Tuning

Latin America

Higher Education in Latin America: reflections and perspectives on **Computer Science**

José Lino Contreras Véliz (ed.)

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Tuning Latin America Project

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José Lino Contreras Véliz (editor)

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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 Computer Science 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*

1

Introduction

Subject Area of Computer Science in the ALFA Tuning Latin America project is made up of academic representatives from fourteen Latin American countries: Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru and Uruguay; and is coordinated by Dr José Lino Contreras Véliz, from Chile (Tuning LA, 2011). Together with the areas of Agronomy and Psychology, the Area of Computer Science began its activity in the second phase of the project, where its main challenge was to make the progress achieved by older areas and move forward with them towards the new objectives. Hence, defining the Profile for the Graduate Area was the first important task, as were the analyses and proposals for teaching, learning and assessing the profile competences, measuring the time students devote to their academic studies and obtaining views regarding the future of the discipline and profession, among other issues.

Obtaining a Graduate Profile for Computer Science involves special difficulties due to its recent origin, and the rapid evolution it and related technologies have experienced, meaning that the expertise and techniques supporting it are constantly changing. Moreover, the use of computer science is constantly growing in practically all spheres of human activity, giving rise to a large number and diversity of scenarios in which to practise the profession.

This document presents the professional Meta-profile for degrees in Computer Science drawn up by the Tuning group. The team channelled its efforts into identifying the fundamental qualities professionals in computer science are expected to have when they complete their degree programmes, irrespective of their area of specialisation or the context in which they will practise their profession. Teaching, learning and assessment strategies for generic and subject-specific competences, observations on students' academic workload in the area, and possible future scenarios regarding the discipline and profession are also presented.

The members of the Tuning Computer Science group hope that the fruits of their work, summarised in this document, constitute a useful contribution to the Latin American and worldwide educational community with regard to curricular review and renewal processes in the field of computer science. They also acknowledge and thank the project managers, directors and assistants for the enormous effort they have made for many years so that a large group of Latin American academics could work altruistically in collaboration, targeting objectives that will no doubt help to improve professional development proposals in Latin America, and make a significant contribution towards the creation of a Latin American Higher Education Area.

2

Description of the Subject Area

This section presents background information about the countries involved in the project and specifically in the subject area of Computer Science, and covers, in addition to other aspects, demography, numbers of higher educational establishments and computer science degree programmes. The information was obtained in 2011 from sources available on the Internet and from contributions made by representatives in the group. Although not all the information corresponds to the same date, it provides an overall view of relevant background history of the subject in the different countries.

2.1. Countries involved in the Area of Computer Science

Table 1 shows the 19 countries involved in the Tuning Latin America project, of which 14 are represented in the Subject Area of Computer Science (marked with a √ in the TLA CS column).

The 20 Latin American countries make up an approximate total population of 572 million inhabitants, of which 98.3% belong to countries participating in the Tuning Latin America project, with an approximate total of 463 million inhabitants. The 14 countries represented in the subject Area of Computer Science, with approximately 463 million inhabitants, make up 81% of the Latin American population.

Table 1
Countries involved in the Tuning Latin America project
and Area of Computer Science

TLA	TLA CS	Country	Population in thousands	Pop. %			Area of Computer Science
✓	✓	Brazil	190,733	33.9			Jamil Salem Barbar
✓	✓	Mexico	112,323	20.0			Patricia Chávez
✓	✓	Colombia	45,925	8.2			Jorge Quevedo Reyes
✓	✓	Peru	29,798	5.3			José A. Pow-Sang Portillo
✓	✓	Chile	17,248	3.1			José Lino Contreras Véliz
✓	✓	Ecuador	14,307	2.5			Cecilia M. Hinojosa Raza
✓	✓	Cuba	11,243	2.0			Roberto Sepúlveda Lima
✓	✓	Bolivia	10,416	1.9			Javier Alanoca Gutiérrez
✓	✓	Honduras	8,200	1.5			Héctor José Duarte Pavón
✓	✓	Paraguay	6,548	1.2			María Elena García Díaz
✓	✓	Nicaragua	5,465	1.0			Augusto Estrada Quintero
✓	✓	Costa Rica	4,301	0.8			Gabriela Garita
✓	✓	Uruguay	3,425	0.6			Laura González
✓	✓	Panama	3,406	0.6	463,338	81.0%	Diana Bernal
✓		Argentina	40,091	7.1			
✓		Venezuela	28,893	5.1			
✓		Guatemala	14,700	2.6			
✓		R. Dominicana	9,378	1.7			
✓		El Salvador	5,744	1.0	562,144	98.3%	
		Haiti	9,800	1.7	571,944	100.0%	

2.2. Higher Education in the countries involved in the Area of Computer Science

Table 2 shows information provided by representatives from each country regarding higher education in their countries: numbers of universities, student numbers and the estimated number of computer science degree programmes. Of the total number of computer science students in Latin America (413,577), the information shows that over half (55%) belong

Table 2
Countries represented in the group of Computer Science and data on Higher Education

Country	Population in thousands	Number of Univ.	Number of state Univ.	% State Univ.	Students in Higher Education	Students in Computer Science degree programmes	% Computer Science students compared to total	Year of data
Brazil	190,733	2,377	278	12	6,380,000	118,064	29	2010
Mexico	112,323	2,995	928	31	3,300,000	106,000	26	2011
Colombia	45,925	342	107	31	1,053,800	46,895	11	2010
Peru	29,798	102	35	34	840,000	48,000	12	2010
Chile	17,248	60	16	27	978,000	22,462	5	2011
Ecuador	14,307	71	24	34	312,000			2006
Cuba	11,243	68	68	100	315,116	6,078	1	2011
Bolivia	10,416	53	10	19	310,000	15,000	4	2011
Honduras	8,200	22	6	27				
Paraguay	6,548	56	8	14	100,000	15,000	4	2011
Nicaragua	5,465	56	6	11	200,000	30,000	7	2011
Costa Rica	4,301	55	4	7	351,116	6,078	1	2011
Uruguay	3,425							
Panama	3,406							
	Total	6,257	1,490		14,176,032	413,577	100	
	Average			23			3	

to Brazil and Mexico, followed by Colombia and Peru, with 11% and 12% respectively. It can also be seen that, on average, only 23% of the universities in the countries represented in the group are state-run, the exception being Cuba, where there are no private universities. Furthermore, from the information available, it can be seen that 3% of students in higher education are taking computer science degree programmes.

Table 3
Some names of Computer Science degree courses
and their length in semesters

Sample Degree programme names	Length in semesters				Total
	8	9	10	12	
Degree in Computer Science	1				1
Degree in Information Science	1				1
Degree in Administrative IT		1	1		2
Degree in Computing			2		2
Degree in Computer Networks	1				1
Engineering in Computer Systems		1	2		3
Engineering in Computer Technology		1			1
Engineering in Computing			2		2
Engineering in Computer Execution	1				1
Computer Science Engineering	1		4		5
Computer Science Civil Engineering				1	1
Engineering in Systems			3		3
Systems and IT Engineering			1		1
Engineering in Systems and Computing			1		1
Software Engineering	1		2		3
Administrative IT Engineering			1		1
Engineering in Business and IT		1			1
Engineering in Networks and Telecommunications	1		1		2
Engineering in Computer Science			1		1
Total	7	4	21	1	33
Percentage	21%	12%	64%	3%	

2.3. Types of degree programmes in Computer Science

Computer Science degree programmes in Latin America have a wide range of names, lengths and qualifications, including «degree» and «Engineering» courses in: Systems, Computer Science, Computing, Information Science, Information Technology, Computer Networks, Computer Systems, Computer Technologies, Systems and Information Technology, Systems and Computing, Software, Networks and Telecommunications, Administrative IT, and others. The length of courses varies between 8 and 12 semesters, with 10 being the most common.

