
15. Prevent and assess risks attached to civil engineering work.
16. Handle and interpret field information.
17. Use information technologies, software and tools for civil engineering.
18. Interact with multidisciplinary groups and provide comprehensive civil engineering solutions.
19. Use quality control techniques in civil engineering materials and services.

Source: put together by the 2013 Civil Engineering team.

1.3. Presentation of key aspects of the meta-profile prepared in the area

16 professionals took part in the second phase of *Tuning Latin America: Educational and Social Innovation* project, representing universities and higher educational establishments from the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Paraguay, Peru, Venezuela and Rumania. Subsequently, general agreements were reached from several discussions and reflections as to how to design competence-based academic-professional meta-profiles[1]. The meta-profile defined for the thematic area was adjusted and a review of the contrast made among participant countries conducted.

Review of the meta-profile

In this respect, the civil engineering team conducted a review of the generic and specific competences to be included in the meta-profile. It also reviewed the classification made for an analysis of generic competences carried out by the Tuning Project during its first phase, referred to as components or factors (Beneitone, 2007, p. 67) and decided how to group together similar competences within four dimensions[2] —cognitive, social, technological and international, and interpersonal— as shown in Figure 1.

Cognitive dimension

This includes those competences related mainly to the intellectual system of the human being (Sanz, 2010, p. 21).

Social dimension

Within this dimension can be included those socio-affective competences related to coexistence with other individuals, group work and collaboration, among others.

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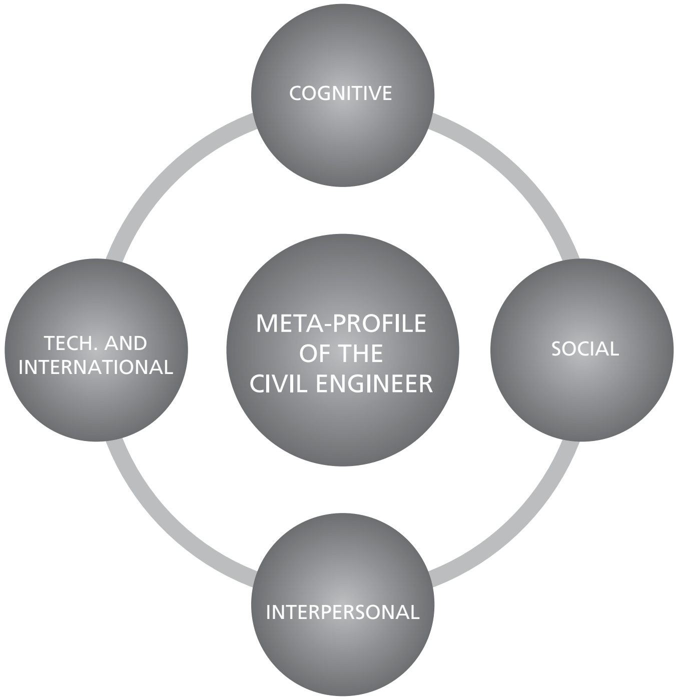
[1] The meta-profile represents structures in areas and combinations of competences (both generic and specific) that lend identity to the disciplinary area.

[2] According to the *Real Academia* dictionary, *dimension* means an aspect or facet of something.



Source: put together by the 2013 Civil Engineering team.

Figure 1
Dimensions of the civil engineer meta-profile

In this aspect, knowing how to work together with other people will be carried out in a communicative and constructive way, evidencing group-oriented behaviour and interpersonal understanding (Blanco et al., 2009, p. 22; Sanz, 2010, p. 21).

Technological and international dimension

The technological dimension includes those competences that are related to the search for and handling of information and communication and to the creation and application of knowledge. New technologies facilitate teaching and learning and communication with others (Sanz, 2010, p. 22).

Interpersonal dimension

This includes individual competences linked to the ability to express one's own feelings, critical skills and self-criticism.

Table 4
Meta-profile proposed for the civil engineer in Latin America
(May 2011, Colombia)

Dimension	Competence
Cognitive	Capacity for abstraction, analysis and synthesis. Use spatial abstraction and graphic representation. Ability to apply knowledge in practice. Apply knowledge of basic science and civil engineering science. Knowledge about the area of study and profession. Devise, analyse, plan and design civil engineering work. Knowledge about the area of study and profession. Build, supervise, inspect and assess civil engineering work. Operate, maintain and renovate civil engineering work. Ability to identify, consider and deal with problems. Prevent and assess risks attached to civil engineering work. Identify, assess and implement the most suitable technologies for their context. Handling and management of disasters in civil engineering work.
Social	Ethical commitment. Consider the environmental and social impact of building work. Propose solutions that may contribute towards sustainable development. Commitment to quality. Use quality control techniques in civil engineering materials and services.
Technological and international	Skills in the use of information and communications technologies. Use information technologies, software and tools for civil engineering. Ability to formulate and administer projects. Plan and schedule civil engineering work and services. Handle and interpret field information. Capacity for communication in a second language. Ability to work within international contexts.
Interpersonal	Capacity for decision-making. Manage and supervise human resources. Administer material resources and equipment. Understand and associate legal, economic and financial concepts with decision-making, project management and civil engineering work. Capacity for teamwork. Interact with multidisciplinary groups and provide comprehensive civil engineering solutions. Capacity for oral and written communication. Ability to innovate and undertake business ventures.

Source: put together by the 2013 Civil Engineering team.

They tend to facilitate social interaction and cooperation processes (Blanco et al., 2009, p. 23).

The following can be stated with regard to the design of the meta-profile:

- The first column will be referred to as a *dimension* and an updated draft of each of them will be provided in the second column.

- In the case of the competence related to the environmental impact of building work, it was agreed to change the draft version, as the previous one was rather too ambitious for a civil engineer. It will thus be restated as follows: *Consider the environmental and social impact of building work.*

1.4. Contrasting the meta-profile in participant countries and universities

Contrasting competences in Latin America

Any gap existing between the Tuning Project and participant universities was reviewed, and the information sent was discussed and clarified. The competences defined in the meta-profile were included in a comparison matrix , and each participant in the civil engineering team was requested to contrast the extent to which each competence is included in curriculum and policy documents in their own countries.

In Table 5 it can be noted that a comparison was made between the competences defined in the Tuning Project and those defined by participant universities, and this gap was weighted as follows: 1 corresponds to a non-included competence, 2 competence in the process of being achieved/low level of compliance, 3 competence in the process of being achieved/average level of compliance, and 4 competence in the process of being achieved/high level of compliance.

In addition to the comparisons made, the following general clarifications regarding the inclusion of work according to competence in each university were also provided:

Table 5
Matrix for contrasting competence

Tunning competences	University-country	Competence defined in the university	Gap	Plan of action	Outlook over time
1. Capacidad de abstracción, análisis y síntesis	Universidad Nacional de Rosario (Argentina)	Competence for identifying, formulating and dealing with engineering problems; capacity to identify an d formulate problems (1.to.4)	2	Representation system-Mec Apl-Es-truct	0-5 años
	Universidad Tecnológica Nacional (Argentina)	Capacity for abstraction, analysis and synthesis	4		Short-term
	Universidad Privada Bolivariana				
	Universidad Federal de Santa Catarina (Brazil)				
	Universidad Federal de Uberlandia (Brazil)	Use spatial abstraction in graphic representation			
	Universidad de Concepción (Chile)	Capacity for abstraction, analysis and synthesis	4	Science subjects, engineering drawing	Short-term
	Universidad Industrial de Santander (Colombia)	In the process of being achieved	4		Short-term
	Instituto Tecnológico de Costa Rica (Costa Rica)	Assess interaction between different materials in solving constructive problems			
	Instituto Superior Politécnico (Cuba)				
	Universidad Católica de El Salvador (El Salvador)	Still not defined as to whether they will work according to competence			
	Universidad de San Carlos (Guatemala)	Capacity for abstraction, analysis and synthesis	2	Curricular reform	Short-term
	Universidad Nacional Autónoma de Honduras (Honduras)	Capacity for abstraction, analysis and synthesis	4		Short-term
	Universidad Nacional de Ingeniería (Nicaragua)	Integration of competences, commands and integrating modules			
	Universidad Católica Nuestra Señora de Asunción (Paraguay)	Capacity for abstraction, analysis and synthesis	4	Permanently improve capacity via continuous assessment of teaching-learning processes	Short-term
	Universidad de Piura (Peru)	Is defined in two courses	4	Not considered	Med. term
	Universidad Centroccidental «Lisandro Alavarado» (Venezuela)	Capacity for abstraction, analysis and synthesis	4	This is achieved via theoretical-practical teaching of basic scientific knowledge and graphic representation	Short-term

Source: put together by the 2013 Civil Engineering team.

- *Instituto Tecnológico de Costa Rica:* an academic model has been approved that promotes competence-based development. There is an institutional project for curricular competence-based development and the Construction Engineering degree course is a pilot programme.. There is also the influence from the accreditation model provided by the Canadian Engineering Accreditation Board (CEAB), in which one of the assessment components is the inclusion of graduate attributes.

- *Universidad Tecnológica Nacional, Facultad Regional Avellaneda (Argentina):* afterthe 2004 academic year, a pilot plan was implemented for the first two years of civil engineering, with a view to improving academic quality and moving to a teaching methodology that focuses on the students' creative activity and the critical resolution of problems. To this end, the role of teaching staff needed to be one of mediation between areas of knowledge and students' activities. This permitted a high degree of compliance with generic competences during those first two years and also with the specific ones in some laboratory work. However, the result has not been uniform, as we have no competence-based syllabus and, therefore, everything depends on the criteria adopted by the teacher in each case as no specific directives have been set out.

- *Universidad de San Carlos de Guatemala:* the Universidad de San Carlos de Guatemala is the only state university in the country set up by constitutional mandate. It has 133 years' experience of training civil engineers, and embarked on the self-assessment process for accreditation purposes in 2008 in collaboration with the Central American Accreditation Agency (ACAAI), which resulted in curricular re-adaptation. The competence-based profile was devised, and employers, students, graduates and teachers have taken part in reviewing it. Awareness-raising and training of teachers has also got underway, and these processes have led to many positive changes. The curricular re-adaptation approved by the General Board has changed the curricular focus from objectives to competences (significant learning).