By way of example and without this being the result of a detailed study, Table 3 shows a list of degree course names existing in the countries involved in the project. It can be seen that most (64%) are of 10 semesters in length.

2.4. Computer Science Programmes in countries involved in the Area of Computer Science

This section presents additional background information on computer science programmes in the countries represented in the group of Computer Science. There is also background information on higher education systems, labour aspects and so on. The countries are shown in alphabetical order and the information was contributed by the representatives from each country.

Bolivia

The Higher University Education System in the Plurinational State of Bolivia is made up of 10 state-run universities, 40 private universities, and 3 attached to the Executive Committee of the Bolivian University (CEUB), which is an agency responsible for coordinating, planning and scheduling joint activities. There are also Special Status Universities such as the state-run universities of the armed forces, police, pedagogy and the Indigenous, Intercultural and Productive Universities, the National Association of Private Universities (ANUP), all of which are under the supervision of the Ministry of Education. The public system is regulated by the CEUB, and the private system is governed by the higher education act number 70, Abelino Siñani (Education Act of Bolivia, 2010). Education in the public system is free, and between US$ 1,000 and US$ 2,600 are paid yearly in the private system. It is estimated that there are some 250,000 students in the public system and 60,000 in the private system.

The Computer Science and Systems degree programmes have basic sciences as their foundation, with a strong emphasis on mathematics and physics. In many cases, the IEEE and ACM Curricular Recommendations, 2005, were taken on board to structure curricula. Formation in programming, data structure, databases, information systems, software engineering and networks enables graduates to respond appropriately to Bolivian professional market demands. Other subjects included are expert systems, artificial intelligence, simulation and modelling as a good complement to professional education. Professional education is also complemented by subjects in the areas of finance, administration and applied mathematics, such as statistics and operations research. The most common qualifications are Degrees in Computer Science, Computer Engineering, Systems Engineering, Administrative IT Engineering and Computer Systems Engineering, most of which are 5-year degree level courses. It is estimated that there are some 12,000 students taking computer science degree programmes in the public system and 3,000 in the private system.

Labour demand for Systems Engineers or Computer Engineers in Bolivia is continuous because of the constant growth of business applications in the public and private sectors. Nonetheless, there is an increasing need for professionals who are highly qualified in databases, software project management, security and other fields. Foreign software development companies, known as software *maquiladora* companies, have also been set up. Although there is demand, the number of professionals in the area has caused wages to fall in line with the professional supply generated by almost all the state-run and private universities. Wages for new graduates vary between US$ 300 and US$ 1,000 according to the company and the graduate's university, the minimum wage being Bs. 815 (US$ 115).

Brazil

Brazil has public and private higher educational establishments (IES). In 2010, there were 278 public and 2,099 private higher educational establishments. Students do not pay enrolment or monthly fees in the public sector, and the Government awards full and partial grants to students in the private sector for degree and further development via the University for All Programme (Prouni, 2005). Approximately 6,380,000 students currently study in higher education.

In Brazil, the Ministry of Education and Culture (MEC) have overall control of all degree programmes and is responsible for laying down rules and standards in higher education, defining syllabus guidelines, accreditation, licensing, and disqualifying and renewing the operation of educational establishments and degree programmes. The IES awards «Bachelor's Degree», «Degree» and «Technologist Diploma». The «Bachelor's Degree» is obtained by those intending to work professionally after a 4 to 5-year course. The «Degree» is awarded to those intending to work in education, and the «Technologist Diploma» is obtained after a 2 to 3-year courses by professionals intending to work in highly specific areas, e.g.: «Technologist in Data Processing».

Professions in the area of computing are not regulated, but the Brazilian Computing Society's (SBC) guidelines can be used, this being one of the most important agencies uniting researchers, lecturers, students and professionals devoted to scientific research, educational and technological development in the entire area of computing. The main degree programmes in Computer Science are: «Computer Science», «Computer Engineering», «Information Systems», «Software Engineering», and «Degree in Computing». In 2009 there were 334 degree courses in «Computer Science», 124 in «Computer Engineering», 559 in «Information Systems», 71 in «Degree in Computing», 2 in «Software Engineering», 23 specific further programmes and 918 in technology. In 2010, there were 781,609 enrolments on technological degree courses, with 66,664 in the area of information processing and 51,400 in the area of Computer Science.

Demand for professionals in the area of computing is extremely high. Students, prior to completing their degree, can take on a paid internship in a company, which is a compulsory subject in most programmes. The average starting wage of a new graduate is approximately US$ 750 to US$ 1,100, with the minimum legal, monthly wage being R$ 622 (US$ 342).

Chile

Higher Education in Chile is studied at universities, vocational education colleges, technical education centres and schools of the armed forces. In 2011, there were 60 universities (16 state-run and 44 private). The State provides direct financial support to 16 state-run and 9 private universities, which together make up the group of 25 «traditional» universities. Studies are paid in all universities and degree programmes, and fees vary according to the type of degree and establishment, being between US$ 1,500 and US$ 10,000 per year in 2011. Although there are both state and private grants and subsidies for students with scarce financial resources, these fail to cover the cost of degree programmes and many find they need to work and/or resort to bank loans in order to study. Higher educational establishments can create degree programmes in any area, and define profiles, curricula, educational processes and fees in an open system where the chief regulating mechanism is market forces. In 2011, there were 978,028 students enrolled in the entire Higher Education system.

There are 3 types of engineering degree courses in Chile: *performance engineering* and *engineering,* offered by universities, professional institutes and the Armed Forces; and *civil engineering*, which is only studied at universities. The Chilean General Education Act states that, prior to graduating, civil engineering students must graduate in the *Degree in Engineering Sciences*, which is only awarded by universities (General Education Act of Chile, 2009). Owing to the ease with which degree programmes can be created and the higher status and wages of a qualified «engineer», there is a wide range of engineering degrees, ranging from the most traditional such as electricity, mechanics and chemistry, etc., to non-conventional engineering such as tourism, risk prevention, human resources, landscaping and trade.

The length of most performance engineering degrees is 8 semesters, engineering 10, and civil engineering 12. For the latter, each university defines the criteria for awarding of the Degree in Engineering Sciences, which generally includes studies of the basic sciences (mathematics, physics and chemistry), and engineering sciences (thermodynamics, materials science, fluid dynamics, economics, optimisation, systems theory, etc.). Programmes also include general subjects and subjects attached to the speciality. Students also carry out industrial and professional practical education, and projects or assignments covered within their qualification.

Generally speaking, in Chile, the terms Computing and Computer Science are used as equivalents both in degree programmes and the professional field. The most common qualifications are Performance Engineer, Engineer or Civil Engineer in Computer Science; or in Computing and Information Technology. There are also computer science degrees in more specific areas such as Engineering in Computer Networks, Databases, Web Systems, Information Systems and so on.

In 2011, the fees for computing and civil computer science degree courses were between US$ 3,000 and US$ 9,900 per year.

Computer Science degree programmes attract a large number of young people who enrol from secondary education and they are among the degrees that attract most students in higher education, with 22,462 enrolled in 2011. The average employability in the first year after graduating stands at 85%, with monthly wages of US$ 1,100 to US$ 2,600. In Chile, the minimum legal wage is 180,000 pesos (US$ 375). The main employers are national and international companies in the areas of retail trade, finance, telecommunications, mining, consultancy, basic services, and so on. Many graduates also set up companies or work independently.