- *Universidad Federal de Uberlandia (Brazil):* work has been carried out on the validation of competences in areas such as structures and water and environmental resources. Advantage is being taken of competences and their acquisition at the end of the degree course. One problem has been articulation with schools that provide components of engineering programmes, such as mathematics and physics. It is also a member of the Mercosur accreditation system, and accreditation and its indicators are competence-based. Brazil has a very strict law governing this which means that changes cannot be implemented swiftly, with many agents also being involved. However, the content of vocational training subjects in the new syllabus is incorporated via broad-ranging projects in which students are assessed according to competences.

- *Universidad Católica Nuestra Señora de la Asunción (Paraguay):* they indicate that what was generated in the previous phase of the project has helped in carrying out self-assessment and accreditation of engineering syllabuses.

- *Universidad Nacional de Ingeniería (Nicaragua):* the university approved an academic model whose core theme is research and which is competence-based. In the case of civil engineering, the 19 competences generated by Tuning were reviewed, analysed and degree course profiles defined accordingly. One problem still to be resolved is how competences are going to be assessed.

- *Universidad Industrial de Santander (Colombia):* changes in the university started 10 years ago on different levels: institutional, and according to faculty and school. This has been the case with civil engineering, as the purpose of study was analysed and the areas and the competences for each of them defined. Pedagogic training workshops have been organised for teachers, which has proved to be more difficult. The teacher's role is changing from being a conveyer of knowledge to a mediator in the generation of knowledge.

- *Universidad Católica de El Salvador (UNICAES):* the work carried out by Tuning has contributed substantially to a definition of the syllabus at the Universidad Católica de El Salvador, in accordance with the country's needs. The main contribution has been in an improvement to the current civil engineering curriculum regarding the design of the graduate profile for engineers.. The meta-profile helped to update the 2012 curriculum for the 2013-2017 syllabus. UNICAES is also working towards institutional accreditation via the Ministry of Education in favour of continuous improvement in terms of academic quality, while at the same time the accreditation process is being analysed with a regional body, albeit on an engineering degree level.

UNICAES is currently working with the Ministry of Education (2012) to embed the substantial progress made by Tuning and to promote a competence-based educational model. However, the current syllabus is not based on that model, but rather, on the traditional model based on objectives and content.

- *Universidad Nacional Autónoma de Honduras:* there have been difficulties with the curricular part, especially with regard to teaching staff. Self-assessment with a view to accreditation by the ACAAI is being completed, and competences will soon start to be included.

- *Universidad Privada Boliviana (UPB-Bolivia):* there has been a phenomenon in the country of many civil engineering degree courses being accredited by Mercosur, more than in any other country from the region. However, around 3 universities have shown an interest in competence-based curricula. In the specific case of the UPB, a process involving the design of competence-based programmes has recently got formally underway, although a career-based academic model was already implemented 20 years ago. One of the main obstacles to taking things further thus far has been the delay in approval by the Ministry of Education of the General Regulations governing Private Universities.

- *Universidad de Concepción (Chile):* there have been external bodies in the case of Chile that have favoured the introduction of this issue, among others the Engineering Teaching Association, which organises an annual forum and pursues joint projects with the Government. Funds have been obtained for advice about and training in competences. Engineering syllabuses have always included competences on a non-explicit level. This is a voluntary process and reachable goals need to be proposed, and learning results also need to be taken into account. Time has been taken to define competence-based profiles.

- *Universidad Centroccidental «Lisandro Alvarado» (Venezuela):* specific competences are clearly-defined in the case of civil engineering, but there have been problems with defining generic competences. A great deal of emphasis is placed on students' internships and end-of-design projects, and difficulties have been experienced in defining credits.

- *Universidad Nacional de Rosario (Argentina):* syllabuses for civil engineering degree courses in Argentina are content-based, according to the regulations in force (Resolution ME No. 1232/01). The issue of competences is being introduced, and in fact some competences are being developed in many subjects on our course to varying degrees. However, no reforms towards competence-based syllabuses are being considered at present.

- *Universidad de Piura (Peru):* as far as engineering is concerned, work is being carried out on a major scale on accreditation with the American ABET credit system and on the strategic plan. The results of the first Tuning phase were disseminated, gaining a favourable reaction while at the same time raising many doubts with regard to its implementation. A competence-based training seminar is needed, and National Tuning Centres need to project themselves more. As for the domestic scenario, the university is above average for the country – the situation in the country is a difficult one, the reality is very diverse and there are few universities that are able to implement this methodology. Stricter guidance by government and better quality in universities is required.

- *Universidad Federal de Santa Catarina (Brazil):* an attempt has been made at this university to advance along the lines discussed during the first phase of the project. This has focused on a definition of competences, and the need for competence assessment mechanisms has been made clear. It has been noted that alternative forms of assessment such as laboratory experiments and simulations have reduced the time needed by students to become competent, and the number of fails has also dropped. The need for changes in teaching methods and infrastructure has been taken into consideration, as this is deemed important to ensure quality of competence-based teaching and training. The relationship existing between teachers and industry via extramural study projects in which students also take part is also very important.

- *Instituto Superior Politécnico (Cuba):* Training got underway in Cuba in 2007 that incorporated skills that can be viewed as competences, and in which students need to engage in integrating projects. Practical training is deemed to be an essential requirement and students are required to carry out practical work every year. The inclusion of languages and computing has also been given prominence, and practical examples from the different areas have been used in the case of mathematics and physics. One major aspect is that the teacher who teaches is not the one who assesses – the former is viewed as a coach who prepares students so that others may assess them.

1.5. Results of comparing competences according to university

Below the results are shown of the data analysis involving a comparison of the level to which the competences defined in the Tuning Project are included in each of the participant universities. 15 out of the 16 universities taking part provided the relevant data. It is important to make clear that this exercise refers to a self-assessment by participant universities, taking the Tuning competences as a reference point.

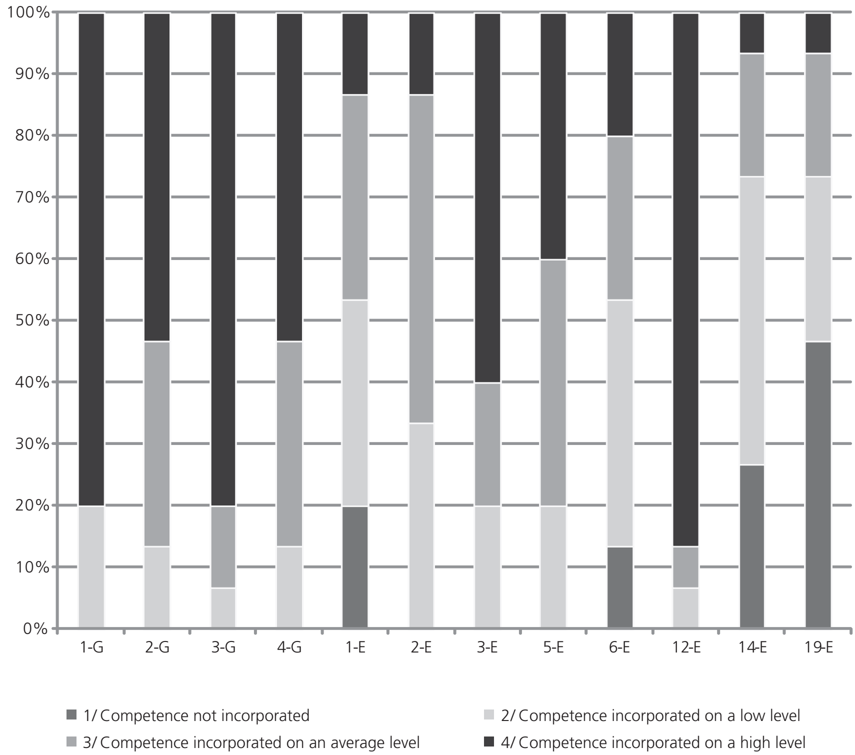
In the case of the Instituto Superior Politécnico de Cuba, only the innovation theme is relevant in the competence related to innovating and undertaking business ventures, as entrepreneurship is not widespread owing to the political system.

It can be observed in Table 6 that in the case of the competence *Ability to work within international contexts*, 11 out of 15 universities state that this has not been incorporated or has only been incorporated on a low level. Likewise, the competence *Ability to innovate and undertake business ventures*, 8 out of 15 universities point out that this has not been incorporated or has only been incorporated on a low level, whereas those competences that have been subject to a high level of incorporation in participant universities are: *Capacity for abstraction, analysis and synthesis; Knowledge about the area of study and profession; Ability to apply knowledge in practice; Ability to identify, consider and deal with problems*.

Table 6
Level of incorporation of generic competences

	Generic competence	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
1	Capacity for abstraction, analysis and synthesis	0	3	0	12
2	Ability to apply knowledge in practice	0	2	5	8
3	Knowledge about the area of study and profession	0		12	12
4	Ability to identify, consider and deal with problems	0	2	5	8
5	Skills in the use of information and communications technologies	0	2	6	7
6	Capacity for decision-making		14	5	5
7	Capacity for teamwork		12	6	6
8	Ability to formulate and administer projects	0	5	6	4
9	Ethical commitment	0	4	5	6
10	Commitment to quality	0	4	5	6
11	Ability to work within international contexts	5	6	0	4
12	Ability to communicate in a second language		15	6	3
13	Capacity for oral and written communication	0	4	6	5
14	Social responsibility and citizenship	2	5	4	4
15	Ability to learn and constantly keep up-to-date		12	7	5
16	Ability to innovate and undertake business ventures	3	5	5	2

Source: put together by the 2013 Civil Engineering team.



Source: put together by the 2013 Civil Engineering team.

Figure 2
Level of incorporation of generic competences in participant universities

In accordance with the comparison made of the specific competences, it can be observed in Table 7 that 7 out of 15 universities have not incorporated the competence *Handling and management of disasters in civil engineering work*, in the same way that 9 out of 15 universities have incorporated the competence *Understands and associates legal, economic and financial concepts with decision-making, project management and engineering work* on a low level. Likewise, 8 out of 15 universities have incorporated the competence *Interacts with multidisciplinary groups and provides comprehensive civil engineering solutions* on a low level.

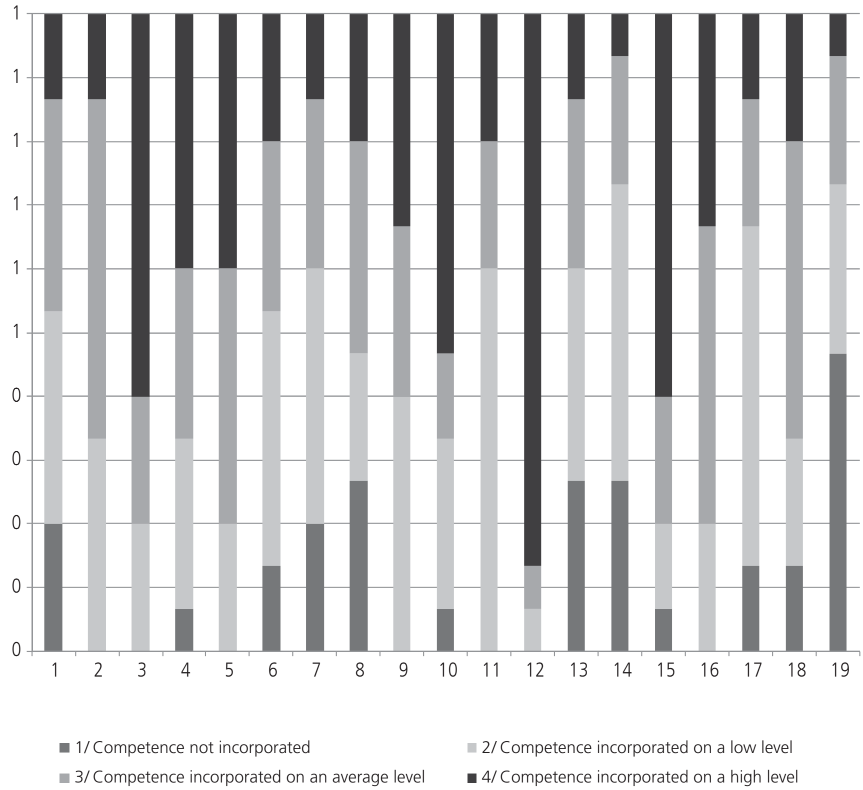
Table 7
Level of incorporation of specific competences

	Specific competence	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
1	Apply knowledge of basic science and civil engineering science	3	5	5	2
2	Identify, assess and implement suitable technologies according to their context	0	5	8	2
3	Devise, analyse, plan and design civil engineering work	0	33		9
4	Plan and schedule civil engineering work and services		14	4	6
5	Build, supervise, inspect and assess civil engineering work	0	3	6	6
6	Operate, maintain and renovate civil engineering work	2	6	4	3
7	Understand the environmental and social impact of building work	3	6	4	2
8	Shape and simulate civil engineering systems and processes	4	3	5	3
9	Manage and supervise human resources	0	6	4	5
10	Administer material resources and equipment		14	2	8
11	Understand and associate legal, economic and financial concepts with decision-making, project management and civil engineering work	0	9	3	3
12	Use spatial abstraction and graphic representation	0	11		13
13	Propose solutions that may contribute towards sustainable development	4	5	4	2

	Specific competence	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
14	Prevent and assess risks attached to civil engineering work	4	7	3	1
15	Handle and interpret field information	1	2	3	9
16	Use information technologies, software and tools for civil engineering	0	3	7	5
17	Interact with multidisciplinary groups and provide comprehensive solutions for civil engineering	2	8	3	2
18	Use quality control techniques in civil engineering work and services	2	3	7	3
19	Handling and management of disasters in civil engineering work	7	4	3	1

Source: put together by the 2013 Civil Engineering team.

The competences incorporated on a high level refer to *Use spatial abstraction and graphic representation* in which 13 out of the 15 universities have done this, while 9 out of 15 universities also state that the competences *Devise, analyse, plan and design civil engineering work* and *Handle and interpret field information* have been incorporated on a high level.



Source: put together by the 2013 Civil Engineering team.

Figure 3
Level of incorporation of specific competences in participant universities

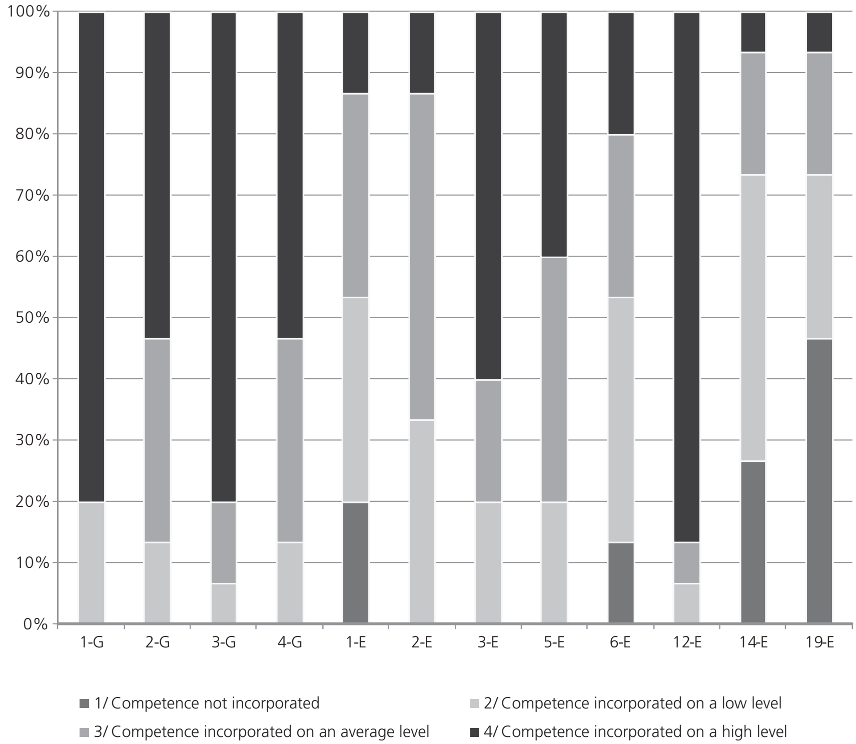
In organising competences into the dimensions selected by the Civil Engineering team and analysing their level of incorporation, it can be observed in Table 8 that, within the cognitive dimension, the competences 1-G *Capacity for abstraction, analysis and synthesis* and 12-E *Use spatial abstraction and graphic representation* have been shown to be competences that have been incorporated on a high level within universities, whereas competence 19-E *Handling and management of disasters in civil engineering work* is one of the competences that has not been able to be incorporated in 6 out of the 15 universities that made the comparison.

Table 8
Level of incorporation of competences according to dimension
(Cognitive dimension)

	Competence/Level of incorporation	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
1-G	Capacity for abstraction, analysis and synthesis	0	3	0	12
2-G	Ability to apply knowledge in practice	0	2	5	8
3-G	Knowledge about the area of study and profession	0		12	12
4-G	Ability to identify, consider and deal with problems	0	2	5	8
1-E	Apply knowledge of basic science and civil engineering science	3	5	5	2
2-E	Identify, assess and implement suitable technologies according to their context	0	5	8	2
3-E	Devise, analyse, plan and design civil engineering work	0	3	3	9
5-E	Build, supervise, inspect and renovate civil engineering work	0		36	6
6-E	Operate, maintain and renovate civil engineering work	2	6	4	3
12-E	Use spatial abstraction and graphic representation	0	1	1	13
14-E	Prevent and assess risks attached to civil engineering work	4	7	3	1
19-E	Handling and management of disasters in civil engineering work	7	4	3	1

Source: put together by the 2013 Civil Engineering team.

At this point it should be mentioned that, despite the fact that a competence-based curricular design is not referred to by most of the participant universities, a civil engineer's training requires the development of knowledge, abilities and skills, which is why the competences defined by the group within the Tuning project have been incorporated gradually.



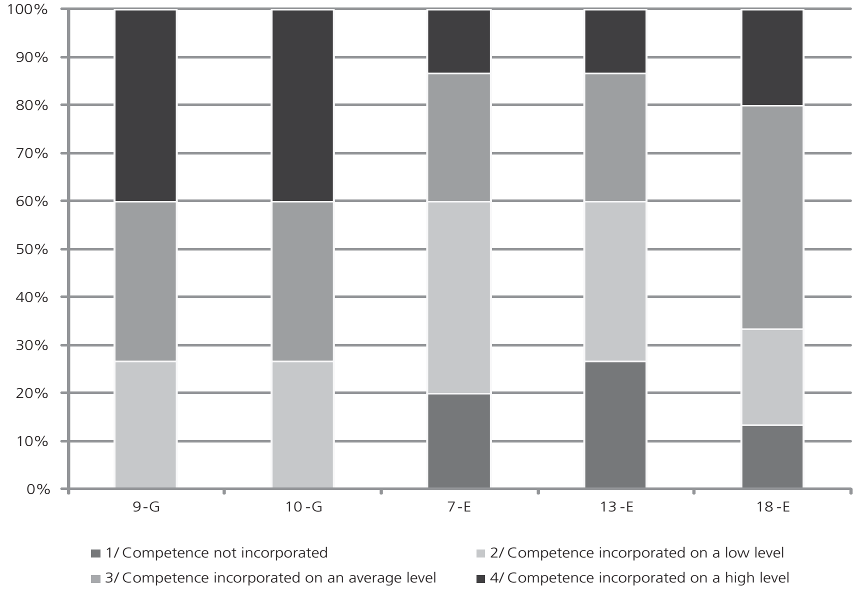
Source: put together by the 2013 Civil Engineering team.

Figure 4
Level of incorporation of specific competences
within the cognitive dimension in participant universities

Table 9
Level of incorporation of competences according to dimension
(Social dimension)

	Competence/Level of incorporation	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
9-G	Ethical commitment	0	4	5	6
10-G	Commitment to quality	0	4	5	6
7-E	Understand the environmental and social impact of building work	3	6	4	2
13-E	Propose solutions that may contribute towards sustainable development	4	5	4	2
18-E	Use quality control techniques in civil engineering materials and service	2	3	7	3

Source: put together by the 2013 Civil Engineering team.