Colombia

Higher education in Colombia is regulated by the State via the Ministry of National Education (MEN), which draws up policies, regulates and determines criteria and parameters for improving access, quality and fairness in education. Higher educational establishments (IES) are universities and institutes and they have autonomy to build their own programmes, which is what stamps their distinguishing seal on the professional circuit and labour market, but they must, however, respond to the supervision and control regulations and indicators determined by the MEN. In 2011, there were 342 universities in Colombia, of which 107 were public and 235 private.

The IES offer different levels of education as follows: Professional Technician, which provides education in occupations of an operative and instrumental nature; Technological Education, which provides education in occupations, academic education and specialisation programmes; Professional Education, which provides education in scientific or technological research in disciplines and production, development and knowledge transfer; and Post-graduate Education, which provides education in specialisation, master's degrees, PhD and post-doctorate qualifications. On completing their university studies, students must sit compulsory higher education quality examination. In 2010, the number of university students was 1,053,800 (not including technicians, technologists or post-graduates).

The computer science curriculum comprises the areas of basic science, basic engineering science , applied engineering and an area of complementary education. The area of basic science includes subjects such as mathematics, physics, and economic and administrative sciences. The subject-specific area includes topics concerning programming, technology, business processes, data management and so on, while the professional or specialist area includes elective courses in the relevant specialisation. Most of the programmes are 10 semesters in length and the qualifications awarded are mainly Systems Engineer, Systems and Computer Engineer, Systems and IT Engineer, and Telecommunications Engineer. Some universities now wish to change programmes in the area of systems to 4 years, as changes in the professional field evolve extremely quickly and so attempts are made to keep professionals up-to-date by studying post-graduate courses in the specialisation they need. The yearly degree course fees in state-run universities range from US$ 500 to US$ 2,000, and from US$ 2,500 to US$ 15,000 in private universities, depending on the university's ranking or quality.

The number of graduates in Systems Engineering, Telematics and similar in 2010 was close to 9,023, making it the highest among the different types of engineering. Nonetheless, this number is insufficient for the Colombian market, which is especially made up of multinational and national companies, many of which are in the area of building software. In 2010, there were 46,895 students enrolled on computer science degree courses.

Average monthly wages in the area vary between US $1,000-US$ 3,400 according to experience, expertise, or potential in competences such as: proficiency in a second language, ability to integrate and be productive in working groups, self-learning in new technologies, teleworking with virtual office space and so on. The legal minimum wage is $ 634,500 (US$ 350).

Costa Rica

Higher education in Costa Rica is divided into state-run and private higher education. There are four state-run universities regulated by the National Council of Rectors, CONARE, which offer degree programmes in Computer Engineering or Systems and Administrative IT Engineering. There are 51 private universities approved by the National Council of Private Higher Education, CONSUP, of which 25 offer computer science degree programmes nationwide.

Agreements exist with university colleges to validate subjects and enrol baccalaureate students in state-run universities. Some universities stipulate baccalaureate as the minimum requirement to take a university degree, which is 5 to 6 years in length with an average of 40 courses taught in 8 to 10 quarterly periods or semesters according to each university's regulations. The study fees in state-run universities are US$ 78 per course, with a maximum of US$ 624 per year. In private universities the fees are US$ 128 per course, and can rise to US$ 1,536 per year. Depending on their financial situation, state-run university students have access to grants to pay for courses, upkeep and housing. There is also a loan system to help finance studies.

At degree level, programmes specialise in areas such as: Project Administration ICT, Software Quality, Telematics and Networks, Web Applications and mobile devices. Degree programmes are structured into nine to eleven courses over three quarterly or six-month periods, and graduation is required in assignments such as: theses, projects, internships and graduation exams.

Computer science degree programmes at state-run universities offer vocational education which includes courses based on mathematics and computational logic. An average of 75% of education courses are aimed at vocational education, four to six courses are aimed at humanistic education, two to four are backup courses in administrative processes, and two to four in English.

Recent studies on the professionals most needed in Costa Rica between 2010 and 2020 place Computer Engineering and related professions at 45.16% of all subjects. The chief sources of employment for Computer Science professionals are the financial, trade and production sectors, companies devoted to selling software and call centre backup companies.

Cuba

The Higher Education System in Cuba is accountable to the Ministry of Higher Education in all aspects. There are 68 public universities and no private or grant-maintained universities.

There are polytechnic institutes, which are establishments offering secondary-higher education where technicians are trained. A considerable number of technicians go on to study engineering at university having complied with the enrolment requirements for Higher Education.

Education in Computer Engineering in Cuba is based on the Syllabus (version D) that is drawn up and controlled by a national commission attached to the Ministry of Higher Education, which is led by an academic from the Rector Centre and made up of specialists from different universities and employment agencies nationwide. The conception of Computer Engineering in Cuba is centred on a fundamental subject called Software Engineering and Management, which almost unequivocally defines the degree programme's approach towards this emerging type of engineering. The course is divided into two types: face-to-face, with complete student dedication, and semi-face-to-face, for people who are working.

The Syllabus lays down the main elements of programmes such as the educational and instructive aims, strategies for development in values, the structure and content of each discipline and subject, bibliography and specific methodological indications. It has a subject-specific approach and is shaped by a basic curriculum, the university's own curriculum and a curriculum of optional, elective subjects.

The basic curriculum comprises the compulsory subjects for all students enrolled on the degree programme and makes up 78% of the course. It includes Philosophy, Economics and Social Sciences, subjects in English, Mathematics, Applied Mathematics, Organisation Management, Computer Systems Infrastructures, Pedagogy and so on. The university's curriculum is designed by each establishment and enables specialisation that responds to local or contextual situations, which has led to some establishments fine-tuning their programmes towards a specific area of Computer Science. This comprises 12% of the content. The curriculum of optional, elective subjects represents 10% of the programme and is a flexible element in the Syllabus (version D) as it enables new subjects to be incorporated dynamically into the development of Computer Science. All students must study the subjects included in their university's curriculum and a predetermined number of subjects from the optional, elective curriculum.

The programme is also characterised by the fact that it incorporates Professional Practice as part of the basic curriculum, which includes several professional work components and end-of-study assignments, scheduled to be performed during a semester with a study workload of 800 hours, and which also includes a Research course.

Students taking computer science degree programmes make up 6,078 of a total of 351,116 students in the Cuban Higher Education system. There is an average of 819 new places for enrolment per year at the 17 universities offering computer science programmes. The wage for new graduates stands at US$ 495 on average. The legal minimum monthly wage in Cuba is US$ 225.

Ecuador

The Higher Education System in Ecuador —SESE— is made up of universities and polytechnic schools; technical, technological and pedagogical institutes of higher education; and conservatories of music and the arts. The system comprises 64 universities (24 public, 8 co-funded and 32 private), 7 polytechnic schools and 282 institutes of higher education. It is currently going through a process of change due to new legislation that has placed emphasis on principles of quality and allegiance, whereby the Higher Educational Establishments (IES) that fail to meet the minimum requirements will be closed. Degree programme accreditation is another issue dealt with by the IES, which is accountable to the Council for Quality Accreditation and Assurance in Higher Education —CEAACES— for accrediting and assuring the quality of establishments, degree courses and programmes.

Initial enrolment on computer science degree programmes is free of charge in state-run universities. Students only pay between US$ 100 and US$ 600 per year for university and/or administrative services. It should be noted that if students fail one or more subjects, they are no longer eligible to cost-free status and must pay for the subjects they are taking (E.g. US$ 50 per credit). At co-funded universities reliant on state subsidies, students pay between US$ 3,000 and US$ 10,000 per year. In 2006, there were 312,000 students in enrolled higher educational establishments.