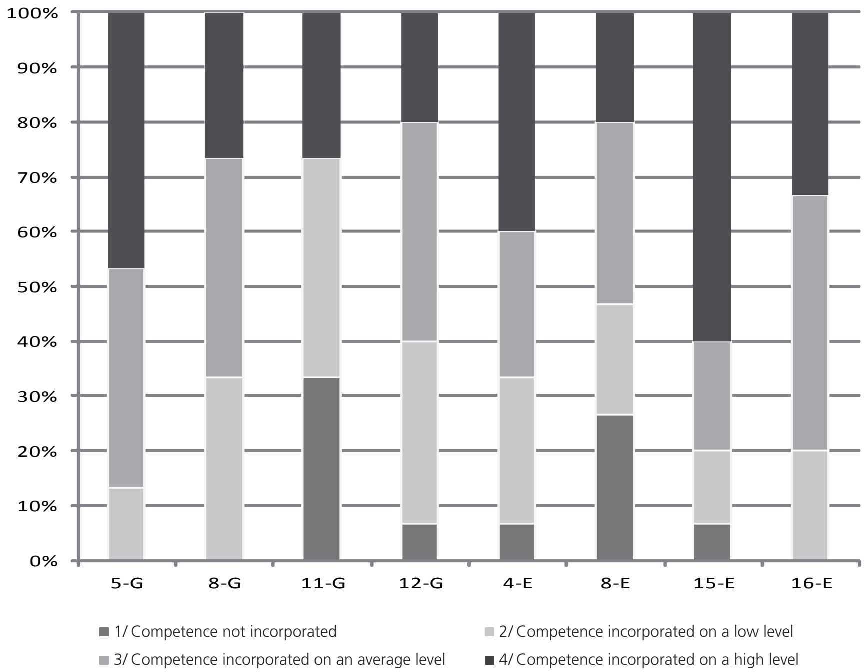
Source: put together by the 2013 Civil Engineering team.

Figure 5
Level of incorporation of specific competences
within the social dimension in participant universities

Table 10
Level of incorporation of competences according to dimension
(Technological and international dimension)

	Competence/Level of incorporation	**1 Competence not incorporated**	**2 Competence incorporated on a low level**	**3 Competence incorporated on an average level**	**4 Competence incorporated on a high level**
5-G	Skills in the use of information and communications technologies	0	2	6	7
8-G	Ability to formulate and administer projects	0	5	6	4
11-G	Ability to work within international contexts	5	6	0	4
12-G	Ability to communicate in a second language	1	5	6	3
4-E	Plan and schedule civil engineering work and services	1	4	4	6
8-E	Shape and simulate civil engineering systems and processes	4	3	5	3
15-E	Handle and interpret field information	1	2	39	
16-E	Use information technologies, software and tools for civil engineering	0	3	7	5

Source: put together by the 2013 Civil Engineering team.



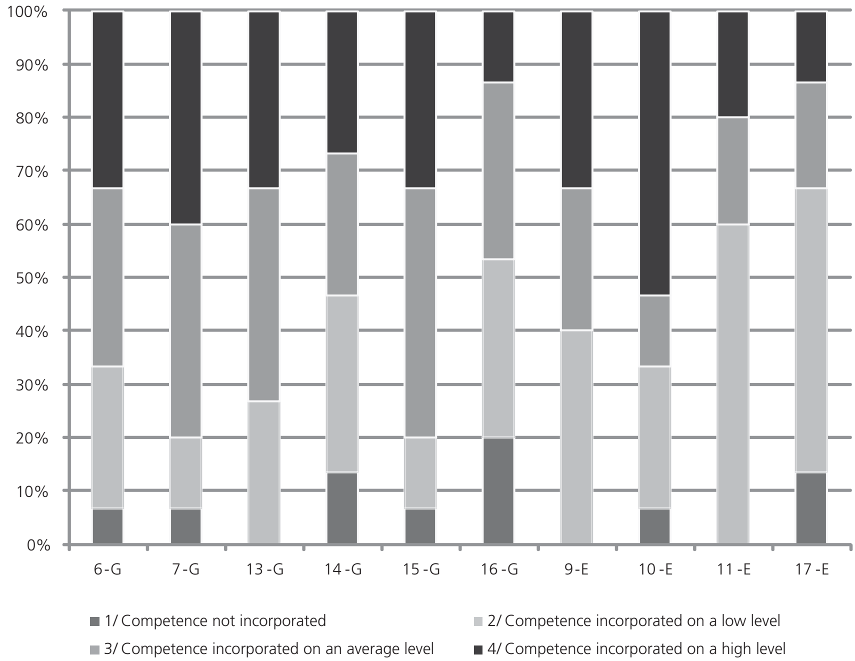
Source: put together by the 2013 Civil Engineering team.

Figure 6
Level of incorporation of specific competences
within the technological and international dimension in participant universities

Table 11
Level of incorporation of competences according to dimension
(Interpersonal dimension)

	Competence/Level of incorporation	1 Competence not incorporated	2 Competence incorporated on a low level	3 Competence incorporated on an average level	4 Competence incorporated on a high level
6-G	Capacity for decision-making	1	4	5	5
7-G	Capacity for teamwork	1	2	6	6
13-G	Capacity for oral and written communication	0	4	6	5
14-G	Social responsibility and citizenship	2	5	4	4
15-G	Ability to learn and constantly keep up-to-date	1	2	7	5
16-G	Ability to innovate and undertake business ventures	3	5	5	2
9-E	Manage and supervise human resources	0	6	4	5
10-E	Administer material resources and equipment	1	4	2	8
11-E	Understand and associate legal, economic and financial concepts with decision-making, project management and civil engineering work	0	9	3	3
17-E	Interact with multidisciplinary groups and provide comprehensive solutions for civil engineering	2	8	3	2

Source: put together by the 2013 Civil Engineering team.



Source: put together by the 2013 Civil Engineering team.

Figure 7
Level of incorporation of specific competences within the interpersonal dimension in participant universities

1.6. Final meta-profile for the area of civil engineering

Thought was given to the meta-profile at the meeting in Chile in light of the results obtained in surveys and in discussions, leading to agreement about the final proposal for the meta-profile for the area of civil engineering, as consolidated in Tables 12 and 13.

Table 12
Project: Tuning-Latin America: Educational and Social Innovation (May 2012), Chile
(Meta-profile for the Area of Civil Engineering)

Dimension	Competence
Cognitive	Abstraction, analysis and synthesis. Represents graphically. Applies knowledge of basic science and civil engineering science. Devises, analyses, plans and designs civil engineering work. Builds, supervises, inspects and assesses civil engineering work. Operates, maintains and renovates civil engineering work. Identifies, considers and deals with problems. Assesses and prevents risks associated with the design and construction of building work. Identifies, assesses and implements the most suitable technologies for their context. Handles and manages the impact of disasters on engineering work. Civil.
Social	Acts ethically. Proposes solutions that may contribute towards sustainable development. Is committed to quality. Uses quality control techniques in civil engineering materials and services. geniería civil.
Technological and international	Has the ability to use information and communications technologies. Uses information technologies, software and tools for civil engineering. Formulates and administers projects. Plans and schedules engineering work and services. Handles and interprets field information. Communicates in a second language. Has the ability to work within international contexts.
Interpersonal	Takes decisions. Manages and supervises people. Suitably administers materials and teams. Understands and associates legal, economic and financial concepts with civil engineering work. Works as part of a team. Interacts with inter- and multidisciplinary groups and provides comprehensive civil engineering solutions. Communicates orally and in writing. Innovates and undertake business ventures.

Source: put together by the 2013 Civil Engineering team.

Table 13
Result 1: Generic competences

Generic competence	Definition
1. Abstracts, analyses and synthesises	A university graduate's ability to take real problems and shape them in order to analyse and synthesise intervening variables.
2. Applies knowledge in practice	A university graduate's ability to apply the theoretical concepts acquired in the practice of their profession.
3. Identifies, considers and deals with problems	A university graduate's ability to identify real problems, consider a model for dealing with them and find possible solutions, in accordance with their area of study.
4. Skilled in the use of information and communications technologies	A university graduate's ability to communicate using electronic means and take advantage of technology to deal with problems, using the Internet, data bases and other sources.
5. Takes decisions	A university graduate's ability to analyse different alternatives and decide which is the most suitable. Includes the personal leadership skill.
6. Works as part of a team	A university graduate' ability to work with various people, thus boosting each of their characteristics.
7. Formulates and administers projects	A university graduate's ability to formulate projects, administer them and successfully put them into practice from a technical and economic standpoint.
8. Acts ethically	A university graduate's ethical behaviour in developing their personal and professional life.
9. Is committed to quality	Quality control standards applied by a university graduate in each work assignment, in accordance with their professional field.
10. Has the ability to work within international contexts	A university graduate's ability to work with people from different cultures and within different environments to that of their country of origin.
11. Communicates in a second language	The ability to communicate in at least a second language, preferably English.
12. Communicates orally and in writing	A university graduate's ability to draft reports and papers which can be understood by third parties and to suitably convey the message.
13. Innovates and undertakes business ventures	A university graduate's ability to generate business, companies and patents, among others.

Source: put together by the 2013 Civil Engineering team.

Definition of competences

A definition of each of the competences adopted is proposed in order to make use of a common language.

Table 14
Result 2: Specific competences

Specific competences	Definition
1. Applies of knowledge of basic science and civil engineering service	A civil engineer's ability to apply the theoretical concepts acquired in practice.
2. Identifies, assesses and implements the most suitable technologies for their context	A civil engineer's ability to identify opportunities for introducing technologies into the processes they develop by adapting them to their environment.
3. Devises, analyses, plans and designs civil engineering work	A civil engineer's ability to identify a need, propose a solution based on some building work and design it.
4. Plans and schedules civil engineering work and services	A civil engineers' ability to identify the resources required in building work and plan them in terms of time and cost.
5. Builds, supervises, inspects and assesses civil engineering work	A civil engineer's ability to oversee a construction process by suitably conveying ideas to operators and workers, identifying the key elements in the process and applicable regulations.
6. Operates, maintains and renovates civil engineering work	A civil engineer's ability to identify the components in the lifespan of a project and the activities required to maintain building work in an optimum state.
7. Considers the environmental and social impact of building work	A civil engineer's ability to identify any environmental and social impact that may be caused by a civil engineering project and propose ways of alleviating this.
8. Manages and supervises people	A civil engineer's ability to work with groups of people, identifying each of their characteristics and fostering their development.
9. Suitably administers material resources and equipment	A civil engineer's ability to optimise the use of resources associated with an engineering project.
10. Understands and associates legal, economic and financial concepts with decision-making, project management and civil engineering work	A civil engineer's ability to identity the regulations applicable to an engineering project and their implementation.