In order to obtain an academic degree, professional university or polytechnic Engineering qualifications, a minimum of 225 credits of the academic programme must be passed, the end-of-degree assignment completed (20 credits), pre-professional internships undertaken and community ties made, which are defined, planned and monitored in the specific area of the degree programme. The face-to-face academic programme is of a minimum of four and a half years' duration for the academic degree and professional university or polytechnic qualification. The semi-face-to-face programme is of a minimum length of five years. Engineering degree programmes must include content on the basic sciences and mathematics relevant to the area of knowledge covered in the course, specific content of the sciences needed for the qualification and general educational content enabling both the national and international environment surrounding future professionals to be located and understood.

Universities currently offer some 50 computer science degree programmes, the most common being systems engineering, computer engineering, IT systems engineering, and computer systems engineering. The variety of qualifications offered is due to excessive freedom at universities and a lack of control, at the time, on the part of the higher education rectorial organisation. Despite the National Secretariat of Higher Education, Science, Technology and Innovation SENESCYT-beginning to take action in 2010 aimed at standardising qualifications, action has failed to be proposed to ascertain the number and profile of professionals needed by the country in the Area of Computer Science, nor are there regulations that help to determine the degree programmes that universities should offer and their level of quality, taking into account international parameters.

There is a great deal of demand for computer science professionals in Ecuador, especially Software Engineers, Analysts, Programmers, Database Operators, Network Administrators, IT Managers and Consultants, and the importance of Software Architecture and Computer Security is growing. The wage for a newly-graduated engineer is US $700 in state-run companies and US$ 500 in the private sector. The legal minimum monthly wage is US$ 292. The most important competences for employers are: capacity for abstraction, analysis and synthesis, ability to identify, consider and deal with problems, ability to learn and keep constantly up-to-date, and commitment to quality and capacity for teamwork.

Honduras

Universities in Honduras are of two types: those receiving State subsidies, and private universities which receive no state contribution. There are 6 state-run and 16 private universities. The National Autonomous University of Honduras (UNAH) is in charge of organising, managing and developing higher education through the following agencies: the Board of Teaching Staff, the Council of Higher Education and the Higher Education Technical and Management Council. The Board of Teaching Staff has the power to hear appeals against Council of Higher Education resolutions, and also acts as an advisory body in determining criteria for academic principles concerning affairs in which intervention is requested. Education in state-run establishments is free of charge while between US$ 600 and US$ 2,000 is paid yearly in private universities, depending on the degree course and university.

There are degree courses from undergraduate to PhD level (in medicine and surgery). Post-graduate programmes in specialisation and master's exist alongside PhD levels. Studies are linked to value units. For example, there are short degrees with 80 to 100 value units and of two years duration; degrees with 160 value units or above; PhDs in medicine and surgery with a minimum of 320 value units, and a duration of six to eight years; Specialities with 30 to 90 value units more than the degree, and a duration of three years. The two largest universities, UNAH and the National Pedagogical University, are the only universities that set entrance exams, either based on skills and/or knowledge.

Programmes are designed by each university but all must respect the legislation laid down by the Higher Education Act of Honduras, which states that programmes must contain subjects related to general education - providing students with the theoretical elements and suitable experience to broaden their understanding of nature, humanity and society, and specific elements enabling students to acquire subject-specific, theoretical and practical expertise, develop abilities and skills, cultivate values and take on attitudes within the framework of related scientific and technological subjects that form part of their professional field.

There is no legislation promoting an official name for computer science degree courses in Honduras. There are degree courses in computer science engineering, computer systems, administrative IT, industry and systems. Most maintain general education in their curricula and subject-specific subjects, extramural study programmes and vocational education at the end of the programme, in addition, in some cases to the submission of a graduation or thesis project.

Computer science degree programmes are widely welcomed by young students and their numbers are growing nationwide. The main employers of graduates are telecommunications companies, software manufacturers, banking and industry, and many graduates develop their own business projects.

Mexico

There are 928 state-run and 2,067 private higher educational establishments in Mexico, with a student population of approximately 3,300,000. In general, studies are free of charge in state-run establishments although the equivalent of a yearly fee of US$ 500 may need to be paid for some degree programmes. Yearly course fees in private establishments can range from US$ 2,500 to US$ 13,000.

Close to 160 programmes related to computer science are registered in the National Association of Universities and Higher Educational Establishments —ANUIES— offered at over 900 different establishments, where some 106,000 students study (2010-2011 stage).

Programmes are normally divided into bachelor's degrees and engineering degrees according to their approach and the most common are Computer Systems Engineering and a bachelor's degree in Computer Science. Another important point regarding students enrolled in computer science is that approximately 66% study at state-run establishments and 34% at private establishments.

In Mexico, the National Association of Information Technology Higher Educational Establishments —NIEI— states that there are four domains of professional development in information technology and computer science, which are mainly covered by state-run establishments. The four domains are identified by the following names: Degree in Information

Technology, Degree in Software Engineering, Degree in Computer Sciences, and Computer Engineering.

The ANIEI defines profiles for the four qualifications similar to those stated by the Association for Computer Machinery in the reference document «Computing Curricula 2005» (ACM/IEEE Curricular Recommendations, 2005), which puts forward an approach to computer science in the following areas: Computer Sciences, Computer Engineering, Information Systems and Software Engineering.

In the case of private universities, programmes aimed vocationally at the needs of industry are normally offered, and given the proximity to the United States, the most common areas of specialisation chosen by students are the software development industry and infrastructure solutions, and information systems.

The average monthly wage of a Computer Science professional who has recently completed their degree is equivalent to US$ 600. Depending on the establishment and company, up to US$ 3,500 per month can be earned. The legal minimum wage in Mexico stands at US$ 4.6 per day, although this can vary according to the region and profession. This amounts to approximately US$ 110 per month. The labour market for computer experts in Mexico is extremely varied, with many job offers in international companies devoted to Applications Development and Computer Services, such as telecommunications, financial and business companies, although many graduates also work independently in their own companies.

Nicaragua

The establishments within the university system that make up the National Council of Universities —CNU— are autonomous non-profit establishments. The CNU is responsible for authorising legally established Universities and Centres of Higher Technical Education so that they can award academic degrees in different subjects, without undermining the academic autonomy such establishments enjoy. With regard to the private sector, these universities are organised by the Superior Council of Private Universities, COSUP. A total of 56 authorised higher educational establishments are registered in the CNU —6 state-run and 50 private— of which 4 state-run and 6 private establishments receive contributions from the state budget.

For the level of higher technical education, the National Technology Institute —INATEC— is the governing body and regulatory agency for technical education. Students contribute a symbolic annual fee for their studies in the public system, which varies between US$ 20 and US$ 50. Annual study fees in the private system range from US$ 300 to US 2,000. It is estimated that there is a student population of some 200,000 enrolled in higher education.

In Nicaragua, education in Computer Science is developed on different teaching levels: basic education, secondary education, technical education (polytechnic and technological institutes) and higher education (universities), with both public and private funding. Each has their own programmes and requirements according to level. It is estimated that there are some 28,000 to 30,000 computer science students nationwide, which represents approximately 15% of the total university student population.

Some common qualifications are: Senior Computer Technician, Graduate in Computer Sciences, Graduate in Educational Computing, Computer Engineer, Systems Engineer, and Information Systems Engineer. Moreover, there is a range of qualifications in more specific study areas, such as Graphic Design, Computer Networks, Hardware, PC Repair and Maintenance, Information Systems, Web Systems, ICTs, Multimedia Systems and so on.

The monthly wage of newly qualified professionals ranges from C$7,000 (US$ 300) to C$18,000 (US$ 765). The legal monthly wage in Nicaragua stands at C$2,925 (US$ 125) in the industrial sector and C$3,390 (US$ 145) in the communications sector. The main employers of computer science professionals are private companies (for automating their systems), web applications development, telecommunications and networks, and mobile telephony. There is a great deal of demand for computer experts in the public sector.

Paraguay

Higher Education in Paraguay is managed by higher educational establishments comprising universities, higher university institutes and higher vocational education institutes, which develop teaching, research and extension activities organisationally structured into faculties, departments or equivalent academic units.

In the absence of regulations governing the opening of new universities, more than 56 universities were created within a short period of time, 90% of them private. Today there are 8 decentralised state-run universities and 48 private ones. State-run universities are subsidised by the State and students pay approximately US$ 200 per year for their studies. At private universities, students pay between US$ 3,500 and US$ 3,900 for their studies. There is a state grant programme, which is insufficient given the heavy demand for higher education. Some 100,000 students currently enrol in higher education, although there are growing numbers of candidates who fail to meet the academic requirements stipulated by universities in order to be accepted. The lack of credibility in most private establishments and the predominance of a certain trend towards cutting corners among students have eroded the standards of quality in higher education in Paraguay.

In Paraguay there is no legislation for the naming computer science degree courses, and so there are several names. In general, degree courses are 8 to 10 semesters in length, depending on the establishment, and go under the names of: Computer Engineering, Degree in Computer Sciences, Systems Engineering, Degree in Systems, Degree in Systems Analysis, Degree in Programming, Systems Engineering, Computer Science Engineering and so on. Subjects in the areas of mathematics, physics, complementary or general sciences and sciences specific to Computer Sciences are included in most programmes. Extramural activities and work internships are also included, but only some include an end-of-degree project, where a publication is required prior to obtaining the qualification. The National University of Asunción, the oldest in the country, holds 45% of university students and has 6,800 students enrolled on computer science degree courses.

Technological degrees are not so highly regarded as degrees of a social type (Law, Philosophy, Education, Psychology, etc.) as candidates see difficulties in studying mathematics and physics in order to gain access to the course without looking into the high labour demand existing in the area and high wages earned by quality professionals in computer science. Entrance exams are compulsory in state-run universities and demand thorough preparation as they are highly competitive, due to the limited number of places existing in technological degree courses. Graduates from state-run universities are highly sought after in companies and industries involved in the field, unlike those graduating from private universities, owing to the large differences in entrance requirements to courses. For students who have obtained their credits and are in the process of submitting their end-of-degree project, wages range from US$ 900 to US$ 2,200, i.e. between 3 and 6 times the legal minimum wage (US$ 361, in 2012). Employers are, to a large extent, telecommunications companies, supermarket chains, software companies and so on, although many students decide to work independently.

Peru

Higher Education in Peru is provided by universities, institutes and technical and vocational education colleges. There are 35 state-run and 67 private universities, where academic bachelor's, master's and PhD degree courses are studied, as well as professional degree-level qualifications and their equivalents (e.g. Engineer). The Bachelor's degree is obtained with a minimum of ten semester length periods, or the equivalent in years or credits. Professional degree-level qualifications or equivalents require the possession of the Bachelor's degree, and there are 3 ways to obtain the qualification: writing a thesis, preparing an assignment or document after graduating; or three consecutive years of providing professional services in work related to their speciality, or any other conditions defined by the university. The Master's or PhD degrees require public support and the approval of an original and critical research project. Non-university studies are taught by institutes and schools that award technical and professional qualifications, whose courses range from 4 to 10 academic semesters. Education is free of charge in state-run universities, and between US$ 2,800 and US$ 11,250 is paid for engineering degree courses in private universities. According to data in 2010, there were some 840,000 university students.

Institutes offer technical programmes and universities Bachelor's degree programmes and professional degree-level or Engineering programmes in Computing and Computer Science. Most university qualifications in the area correspond to «Engineers» and very few to «Graduates». There is no consensus among universities in Peru with regard to qualification names. In the area of computer science, terms are included such as «Computing», «Computer Science», «Systems», and others. Among the Computing or Computer Science qualifications existing in Peru, there are: «Systems Engineering» (30 universities), «Systems and Computer Science Engineering» (8 universities), «Computer Science and Systems Engineer » (8 universities), «Computer Science Engineer» (7 universities), «Computer and Systems Engineering» (3 universities), «Computer and Systems Engineer» (3 universities) and «Software Engineering» (2 universities). Some universities now offer the qualification of «Degree in Computer Science». In 2010, some 48,000 students were registered in computer science degree programmes.

Demand for professionals in Computer Science and Information Technology on the part of Peruvian companies and organisations has grown in recent years. This is reflected in the fact that most of the country's universities offer at least one degree programme related to the area. The wage for newly-graduated professionals stands at around 1,500 new soles (US$ 555), and the legal monthly minimum wage in Peru is 750 soles (US$ 282). The companies that most demand systems engineers are those related to IT solutions development and implementation services provided to third parties, known as outsourcing companies.

2.5. Key aspects of the meta-profile

Preparation of the meta-profile began by identifying the competences associated with the discipline which students should possess on completing their degrees. Then, along with a set of generic competences, these were evaluated in the countries involved by employers, graduates, academics and students in advanced courses, by means of surveys on the levels of importance and the levels of achievement by students during their degrees. The respondents gave values 1, 2, 3 or 4 to each competence, 1 being the lowest importance or achievement and 4 the highest.

Table 4
Total numbers of surveys received in the Area of Computer Science

	Generic	Subject-specific	Total
Academics	348	322	670
Employers	255	231	486
Students	960	827	1,787
Graduates	436	396	832
Total	1,999	1,776	3,775

Table 4 shows the number of answers received, Tables 5 shows the 13 subject-specific competences, and Table 6 the 27 competences assessed. The competences are listed in descending order according to the average level of *importance* reported in the surveys.

Table 5
Generic competences in order of importance
(from high to low)

Num.	Generic competences	Imp.	Achieve.	Diff.	Diff. %
2	Ability to apply expertise in practice	3.77	2.90	0.87	23
1	Capacity for abstraction, analysis and synthesis	3.76	3.07	0.69	18
15	Ability to identify, consider and deal with problems	3.76	3.06	0.70	19
10	Ability to learn and keep constantly up-to-date	3.75	2.96	0.80	21
8	Skill in the use of information and communications technologies	3.70	3.05	0.65	18
27	Commitment to quality	3.68	2.90	0.78	21
17	Capacity for teamwork	3.66	3.01	0.64	18
18	Capacity for decision making	3.63	2.78	0.85	23
26	Ethical commitment	3.59	2.88	0.71	20
9	Research capacity	3.59	2.85	0.74	21
25	Ability to design and manage projects	3.59	2.70	0.88	25
4	Knowledge of the area of study and profession	3.58	2.99	0.59	17
3	Ability to organise and plan time	3.52	2.60	0.92	26
14	Creative capacity	3.51	2.65	0.86	25
7	Ability to communicate in a second language	3.50	2.22	1.27	36
6	Capacity for oral and written communication	3.49	2.63	0.86	25

Num.	Generic competences	Imp.	Achieve.	Diff.	Diff. %
11	Ability to search for, process and analyse information deriving from different sources	3.49	2.93	0.56	16
13	Ability to act in new situations	3.46	2.69	0.77	22
24	Ability to work autonomously	3.46	2.92	0.54	16
23	Ability to work within international contexts	3.38	2.26	1.11	33
19	Ability to motivate and steer towards common aims	3.34	2.53	0.81	24
18	Interpersonal skills	3.30	2.68	0.62	19
12	Critical and self-critical capacity	3.28	2.62	0.67	20
5	Social responsibility and citizenship	3.09	2.53	0.56	18
22	Appreciation and respect for diversity and multiculturalism	3.01	2.50	0.52	17
20	Commitment to environmental conservation	2.99	2.17	0.82	27
21	Commitment to their socio-cultural milieu	2.93	2.30	0.63	22