Specific competences	Definition
11. Represents graphically	A civil engineer's ability to shape reality using written signs.
12. Proposes solutions that may contribute towards sustainable development	A civil engineer's ability to propose engineering solutions that may cause lesser environmental impact.
13. Assesses and prevents risks attached to civil engineering work	A civil engineer's ability to identify the risks attached to an engineering project and to propose corrective measures in time.
14. Handles and interprets field information	A civil engineer's ability to interpret laboratory data and field measures to support decisions that need to be taken.
15. Uses information technologies, software and tools for civil engineering	A civil engineer's ability to identify opportunities for introducing technologies into the processes they develop and adapt them to their environment.
16. Interacts with inter- and multidisciplinary groups and provides comprehensive civil engineering solutions	A civil engineer's ability to successfully work with groups from different disciplines.
17. Uses quality control techniques in civil engineering materials and services	A civil engineer's ability to identify and apply the quality control standards applicable to each building work.
18. Handles and manages disasters in civil engineering work	A civil engineer's ability to identify any natural risks that may affect building work and their impact on human settlements, in addition to proposing measures to alleviate this.

Source: put together by the 2013 Civil Engineering team.

Preliminary conclusions:

- The challenge of bringing syllabuses in the area of civil engineering into line within the framework of the Tuning Latin America project has achieved consensus among participant countries with regard to the definition of a common meta-profile for this area of specialisation, based on a set of specific and generic competences.

- To gain a better understanding of the meta-profile, it has been divided into four dimensions; cognitive, social, technological and international and interpersonal.

- Although not all participant universities have made a declaration in favour of a competence-based teaching-learning process on an institutional level, the fact that the trend would seem to be leading towards a systematic change was noted via a comparison process – and as a consequence, a change towards self-assessment and accreditation processes and a competence-based approach.

2

Future scenarios for the Civil Engineer

2.1. Analytical report and summary of interviews

2.1.1. *Brief description of interviewees' profiles*

Defining the knowledge and competences that will be required by professionals in the future is an arduous task. Technological advances are changing at a speed that educational establishments are sometimes unable to keep up with. However, the characterisation of future scenarios, consideration of which professions can be envisaged in each given scenario and which competences these professionals will require are of great importance for the purpose of reviewing syllabuses of existing degree courses and creating new courses.

By way of a further challenge for the Tuning Project, the search for information about a possible situation regarding professions in the future has been explored. The means chosen for this search was via interview, with the aim of gathering the perceptions of well-known and highly-regarded individuals from each of the countries taking part in the Tuning Latin America Project about possible future scenarios for professionals – in this case, in civil engineering.

In this stage of the project, the Civil Engineering group has representatives from Argentina, Brazil, Chile, Colombia, Cuba, Guatemala, Honduras, Nicaragua, Paraguay, Peru and Venezuela. 31 prominent individuals in these countries who carry out or take part in different activities related to the profession were interviewed.

Among the group, 28 were civil engineers, 19 of them university lecturers, 10 work in companies as either professionals or managers, and 9 take part in engineers' associations or boards. As can be seen, most are involved in university teaching together with other professional activities, including international consultancy firms and/or participation in international bodies.

The great merit in terms of the representative nature of the information gathered in interviews lies in the profiles of those interviewed. In addition to the aforementioned professions, interviewees contain in their CVs references to their experiences that back up the considerations provided during the interviews. The main activities carried out by the group interviewed are provided below in order to justify this statement. In the group are the following: Secretary of Technological Links and Productive Development, University Rector, Vice-Secretary of Municipal Public Works and Services, Vice-Chairman of the National Atomic Energy Committee, Director of State Nuclear Fuel Companies, Director of Engineering Service Companies, President of the Diagnostic Centre Foundation in Nuclear Medicine, Administrative Secretary, Planning Secretary, President of the Federal Council of Engineering Deans, Consultant to the Bureau of University Policy for the Improvement in Engineering Teaching Programme, Coordinator of the Strategic Engineering Training Plan, Secondary School Researcher, President of the Engineering Association, President of the Engineering Council, Construction Company Supervisor, Director-Chairman of the Institute of Concrete, Project Company Director, President of the Concreting Services Association, Technical Vice-President of the Latin American Pre-mixed Concrete Federation, Construction Company Director, Technical Manager of the Construction Industry Trade Union, Vice-President of the Regional Engineering Board, President of the National Engineering Institute, University Rector, Innovation Council, President of the National Mining Engineers' Institute, Construction and Company Project Manager, Deputy Manager and Member of the Governing Board of Departmental Assessment, Committee of Guilds, Development Bureau of the Ministry of Construction, Member of the Scientific Council of the Civil Engineering Faculty and of the High Scientific Council, Director of the Civil Engineering School, Dean of the Engineering Faculty, Chairman of the Governing Board of the Engineers' Association, Dean of the Engineering Faculty, Manager of the Engineers' Association, Member of the Civil Engineers' Association and Vice-Dean of the Engineering Faculty.

There is no reference to the person in the above list, as individuals may be carrying out more than one activity simultaneously.

2.1.2. *Discussion of the Characterisation of future scenarios*

It is envisaged that countries traditionally belonging to the Third World will form regional blocks for the rational use and exploitation of their natural and energy – water, land, forests, food, flora and fauna in general. This means helping to strengthen societies in the countries within such blocks.

The biotechnology industry, the construction industry, the construction material industry, the agricultural and fishing industry, the tourist industry, the pharmaceutical industry, the food industry, medical services, computer services, communications and other sectors that contribute to social development will have reached a level of development capable of meeting most of the population's needs, to compete internationally and with a marked influence on other countries, especially within the region.

This growth process will be closely linked to information technologies, automation and communication, the scope of which is difficult to predict in these areas. Nonetheless, this is expected to be impressive, as in less than 50 years things have moved on from black and white TV to components that possess a thousand times more technology and data storage capacity than the most powerful computer of that era. It is true to say that the use of these technologies will evidence a permanent, marked increase in efficiency, productivity and saving. This technological development will make far more information available and communication facilities will need to help optimise processes in the area of Civil Engineering, meaning it is possible that the profession of civil engineer as such will die out and specialist degree courses will emerge.

With regard to construction, the trend is towards more resistant materials that comply with more restricted weighting coefficients with a view to creating more daring structures and designs. This can be seen in developed countries in huge modern constructions. In developing countries, the alternative would involve searching for solutions using local and recycled materials in order to deal with social problems.

It is expected that urbanisation will accelerate worldwide, involving mainly an adult population. This will reduce productive strength and make it necessary to increase productivity, and the resulting metropolises may lack the infrastructure to meet all needs, giving rise to urban mobility problems.

As a result, robotics will also develop a major presence in production processes and in people's lives. Employment in its current form will cease to exist and each individual will need to manage their own work that will be mainly carried out from home. New types of job will need to be created that enable those being absorbed by machines to be replaced – otherwise, there will be a major job deficit.

The basic problems facing mankind will continue to be housing, food and water, and countries will be concerned with how to maintain retired people. There will be a very great need for energy and this will give rise to conflicts in society. Water will be more used in generating energy than for human consumption.

2.1.3. *Approaches and professions that can be envisaged in each future scenario*

Future situation facing civil engineering

Engineering in general will face broad-ranging, huge opportunities to contribute to development and welfare in future scenarios, whatever they may be. Traditional engineering degree courses will mainly continue to exist, but adapted to new paradigms.

Within this new context, the engineer will be an interdisciplinary, transdisciplinary and multidisciplinary professional *par excellence* who will interact with a range of other professions, in several cases not only joining forces and working with them, but also absorbing them into their work method. For instance, in the area of medicine, the biomedical engineer will be a professional who assumes leadership and control over medicine and a doctor will be their closest collaborator.

For some years now the emergence of new types of material has been noted owing to nano-scale work that is enabling these materials to become stronger and more resistant. Nanotechnology will incorporate knowledge of other sciences such as biotechnology, cognoscience and information and communications technologies, i.e. the integration of knowledge that until just a few years ago seemed incompatible.

Likely future scenario

Civil engineering in its specialist areas of road, hydraulic, building, environmental and geotechnical engineering, among others, will be much in evidence in future scenarios. To take this scenario into consideration, one can start from the assumption that civil engineering will remain both firmly-established and consolidated. Therefore, differences between today's civil engineers and those of the future will be noted in major changes to professional approaches and new profiles adapted to new features that will pinpoint problems to be dealt with and they will have a great capacity to adapt their disciplinary know-how when involved in such work. The civil engineer will therefore be a multidisciplinary professional who will need to interact with professionals from other areas.

This scenario is characterised by the need for an increase in the number of civil engineers who hold a more holistic view of urban scenarios. Population growth will have a direct impact on civil engineering, as there will be less space for building and the possibility of creating vertical types of property developments will therefore need to be envisaged (cities). This means large buildings that will house all services deemed essential for life such as housing, health, education, recreation and employment (which will give rise to the study and research of new calculation methods, new materials and building technology as well as a study of greater situations involving risk). Within this new scenario, civil engineers will need to be able to deal with risk of damage to infrastructures owing to climatic phenomena or of some other type, and also include home automation in their designs.

On the other hand, the future need for an increase in productivity and industrialisation will enable civil engineering to approach production engineering and other related professions. Civil engineering will also be strategic in dealing with demands for energy, drinking water, clean air, handling of waste, transport and environmental protection. Thus, demands from the population and governmental bodies will mean that civil engineers should have a command of the technologies required for physical, chemical and biological treatment in the different media.

The civil engineer will need to evidence major skills in the use of software and cutting edge technology. Thus, they will need to have a greater command of computer tools in order to develop studies about territory for better management of space, and therefore will interact more with software and systems engineers.

2.1.4. *Competences that will be required by these professional approaches*

To navigate through and tackle different disciplinary areas, the engineer will need above all to have a solid education in basic sciences and engineering sciences. Apart from mathematics, physics and chemistry, they will need a foundation in biology. While the 20th century has been the century of physics and chemistry, the 21st century is expected to be the century of biology. On the other hand, the best way of facing an uncertain future is estimated to be via a solid foundation in values, as it is expected that ethics, for example, will predominate over the economy in the 21st century.

Future engineers will also need to develop the capacity for innovation as far as possible, based on the successful application of science in dealing with real problems.

Lastly, in a scenario of total globalisation, future engineers will need to have highly-developed skills in order to cope within international contexts.

We can summarise by stating that, apart from the basic competences required to exercise their profession, the main competences required of engineers of the future will be:

- Ability to use modern engineering techniques and tools.
- Adaptation of knowledge of several disciplines and incorporation of this data into projects.
- Ability to manage projects, people, business and costs, among others.
- Ability to work while taking sustainable development and the environment into consideration.