Table 6

Subject-specific competences in descending order of importance

Num.	Specialist Competences	Imp.	Achieve.	Diff.	Diff. %
1	Implementing knowledge of Computer Sciences, Information Technology and Organisations in order to develop IT solutions	3.77	3.11	0.66	17
2	Conceiving, designing, developing and carrying out IT solutions based on principles of engineering and quality standards	3.72	2.90	0.82	22
9	Implementing quality standards in IT solutions development and assessment	3.58	2.62	0.96	27
7	Identifying opportunities in order to remedy redundancy in organisations via the efficient and effective use of IT solutions	3.55	2.69	0.86	24

Num.	Specialist Competences	Imp.	Achieve.	Diff.	Diff. %
13	Assimilating emerging technological and social changes	3.53	2.71	0.82	23
3	Implementing a systemic approach to analysing and dealing with problems	3.52	2.87	0.65	19
8	Leading processes that incorporate, adapt, transfer and produce IT solutions in order to support the strategic aims of organisations	3.46	2.54	0.92	27
10	Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage IT projects	3.45	2.46	0.99	29
5	Playing different roles in IT projects within both local and globalised, multidisciplinary and multicultural contexts	3.42	2.56	0.85	25
12	Implementing research methodologies when pursuing, substantiating and preparing IT solutions	3.41	2.67	0.74	22
6	Implementing knowledge independently and innovatively in the pursuit of IT solutions, with social responsibility and commitment	3.37	2.61	0.76	22
11	Spearheading entrepreneurial ventures in order to create new products and services linked to information technology	3.32	2.43	0.89	27
4	Applying mathematical principles, algorithmic principles and Computer Science theory to model and design IT solutions	3.31	2.76	0.54	16

One significant aspect was the high correlation between the responses of the different groups of respondents, as shown in Table 7.

Table 7
Correlation between answers given by the groups of respondents

Generic competences				
Importance	**Academics**	**Employers**	**Students**	**Graduates**
Academics	1.0000			
Employers	0.8537	1.0000		
Students	0.8822	0.8207	1.0000	
Graduates	0.8683	0.9559	0.9188	1.0000

Achievement	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.9687	1.0000		
Students	0.9298	0.9766	1.0000	
Graduates	0.9236	0.9565	0.9777	1.0000

Subject-specific competences				
Importance	**Academics**	**Employers**	**Students**	**Graduates**
Academics	1.0000			
Employers	0.8537	1.0000		
Students	0.8822	0.8207	1.0000	
Graduates	0.8683	0.9559	0.9188	1.0000

Achievement	Academics	Employers	Students	Graduates
Academics	1.0000			
Employers	0.9687	1.0000		
Students	0.9298	0.9766	1.0000	
Graduates	0.9236	0.9565	0.9777	1.0000

The group conducted a quantitative analysis of the results in order to select the competences, complemented by a qualitative analysis based on agreed criteria regarding the interpretation of these competences. Competences were also selected that had low importance levels but were deemed necessary, given the social and economic trends in professional practice. Table 8 and Table 9 show the selected generic and competences attached to the subject for the meta-profile.* indicates the competences with low-importance levels included in the meta-profile.

Table 8
Selected generic competences

Num.	Generic competences selected	Importance
2	Ability to apply expertise in practice	3.77
1	Capacity for abstraction, analysis and synthesis	3.76
15	Ability to identify, consider and deal with problems	3.76
10	Ability to learn and keep constantly up-to-date	3.75
17	Capacity for teamwork	3.66
9	Research capacity	3.59
25	Ability to design and manage projects	3.59
26	Ethical commitment	3.59
4	Knowledge of the area of study and profession	3.58
3	Ability to organise and plan time	3.52
7	Ability to communicate in a second language	3.50
24	Ability to work within international contexts	3.38
5	Social responsibility and citizenship*	3.09
22	Appreciation and respect for diversity and multiculturalism*	3.01
20	Commitment to environmental conservation*	2.99
21	Commitment to their socio-cultural milieu*	2.93

Table 9
Subject-specific competences selected

Num.	Subject-specific competences selected	Importance
1	Implementing knowledge of Computer Sciences, Information Technology and Organisations in order to develop IT solutions.	3.77
2	Conceiving, designing, developing and carrying out IT solutions based on principles of engineering and quality standards.	3.72
9	Implementing quality standards in IT solutions development and assessment	3.58
7	Identifying opportunities in order to remedy redundancy in organisations via the efficient and effective use of IT solutions	3.55
13	Assimilating emerging technological and social changes	3.53
3	Implementing a systemic approach to analysing and dealing with problems	3.52
10	Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage IT projects	3.45
5	Playing different roles in IT projects in both local and globalised, multidisciplinary and multicultural contexts	3.42

2.6. Competences attached to the meta-profile

The competences selected for the Meta-profile were classified into three categories or dimensions: *Professional Practice, Social Responsibility and Subject-specific Aspects.* Figure 1 shows a diagram of the competence dimensions. The competences for the Subject-specific Aspects dimension are grouped into 4 areas: Principles of Computer Science, Management and Leadership, and Quality and Innovation. The competences for each dimension are shown below.

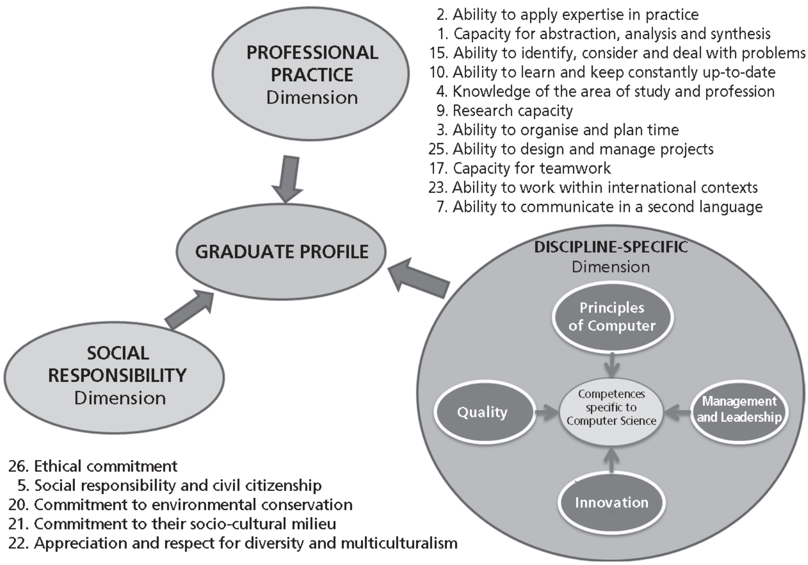

Figure 1
Diagram of the meta-profile's dimensions and competences

The Professional Practice Dimension

The Professional Practice dimension includes competences that constitute the essential and defining principles of a Computer Expert's performance profile and covers the following competences:

- Ability to apply expertise in practice.
- Capacity for abstraction, analysis and synthesis.
- Ability to identify, consider and deal with problems.
- Ability to learn and keep constantly up-to-date.
- Knowledge of the area of study and profession.
- Research capacity.
- Ability to organise and plan time.
- Ability to design and manage projects.
- Capacity for teamwork.

- Ability to work within international contexts.
- Ability to communicate in a second language.

The Social Responsibility Dimension

The Social Responsibility dimension expresses the professional's expected relationship within the socio-cultural, ethical and environmental context of the field of action. The competences attached to this dimension are:

- Ethical commitment.
- Social responsibility and citizenship.
- Commitment to environmental conservation.
- Commitment to their socio-cultural milieu.
- Appreciation and respect for diversity and multiculturalism.

The Dimension of Subject-specific Aspects

The dimension of Subject-specific Aspects reflects elements that determine under what conditions professional practice is conducted and the way in which professionals join organisations as an element of change, leadership and innovation. The competences were grouped into 4 areas: Principles of Computer Science; Management and Leadership; Innovation; Quality. The competences attached to each of this dimension's areas are as follows:

The Area of Principles of Computer Science

- Implementing knowledge of computer sciences, information technologies and organisations in order to develop IT solutions.
- Implementing a systemic approach to analysing and dealing with problems.

The Area of Management and Leadership

- Playing different roles in IT projects within local and globalised, multidisciplinary and multicultural contexts.

- Assimilating emerging technological and social changes.

- Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage IT projects.

The Area of Innovation

- Identifying opportunities in order to remedy redundancy in organisations through the efficient and effective use of IT solutions.

The Area of Quality

- Conceiving, designing, developing and carrying out IT solutions based on principles of engineering and quality standards.

- Implementing quality standards in IT solutions development and assessment.

2.7. Meta-profile for the Area of Computer Science

The following meta-profile was produced from the generic and subject-specific competences selected:

> Latin American computer science professionals contribute to the development of society and the organisations in which they participate with the abilities and skills their expertise in computers, information technologies, systems and organisations bestows on them, together with comprehensive education based on professional ethics, social responsibility and commitment to quality.
>
> They implement knowledge with a high level of abstraction, enabling them to identify, consider and deal with problems, and provide solutions based on computer sciences and information

technologies. Moreover, they stand out for their ability to research and learn new approaches, techniques and paradigms for the subject by constantly updating and expanding their practical expertise and skills.

Computer Science professionals are willing to form multidisciplinary and multicultural teams and work within national and international contexts, where they take on the profession's different roles with leadership. They are able to design and manage projects by organising and planning the resources required to set them in motion. They develop effective and innovative solutions by applying expertise in computer sciences, information and communications technologies and organisational behaviour, together with engineering principles and quality standards.

Computer Science professionals act according to well-established ethical precepts and respect the legal and socio-cultural framework within which they pursue their professional activity. They are aware of their responsibility towards society and the commitment they take on in the need to conserve the environment.

2.8. Comparing the meta-profile with programmes in the countries represented

The meta-profile was compared with the profiles from 5 prominent computer science degree programmes in each of the countries attached to subject area. 49 graduate profiles were analysed and the level of the presence of each competence in the meta-profile was verified by counting the number of times the competence is represented. The results of this analysis are shown in the following sections.

2.8.1. *Universities and degree programmes taken into consideration*

Table 10 shows the list of each country's universities and degree programmes, whose profiles for Computer Science degree courses were compared with subject meta-profile.

Table 10
Universities and degree courses whose profiles were analysed

Country		University	Degree Course
Bolivia	U1	Univ. Privada de Santa Cruz de la Sierra	
	U2	Univ. Autónoma de Gabriel René Moreno	
	U3	Univ. Mayor de San Andrés	
	U4	Univ. Nur	
	U5	Univ. Tecnológica Privada de Santa Cruz de la Sierra	
Brazil	U6	Univ. de Brasilia	Computer Science
	U7	Univ. de Sâo Paulo	Computer Science
	U8	Univ. Federal de Minas Gerais	Computer Science
Chile	U9	Pontificia Univ. Católica de Chile	Civil Engineering in Computing
	U10	Univ. de Chile	Civil Engineering in Computing
	U11	Univ. Técnica Federico Santa María	Civil Engineering in Computer Science
	U12	Univ. de Concepción	Civil Engineering in Computer Science
	U13	Univ. de Santiago de Chile	Civil Engineering in Computer Science
Colombia	U14	Univ. Pedagóg. y Tecnológ. de Colombia	Computer and Systems Engineering
	U15	Univ. de los Andes	Computer and Systems Engineering
	U16	Univ. Nacional de Colombia	Systems Engineering
	U17	Univ. del Norte	Computer and Systems Engineering
	U18	Univ. Industrial de Santander	Systems Engineering
Costa Rica	U19	Univ. Estatal a Distancia (UNED)	BSc in Computer Science Engineering
	U20	Univ. de Costa Rica (UCR)	BSc in Business Computing
	U21	Inst. Tecnológico de Costa Rica (ITCR)	BSc in Computer Engineering
	U22	Univ. Nacional de Costa Rica (UNA)	BSc in Systems Engineering
	U23	Univ. Latina (ULATINA)	BSc in Information Systems Engineering

Country		University	Degree Course
Cuba	U24	Univ. de las Ciencias Informáticas	Engineering in Computer Sciences
	U25	Univ. Agraria de La Habana	Computer Science Engineering
	U26	Univ. Central de Las Villas	Computer Science Engineering
	U27	Univ. de Camagüey	Computer Science Engineering
	U28	Inst. Sup. Politéc. José Antonio Echeverría	Computer Science Engineering
Ecuador	U29	Escuela Politécnica del Ejército	Engineering in Systems and Computer Science
	U30	Escuela Politécnica Nacional	Engineering in IT Systems and Computing
	U31	Escuela Politécnica de Chimborazo	Engineering in Computer Systems
	U32	Escuela Politécnica del Litoral	Engineering in Computer Sciences
	U33	Univ. Central del Ecuador	Computer Science Engineering
Nicaragua	U34	Univ. Nacional de Ingeniería (UNI)	Engineering in Computing
	U35	Univ. Politécnica de Nicaragua (UPOI)	Engineering in Computing
	U36	Univ. de Ciencia y Tecnología (UNICIT)	Engineering in Systems
	U37	Univ. Americana (UAM)	Engineering in Information systems
	U38	Univ. Nacional Autónoma de Nicaragua (UNAMMA)	Degree in Computer Systems
Paraguay	U39	Univ. Nacional de Asunción	Engineering in Computer Science
	U40	Univ. Nacional de Itapúa	Computer Science Engineering
	U41	Univ. Nacional del Este	Systems Engineering
	U42	Univ. Católica Ntra. Sra. de la Asunción	Computer Science Engineering
	U43	Univ. Nacional de Pilar	Systems Analysis
Peru	U44	Pontificia Univ. Católica del Perú	Computer Science Engineering
	U45	Univ. de Lima	Systems Engineering
	U46	Univ. Nacional de Ingeniería	Systems Engineering
	U47	Univ. Ricardo Palma	Computer Science Engineering
	U48	Univ. de San Martín de Porres	Engineering in Computing and Systems
Uruguay	U49	Universidad de la República	

Table 11

Average presence of the meta-profile competences with the competences of the analysed profiles in each country

cn	Competences	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	Ecuador	Nicaragua	Paraguay	Peru	Uruguay	Average	Category	
	The Professional Practice Dimension														
1	Ability to apply expertise	3.6	2.7	1.2	2.2	1.0	3.0	1.0	2.0	1.8	1	3	1.9	High	
2	Capacity for abstraction	3.4	2.7	0.5	1.6	1.0	2.4	0.2	1.5	1.4	0	1	1.4	Medium	
3	Ability to identify, consider and deal with problems	2.6	2.7	1.6	2.2	1.0	2.4	1.0	2.0	1.5	1	1	1.7	High	
4	Ability to learn and keep up-to-date constantly	3.2	2.7	1.0	1.6	1.0	2.8	0.4	1.2	1.4	1	1	1.6	High	
5	Knowledge of the area of study and profession	3.0	2.7	1.0	2.0	1.0	2.8	1.0	2.4	1.0	1	1	1.7	High	
6	Research capacity	2.8	2.3	0.6	1.0	1.0	1.8	0.8	1.6	1.6	1	0	1.4	Medium	
7	Ability to organise and plan time	1.4	2.0	0.0	0.2	1.0	1.8	0.2	1.2	1.0	1	0	0.9	Medium	
8	Ability to design and manage projects	1.2	2.0	0.8	1.4	1.0	1.8	0.6	1.6	1.0	1	1	1.2	Medium	
9	Capacity for teamwork	2.6	2.0	1.6	1.2	0.8	2.6	0.4	1.4	1.4	1	1	1.5	High	
10	Ability to work within international contexts	1.4	2.0	0.6	0.8	0.8	1.8	0.4	1.2	0.4	0	0	0.9	Medium	
11	Ability to communicate in a second language	1.4	1.3	1.2	0.2	1.0	1.8	0.4	0.2	0.4	0	0	0.8	Low	1.4