- Capacity in terms of communication, planning and industrialisation.
- Ability to understand the impact of engineering projects within global and social contexts.
- Ethical commitment, social responsibility and citizenship.
- Ability to adapt swiftly to new processes and technologies.
- Ability to develop within an aggressive, multidisciplinary, dynamic and greatly-changing environment.
- Capacity for innovation, creativity and entrepreneurship.

2.1.5. *Other relevant comments about the future*

Future scenarios depend, in accordance with that stated in the first questions, on political and cultural factors, and professions are linked as agents of change in such a process or perhaps as agents who are resistant to it, by upholding the traditional and liberal values attached to their profession.

It is foreseen that the civil engineer will take on an increasingly predominant role in society, drawing activities and professions which are currently unrelated to the field of engineering closer to it. The engineer by nature creates or seeks certainty and, faced with such an uncertain and volatile scenario, engineering may come to represent the solution or society's weapon to help face and/or deal with situations involving crises or catastrophes, or to achieve the type of harmonious development sought and desired by mankind.

Production processes related to the mining of raw materials or the handling of water, as we are doing today, will need to be pursued in such a way as to ensure they are sustainable and in harmony with nature. This will involve re-defining mankind's priorities and, consequently, achieving an improvement in the quality of life for everyone.

3

Observations concerning student workload from the civil engineering perspective

3.1. The Latin American Reference Credit and its link to the academic workload in the area of civil engineering

As stated in the preliminary conclusions regarding the meta-profile, the challenge in terms of harmonising syllabuses in the area of civil engineering within the framework of the Tuning Latin America project has led to agreement among participant countries in defining a common meta-profile for this specialist subject based on a set of specific and generic competences. However, the link regarding academic activities in the training of civil engineers in Latin America – in particular that referring to academic collaboration between educational establishments, recognition and official approval of studies, student mobility and other factors – is pitched against the barrier of the diversity of measurements existing in the different countries in order to obtain the learning results specified.

In the case of civil engineering, the main cause of this diversity is the differing lengths of programmes in Latin America, ranging from eight to twelve semesters. Linked to this, teaching periods are of differing durations, and there are even differences in the number of teaching periods within one year. The definition of academic credit is not uniform among the different countries, with no less diversity being found even within the countries themselves. The difficulty in defining credit is highlighted in the case of civil engineering owing to the diversity of activities that syllabuses include, such as theoretical classes, practical classes, virtual classes, laboratories, workshops, seminars, field trips, projects, pre-professional internships, personal work and degree course work, among others, several of which are not in many cases assessed within the definition of credit. To all the above should be added the diversity existing in terms of traditions, the organisation of teaching and the context of each educational establishment.

Consequently, a common credit system represents the most suitable option for facilitating the task of overcoming barriers imposed by the natural diversity of the different programmes for civil engineers, and for harmonising syllabuses as demanded by current trends in higher education.

The Latin American Reference Credit (CLAR), whose unit of value estimates workload, measured in chronological number of hours set aside by the student to obtain learning results and successfully pass a subject or teaching period, represents a highly suitable alternative for comparability of the different civil engineering training programmes in Latin America. Such a measurement fits in without any problems with the diversity existing among the different teaching systems, with the different ways of administering syllabuses and with the different durations of civil engineering degrees on the continent, which is why it is compatible with national and institutional autonomy. Furthermore, attention is focused within each academic unit on the student. This gives rise to a review of teaching-learning methodologies and assessment of competences, it makes the curriculum flexible by facilitating recognition of studies, it provides a suitable adjustment of student workload and, to sum up, makes the formative process more efficient.

In the case of civil engineering, measurement of workload should take all the activities envisaged in the different degrees into consideration, and that these should be translated into the chronological number of hours that the student sets aside for it.

These activities are as follows:

- Theoretical classes, which are effectively attended by the student and which are taught directly by the lecturer in charge of the subject.

- Practical classes for dealing with problems, which are effectively attended by the student and which are taught by the lecturer or assistant in the subject.

- Supervised experiences gained by the student in laboratories in different subjects, in addition to reports that need to be drafted based on the results obtained.

- Virtual activities related to distance learning.

- Field trips to learn about civil engineering processes and works.

- Workshops, seminars and exposés of work about specific themes related to the specialist subject in which the student takes part.

- Preparation of individual or group projects.

- Oral or written assessments.

- Pre-professional internships.

- Degree course activities.

- Personal work, reading of texts, preparation of assessments.

Measuring student workload in each of these activities may at first glance involve an estimate by the lecturer or lecturers in charge of the subject or activity. However, a closer reality check would be to consult with the students themselves, which also has the advantage of including a greater number of players in taking the diversity existing between them into consideration and obtaining a more reliable and representative average for the whole. Given the mass consultation required of students, several ways of doing this may be considered, all of which have advantages and limitations. The option of a response every specific period —such as on a monthly basis— is more representative of reality and enables any variation regarding workload throughout the teaching period to be rated. Nonetheless, this requires the disciplined collaboration of all participants in the consultation. The option of carrying out a survey to estimate the average number of weekly hours in each subject at the end of the teaching period is a more simple and direct way of obtaining responses, albeit sacrificing the accuracy of results. On the other hand, it would be desirable in the case of civil engineering degree subjects in which there are more fails —such as basic science subjects— to apply the survey only to students who are studying them for the first time, as it is clear that those who are repeating subjects need a larger amount of work in order to pass them. Similarly, the survey should be answered only by those who attain the minimum competences by passing a specific subject, as the work done by students who fail is not representative of the minimum amount of hours required to achieve learning results.

There was consultation in fourteen countries for the area of civil engineering, and the method chosen was a survey on students who were studying and had passed subjects from the sixth semester of the syllabus for civil engineering degree courses from each of these countries, at the end of the teaching period. This was applied electronically during the month of April 2012, i.e. some months after completing the semester subject to consultation. Parallel to this, lecturers of each of the subjects included in the survey were also consulted, and they had to provide an estimation of the number of hours set aside by students in their subject in order to pass it. It was suggested that there should be a minimum number of ten students and one teacher to be interviewed per subject for the purposes of applying this tool.

The main questions contained in the survey were as follows:

1. What is the total number of hours you estimate that a student had set aside during the academic period for passing their subject, taking into account all face-to-face and non-face-to-face activities?

2. How many weeks of real face-to-face teaching activities did the subject involve, including assessments?

3. How many hours a week on average do you think students set aside for face-to-face and non-face-to-face activities in the subject?

4. Of the following non-face-to-face activities, state which ones did you use/carry out to encourage independent student work:

    - Reading of texts or bibliography.

    - Preparation and development of practical work.

    - Field work.

- Laboratory.
- Preparation and development of written work.
- Virtual activities.
- Study for assessment purposes.

The main results obtained from the overall responses gathered from the fourteen countries in which the consultation was simultaneously applied were as follows:

Table 15

Total number of hours' work required to pass the subjects during the academic period (Sixth semester)

Area	Lecturer	Student
Civil Engineering	695.51	689.97

Source: 2012 workload results.

It can be observed that there is considerable similarity between the estimates made by lecturers and those made by students, with those provided by lecturers being slightly higher. The difference between the two groups is only 5.54 hours, which represents a margin of less than 1%. This small difference lends greater reliability to the results obtained.

3.1.1. *Average number of weeks of the academic period*

The half-yearly academic period varies between fifteen and eighteen weeks in the Latin American countries that took part in the consultation.

The results obtained (Table 16) show once again close coincidence between estimates given by lecturers and students, and the difference of 2.19 hours in the average for both groups is around 4%, with that provided by lecturers being again slightly higher.

Table 16
Average number of hours a week that students set aside for face-to-face and non-face-to-face activities in all subjects in the sixth semester of the syllabus

Area	Lecturer	Student
Civil Engineering	52.03	49.84

Source: 2012 workload results.

This indicator is fairly representative of the amount of time a student sets aside for their studies, as it can be compared with standard ones for the working week which are normally expressed in the number of hours worked a week. From this standpoint, it is possible to classify the result obtained as an excessive, normal or insufficient workload. In the case of the response obtained for the area of civil engineering which overall is estimated at being around fifty hours a week, it is noted that this is above the forty hours' work a week which is generally taken into consideration in different countries, with 25% more than this standard of reference. However, taking the youthful nature of students into account alongside the fact that the vast majority of them do not yet have family responsibilities, this workload is not too excessive and they are, generally speaking, able to cope with it. Notwithstanding the above, the results indicate that it would be desirable to adjust this load to forty hours so as to enable the student to set aside time for other important activities aimed at personal and integral development. This represents a challenge for the adaptation of syllabuses via better distribution of workload across the degree course, in addition to the inclusion of new, more effective and motivating teaching-learning methodologies.

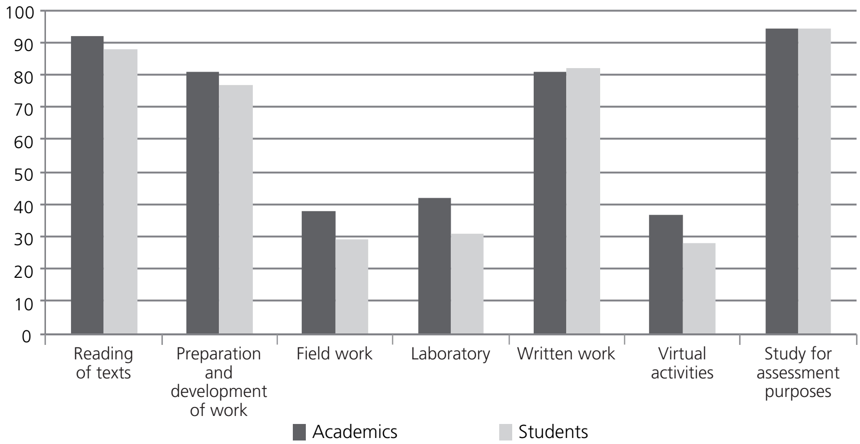
3.1.2. *Non-face-to-face activities used or carried out to promote independent work by students*

The results obtained from the results are shown in the following graph. At first glance, it can be observed that the reading of texts is an activity carried out by most students (close to 90%), in accordance with estimates provided both by lecturers and students themselves. Similarly, around 95% set aside time to prepare assessments and, in the opinion of both groups, 5% hand in these assessments without any prior preparatory work. This is probably due to the fact that they obtained learning results via other activities, mainly attendance in class, for instance.

There are three groups of activities —field work, laboratories and virtual activities— to which less time had been estimated, with percentages of around 40% in the opinion of lecturers and 30% in the opinion of students. These activities are in direct relation to the assessment tasks of the subjects included in the survey, corresponding to the sixth semester of the different programmes. At this level of degree course, theoretical engineering science subjects are grouped together , and not all include laboratory or field work, which would explain the lesser amount of time set aside for this by students. Given that subjects in theoretical engineering science constitute the basis upon which subjects during the professional stage are developed, it is likely that academics would prefer to use direct tuition in the teaching process rather than virtual activities —which in some way give rise to uncertainty with regard to the real amount of time set aside by students—. This could explain the limited extent sixth semester students reported using them. Indeed, it is noted from the results obtained that students make use of these methods to a lesser extent than lecturers expect or hope.

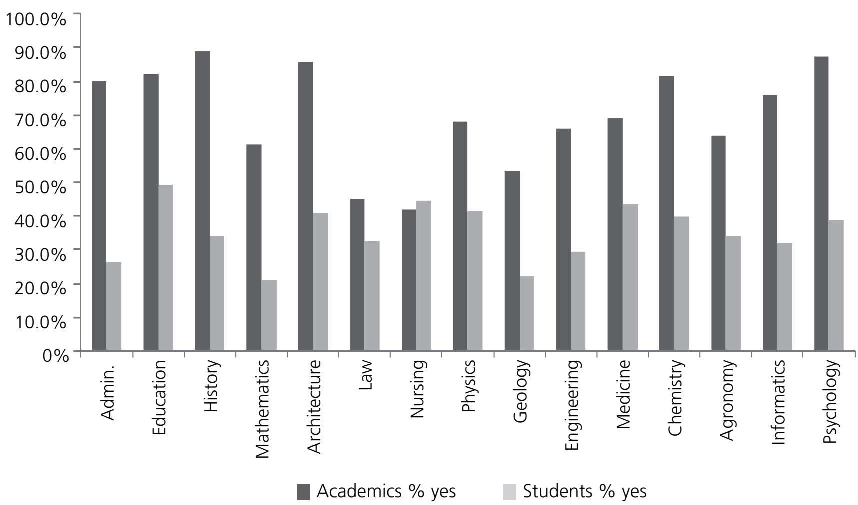
Activities involving the preparation and development of work, or written work, account for level of around 80%, according to both lecturers and students, there being considerable coincidence among responses from the two groups.

Generally speaking, significant agreement is noted in the estimates given by lecturers and students in all these activities, which reflects the fact that the amount of time set aside by students is fairly close to what the lecturer plans in their subject and expects from their students.



Source: 2012 Tuning Latin America Project Coordination.

Figure 8
Non-face-to-face activities: Civil Engineering



Source: 2012 Tuning Latin America Project Coordination.

Figure 9
Planning of non-face-to-face activities

Another question asked of both lecturers and students was about planning the subject, taking into consideration the non-face-to-face hours required to carry out activities. Fig. 9 shows that 70% of lecturers replied *yes*, while only 30% of students did so in the case of civil engineering.

3.2. Final considerations

In short, it can be observed that measurement of student workload is a complex issue, and presents a range of difficulties and complications in order to obtain reliable results. The survey carried out on sixth semester students was a worthwhile exercise as it was applied simultaneously in fourteen Latin American countries and obtained a large number of responses both from academics and students, which makes it adequately valid.

The main limitations of the work are that only a specific semester in the syllabus was taken into consideration, and that the opinion of those interviewed was only gathered at the end of the semester rather than during the different stages of the academic period. This means that it is not possible to establish any variations in the academic work carried out by students over different months. This variation would be of great interest, as it would for instance enable the existence of periods of excessive work to be assessed and modifications could then be made to the planning of subjects in order to achieve a better redistribution of student work.

Because of the limitations mentioned, the results should not necessarily be considered to be a categorical representation of reality or lead to definitive conclusions, they do constitute a reference to be borne in mind in future work of the same type.

Notwithstanding the above, it would appear that the opinions of lecturers and students coincide significantly in the area of Civil Engineering with regard to student workload. This should translate into suitable scheduling of activities attached to subjects on the part of teaching staff and the fact that students would respond by setting aside the time expected of them by the former. However, work overload is noted of about 25% more than what is considered a normal working day, which represents a challenge in the search for and implementation of new, more innovative, effective and motivating teaching-learning methodologies.

The amount of work of around 700 hours per semester estimated by civil engineering students from Latin American countries, which coincides with estimates provided by lecturers, represents an average 1,400 hours a year. This estimate is an annual average for the different types of work defined in the Latin American Reference Credit (CLAR), which to a great extent supports the validity of the results obtained.

4

Summary of the different institutional perspectives regarding teaching, learning and assessment of the competences chosen in the area

An analysis of two of the competences defined in the meta-profile for the civil engineer is described in this chapter, establishing indicators that are proposed for the purpose of assessing the inclusion of the competence and the extent to which it is taken into account in each programme. The learning results will be used to do this, these being understood as referring to what students know, understand and are capable of doing after successfully completing a learning process. Work was carried out on one generic and one specific competence for the purpose of this analysis.

4.1. Methodology used

One generic and one specific competence were jointly selected, for each of which the results expected or sub-competences that the student should show as proof of having achieved them were established.

4.2. Identifying learning results

The competences to be analysed were selected using the results obtained previously, in which the implementation or otherwise of the competences was analysed. Criteria for evaluating the level of success in developing the competences were then discussed.

4.2.1. *Generic competence:* identifies, considers and deals with problems

This competence has been defined as follows: *the ability on the part of the university graduate to identify problems involving the reality of the situation, and consider a model for dealing with it and possible solutions in accordance with their area of study.*

Generic competence

Identifies, considers and deals with problems.

Results expected:

- Identifies and interprets problems within a context (based on reality).
- Formulates a hypothesis.
- Identifies the principles involved in dealing with the problem.
- Defines and shapes the problem.
- Considers solutions to the problem.
- Selects and justifies a solution.
- Validates the solution.

4.2.2. *Specific competence:* manages and interprets field and laboratory information

This competence has been defined as follows: *the ability on the part of the civil engineer to gather and interpret laboratory data and field measurements as a way of supporting decisions that need to be taken.*

Specific competence

Manages and interprets field and laboratory information.

Results expected:

- Identifies the information required.
- Selects information-gathering procedures, techniques and methods.
- Obtains and selects the information.
- Processes and interprets the information.
- Draws up a report and/ or uses the information.

4.3. Identifying curricular components (subjects) developed by each competence selected

The subjects in which each competence is developed are identified for each of them using the following matrix:

Table 17
Identifying competences in the curriculum

Competence/Course	A1	A2	A3	A4	A5	A6	A7	A8	An
C1									
C2									
Cn									

Source: Tuning Latin America Project: Educational and Social Innovation.

Each of the participant universities were asked to carry out this work, which involved interviewing the lecturers who teach each of the subjects that make up the syllabus about the extent to which each of the results or sub-competences is attained, with the fourteen universities providing the information in accordance with criterion A = high, M = average and B = low.

It should be pointed out that it proved impossible to make a comparison between universities due to the fact that the subjects taught at each of them are not always broken down into the same semesters, and the name of the subject of content varies from one university to another. It should be recalled that the purpose of the methodology is clear: to construct compatible, comparable qualifications that are relevant to society and with levels of quality and excellence, in so doing maintaining valuable diversity in terms of the traditions of each of the countries and higher educational establishments.

Table 18
Example of exercise carried out by participant universities

Code	Courses	Generic competence							Specific competence				
		Identifies, considers and deals with problems							Manages and interprets field information				
	Results expected	Identifies and interprets problems within a context	Formulates a hypothesis	Identifies the principles involved in dealing with the problem	Defines and shapes the problem	Considers solutions to the problem	Selects and justifies a solution	Validates the solution	Identifies the information required	Selects the information-gathering procedures, techniques and methods	Obtains and selects the information	Processes and interprets the information	Draws up a report and/or uses the information
107	Topography 1	M	B	M	M	B	M	A	M	M	M	M	M
028	Ecology	M	M	M	B	M	M	A	A	A	M	A	M
112	Intermediate Mathematics 2	M	M	A	A	A	A	A	B	B	B	B	B
114	Intermediate Mathematics 3	M	M	A	A	A	A	A	B	B	B	B	B
152	Physics 2	A	A	A	A	A	A	A	A	A	A	A	B
170	Analytical Mathematics 1	A	M	A	A	A	A	A	A	A	M	M	M

A = high, M = average and B = low.

4.4. Holistic analysis

A holistic analysis as described below was carried out at the Universidad Nacional de Rosario (UNR) and the Universidad Tecno-lógica Nacional (UTN), both in Argentina:

4.4.1. *Definition and description of the generic and specific competence selected (UNR and UTN holistic analyses)*

Generic competence

Identifies, considers and deals with problems.

This competence has been defined as follows: *the ability on the part of the university graduate to identify problems involving the reality of the situation, and consider a model for dealing with it and possible solutions in accordance with their area of study.*

- Identifies and interprets problems within a context (based on reality).
- Formulates a hypothesis.
- Identifies the principles involved in dealing with the problem.
- Defines and shapes the problem.
- Considers solutions to the problem.
- Selects and justifies a solution.
- Validates the solution.

Specific competence

Manages and interprets field and laboratory information.

This competence has been defined as follows: *the ability on the part of the civil engineer to gather and interpret laboratory data and field measurements as a way of supporting decisions that need to be taken.*

Identifies the information required.

- Selects information-gathering procedures, techniques and methods.
- Obtains and selects the information.
- Processes and interprets the information.
- Draws up a report and/ or uses the information.

4.4.2. *Level of competence development (UNR and UTN holistic analyses)*

The level of competence development at the Universidad Nacional de Rosario (UNR) is low in the case of the first subjects, such as in physics, reaching a higher level of development in later academic years.

A Direct Promotion System with the features of a pilot experience was implemented at the Universidad Tecnológica Nacional (UTN) after the 2004 teaching year, in accordance with Decree No. 643 issued by the UTN High Council. In principle, this is —given its cost— confined to the first two years of the civil engineering specialist subject, with a view to improving academic quality and moving towards a teaching methodology that focuses on students' creative activity and the critical resolution of problems, by attempting to improve the number of students who are retained and consequently reducing the number who abandon their studies.

The idea behind the project was to create a learning space in which the student is able to be the producer of their own learning and gain independence for the purpose of managing this. Consequently, the role of teaching staff should be to mediate between the knowledge contained in what is proposed didactically and student activities in order to attain this objective.

After 2010, this experience was extended to the chemical engineering degree course. This plan permitted a high level of compliance with the generic competence in these first two years and also with the specific one in those subjects that include practical laboratory work. Although the level of compliance has been maintained in subsequent academic years, the result is not uniform, as there is no competence-based syllabus and, therefore, everything depends on the criteria adopted by the lecturer in each given case as there are no specific directives governing this.

4.4.3. *List of learning results identified (UNR and UTN holistic analyses)*

We can list the following as results of learning the generic competence, whereby the student:

- Shows independence in dealing with the problem.
- Identifies and organises data regarding the problem.
- Formulates a hypothesis and identifies the principles and variables that define the problem.
- Designs the solution or puts forward different suitably-founded solutions.
- In this last-mentioned case, selects the most suitable option within a specific context based on sound judgement.
- Explains and defends the solution chosen by validating it.
- The following conclusion is reached with regard to learning the specific competence that is mainly attained in subsequent academic years via applied technologies:
  - — Firstly, the student identifies the information required.
  - — Then, they choose the techniques and tools available in order to gather the information, depending on the resources available.
- Obtains experimental registers and selects the most relevant ones.
- Starts to work with them by processing the information required.

- Analyses the results and obtains conclusions and, as required, draws up a report about the activity developed by applying professional criteria for the assessment of possible alternatives.

4.4.4. *Teaching and learning strategies of the learning results identified (UNR and UTN holistic analyses)*

As far as the first years of the UTN degree course are concerned and according to the Pilot Plan implemented, and as interaction between student and lecturer is considered as important as that between students themselves, it is envisaged that planning of group activities should promote discussion between the different points of view held by students. This implies coordination of roles between members of the same group, mutual control of work and a dividing-up of responsibilities with regard to performing tasks.

The collaborative group is the class strategy pursued, in which students ascertain, construct and later discuss with all their colleagues the pooling together required to complete all units. As the teaching team is available with the whole team in the classroom, enough time is also provided to sit down and form part of these groups and guide thought.

This change in the role of teaching staff and students was reinforced by several aspects as follows:

- The classroom was reconditioned by replacing separate desks with work desks, thus facilitating group interaction, and a small classroom library was also fitted.

- The duration of the academic year was adjusted to 40 weeks in total, thus exceeding the annual amount set aside for the other specialist subjects studied at this Faculty (UTN) by 8 weeks.

- There is a lecturer in charge and assistant lecturers in each subject in the first and second year to ensure with a maximum staff student ratio of one (1) member of teaching staff to every twelve (12) students.

Additionally, bibliographic material was also put together at the UTN without losing sight of the main purpose of the project, which is to ensure that materials encourage independence and collaborative exchange, accompanying the student learning process.

Furthermore, as we all know, the acquisition of knowledge by the student is greatly influenced by the type of resource or medium in which the information is provided, special software was developed specific to the subject for both practical and theoretical activities in several programme modules.

As far as the strategy for developing the specific competence is concerned, the carrying out of practical work was intensified in the different laboratories together with the obligation of drawing up detailed reports on them containing relevant data and observations.

4.4.5. *Assessment strategies of the learning results (UNR and UTN holistic analyses)*

As far as the Pilot Plan applied at the UTN is concerned, all professors involved in the first two years of the degree course agreed that the student should be able to identify problems, and consider alternative solutions to problems and be able to discuss them in order to completely meet the objectives set out by the project. They will also need to add new information to their prior reference outline and link this to the problem solving task to a significant extent.

Consequently, assessment is not confined to sitting an examination in which an attempt is made to see how much information the student has retained, but rather, it should ascertain the internal processes of learning involved. Three types of assessment may be distinguished based on this concept and depending on when this is done: diagnostic, continuous/formative and summative.

As for all teaching staff, an agreed register is maintained that takes into account all the aspects listed below, and students are made explicitly aware that it is not only of interest to them to know what mark they obtain in the global, integrating examinations scheduled within the syllabus, but that they are assessed in all aspects, namely:

- Attendance.
- Relevance of participation.

- Group participation.
- Responsibility regarding work requested.
- Mark obtained from assessments of student progress.
- Mark obtained from global and integrating assessments.

These aspects are described in the final discussion with the student at the end of the teaching stage. Regrettably, this plan is applied only during the first two years owing to a budgetary problem (a larger number of teaching staff per committee), which means that assessment is carried out according to content throughout the rest of the degree course except in specific cases at the discretion of teaching staff.

4.4.6. *Some general conclusions about the competence-based teaching, learning and assessment process (UNR and UTN holistic analyses)*

Although there has so far been no competence-based syllabus in place in engineering in Argentina, the implementation of this Pilot Plan at the UTN in civil engineering (the aim of which is to improve academic quality by moving towards a teaching methodology that focuses on the student's creative activity and the critical resolution of problems which, although not a competence-based syllabus, is quite similar to one) has enabled us to contrast results with other specialist subjects taught at our educational establishment using traditional methodology and to ascertain a substantial improvement in academic performance and, therefore, in the number of our students who we retain early on during the degree course.

As for the degree course in civil engineering currently offered at the Universidad Nacional de Rosario, the competences that are going to be developed in each subject are not currently made explicit within subject planning, although activities *are* carried out which encourage the development of competences. In terms of assessment, this is based on content.

For some years now, the Federal Council of Engineering Deans (CONFEDI) of Argentina has been looking into the possibility of implementing a competence-based syllabus in engineering as of 2016, although for the time being degree courses continue to be taught and assessed based on content.

4.5. Conclusions about teaching, learning and assessment of competences chosen in the area

Engineering programmes offered by universities taking part in the project include the two competences selected, even though they are not referred to by the same name. The extent to which competences are included is average to low, although there are some learning results that include competences on a high level, especially those related to dealing with problems.

Generally speaking, the learning strategies used and/or proposed by the universities are:

- Individual or group examinations.
- Laboratory practical work.
- Case study.
- Development of extra class exercises.
- Development of real integrating projects.
- Development of prototypes.
- Resolution of problems, among others.

The institutional perspectives regarding the teaching, learning and assessment of the generic and specific competences agreed in the Tuning project for the area of civil engineering clearly show that it is necessary to implement pedagogic strategies in classrooms in order to construct an academic experience to help enable students to face the world of work.

This implies a change in teaching and learning processes via the mediation of teaching staff, which will lend itself to university education that is linked to the real professional sector for the future engineer.

Therefore, if one wishes to achieve genuine university education, teaching staff need to move beyond the transfer of information, a simple exercise involving text, and implement a pedagogic strategy whose main player is the student. This will help to ensure that professional competences for a future career are developed via academic means that bring the student closer to the real world of work.

Teaching staff should thus recognise the fact that competence-based education requires guidance and the promotion of learning activities, i.e. teachers that are not confined to merely expounding and explaining. From this standpoint, a competence-based strategy that is based on dealing with problems might be a viable alternative for the construction of competences.

As its name suggests, the key element of learning in a teaching strategy based on the resolution of problems is exactly problems or problematic situations. A problem refers to «a situation which is quantitative or otherwise that seeks a solution and for which the individuals involved are unaware of the apparent means or ways of achieving this».

This definition of problem shows the difference between problem and exercise. In an exercise-based teaching strategy, everything is known, data is supplied, the paths to take for possible solutions are known and there are no reasons for the student to question the concepts. The most important thing in the resolution of problems is not the mass, unmanageable set of information that surrounds science, but rather, the basic fundamental processes or major structures required to understand the concepts.

A teaching strategy based on the resolution of problems in the classroom entails making some necessary changes that will, among other aspects, involve: the administering of spaces and flexible class timetables; ability to accomplish tasks outside the classroom; the reconsidering of basic learning activities within class: mediation in order to facilitate understanding of knowledge; and monitoring of cognitive processes and assessments prior to, during and at the end of the knowledge construction process. All this will enable one to gauge whether the competences formulated in the subject were included in the student's knowledge structure.

Moreover, the pedagogic structure used should result in the lecturer being/doing the following: a permanent motivator via questions;

informing students about the facts and knowledge required for analysis and reflection; designing a curriculum based on problematic situations, only taking into account the crucial concepts attached to each subject matter being dealt with; relating the problems put forward that need to be resolved in class with interest; stimulating training with high academic self-esteem on the part of the student, characterised by high levels of confidence and a willingness to take cognitive risks that will enable them to understand that it is normal to make mistakes when one is involved in a learning process and that this is not down to a lack of capacity on the part of the student.

In a teaching strategy based on the resolution of problems, it is very important to start the course by assessing previous knowledge related to the subject which the student will need to incorporate into their knowledge structure, as this is essential for facilitating the understanding of new concepts.

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General conclusions

The challenge facing the harmonisation of syllabuses in the area of Civil Engineering within the framework of the Tuning Latin America project has led to agreement among the participant countries in terms of defining a common meta-profile for the specialist subject based on specific and generic competences. To best understand this, the meta-profile has been divided into four dimensions: cognitive, social technological and international, and interpersonal.

Future scenarios depend, in accordance with that stated in the first questions, on political and cultural factors. Professionals are linked to this insofar as they are agents of change in such a process or, in any event, as agents resistant to it by upholding the traditional and liberal values attached to their profession.

It is estimated that the civil engineer will take on an increasingly predominant role in society by incorporating activities and professions into engineering that are at present quite unrelated. Owing to their very nature, the engineer creates or seeks certainty and, faced with the uncertain and volatile scenario that can be envisaged over the coming decades, engineering may represent the solution to or the weapon used by society in order to face and/or deal with critical or catastrophic situations, or to achieve the harmonious development sought and desired by mankind.

It is accepted that measuring student workload is a complex issue, with a range of difficulties and complications attached to ultimately obtaining reliable results. The study carried out with students from the sixth semester has been worthy of merit as it was applied simultaneously in fourteen Latin American countries and resulted in a large amount of responses, both from academics and students, which makes it adequately valid.

The amount of work of around 700 hours per semester as estimated by civil engineering students from Latin American countries, which coincides with teaching staff estimates, represents an average 1,400 hours a year. This figure is the average among the different ranges of annual workload as defined by the Latin American Reference Credit (CLAR), which to a large extent supports the validity of the results obtained.

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