cn	Competences	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	Ecuador	Nicaragua	Paraguay	Peru	Uruguay	Average	Category	
The Social Responsibility Dimension															
12	Ethical commitment	3.2	2.3	0.8	1.0	1.0	3.0	0.8	1.4	1.0	1	1	1.5	High	
13	Social responsibility and civil citizenship	2.8	1.3	1.2	0.8	0.8	3.0	1.0	1.6	1.2	1	1	1.5	High	
14	Commitment to environmental conservation	1.0	1.3	0.4	0.4	0.4	2.0	0.6	1.0	0.8	0	0	0.8	Low	
15	Commitment to their socio-cultural milieu	1.4	1.3	1.0	0.8	0.8	2.2	0.6	1.2	0.6	1	1	1.1	Medium	
16	Appreciation and respect for diversity and multiculturalism	2.0	1.7	0.2	0.0	0.4	2.4	0.4	0.8	0.8	1	0	0.8	Low	1.1
The Dimension of Subject-specific Aspects The Area of Computer Science Principles															
17	Implementing knowledge of Computer Sciences	3.6	2.7	2.2	1.6	1.0	3.0	1.0	2.6	1.2	1	1	1.9	High	
18	Implementing a systemic approach to analysing and dealing with problems	3.6	2.3	0.2	1.2	1.0	2.0	0.0	2.4	1.2	1	1	1.4	Medium	
The Area of Management and Leadership															
19	Playing different roles in IT projects	2.6	2.0	2.0	1.2	0.4	2.0	1.4	1.8	1.2	1	1	1.5	High	
20	Assimilating emerging technological and social changes	2.6	2.7	1.4	1.0	0.8	2.0	0.4	2.0	1.0	1	1	1.4	Medium	
22	Understanding and applying ethical, legal and economic concepts	1.8	1.7	0.8	1.6	0.8	1.8	1.2	0.8	0.8	1	1	1.2	Medium	

cn	Competences	Bolivia	Brazil	Chile	Colombia	Costa Rica	Cuba	Ecuador	Nicaragua	Paraguay	Peru	Uruguay	Average	Category	
The Area of Innovation															
21	Identifying opportunities in order to improve performance	2.2	2.6	2.6	1.6	0.4	2.0	0.2	1.8	0.8	1	1	1.4	Medium	
The Area of Quality															
23	Conceiving, designing, developing and carrying out IT solutions	2.8	2.7	2.0	1.2	1.0	1.8	0.2	1.4	1.2	1	2	1.5	High	
24	Implementing quality standards in development and assessment	2.0	2.3	0.4	0.6	1.0	1.8	0.4	0.8	1.4	1	1	1.1	Medium	1.5
													11	Medium	
													3	Low	

2.8.2. *Consolidated contrasting*

Table 11 shows the consolidated results of the competences attached to the meta-profile for the subject of Computer Science compared to the profiles analysed in each country. The figures in the columns show the average number of times each competence appears in the profiles analysed. The second-to-last column shows the total average value, and the last shows the average level of competence presence, calculated according to the total average values for the competences. 3 categories were defined for levels of presence: High, if the average is higher or equal to 1.5; Medium, if the average is higher or equal to 0.85 and lower than 1.5; and Low, if the average is lower than 0.85.

2.8.3. *Results*

Table 12 shows the number of competences classified according to High, Medium or Low presence according to their total average presence values in the profiles analysed.

Table 12
Number of competences with high, medium and low presence

Category	Number of competences
High: total average>= 1.5	10
Medium: total average >= 0.85 and < 1.5	11
Low: total average < 0.85	3

Comparison of the meta-profile with the 49 analysed profiles gave a fairly satisfactory competence presence, seeing that 10 fall within the High category, 11 Medium and just 3 have a low presence. The latter correspond to the competences: *Ability to communicate in a second language, Commitment to environmental conservation and Appreciation* and *respect for diversity and multiculturalism*.

It can also be seen that the dimensions of Subject-specific Aspects and Professional Practice are present in the profiles, with indicator averages of 1.5 and 1.4 respectively, and the dimension of Social Responsibility with 1.1.

3

Future scenarios for the Area of Computer Science

Efforts were made to identify future scenarios for each subject area within the project framework in the hope of foreseeing new, emerging professions and the new competences they might require. Prominent figures in the discipline from each country were interviewed, who gave their views on the evolution of computer science and its applications in the coming 15 to 20 years. 35 interviews were conducted in the area - 19 of the interviewees were from the scientific-academic field, plus 15 entrepreneurs and 1 government official. Only 3 of the interviewees were women. 75% of the interviewees hold Master's degrees and 59% of the PhDs are in the area of computer science. 77% of the interviewees have been working for 15 years or longer, 20% between 5 and 15 years and 3% have less than 5 years' work experience.

3.1. Future scenarios for the Area

The overall view of the future obtained from the interviews can be summed up by the following trends:

- The Internet will become the main infrastructure of collaborative work and business.

- Professional performance will be accentuated in a globalised society with practically no borders.

- Complex and unpredictable social, political and economic changes are impending, with critical aspects concerning energy issues and basic resources.

- Computer Science will continue to play an important role as a driving force that will shape the changes foreseen regionally and globally at a personal and organisational level.

3.2. New professions in the Area

The interviewees were somewhat unsure of future scenarios for new professions owing to the rapid changes characterising contemporary society. A small group show concerns about energy and environmental issues, and there are views expressed on highly-flexible and adaptable education models and the intensive use of technologies, social service applications and so on.

In most of the scenarios, professionals will need to be able to perform in multidisciplinary environments, such as justice, economics, medicine, transport and others, where they must be able to understand different kinds of problems, and highlight their competences in abstraction, analysis and synthesis.

The profession might evolve towards the concept of information as a raw material, located at the centre of generating solutions for a complex and wide-ranging set of problems. In this respect, three, non-exclusive professional profiles were envisaged:

1. Professional profiles and competences based on the essential nature of the subject, enabling there to be constant change, adaptability to the environment and an increase in the profession's formality.

2. Professional profiles and competences based on specificity, enabling specific areas of application to be rapidly assimilated.

3. The possible assimilation of the essence of the profession by other subject areas that gain competences and replace future computer experts in the development of IT solutions in order to specific problems.

3.3. Competences required

The opinions received were classified and counted by using the competences included in the project as a reference. In the case of the subject-specific competences for the area, two answers were found that were deemed a new competence which, in principle, had not been identified within the project framework: «*Generating knowledge from information*». As for generic competences, 6 of those identified in the context of the Tuning Latin America project failed to be mentioned by the interviewees. Tables 13 and 14 show the generic and subject-specific competences, respectively, and the frequency with which they were mentioned by interviewees.

Table 13
Generic competences mentioned by the interviewees, and their frequency

	Competence	**Occurrence**
10	Ability to learn and keep constantly up-to-date	8
17	Capacity for teamwork	7
14	Creative capacity	6
6	Capacity for oral and written communication	5
7	Ability to communicate in a second language	5
23	Ability to work within international contexts	4
1	Capacity for abstraction, analysis and synthesis	3
2	Ability to apply expertise in practice	3
26	Ethical commitment	3
9	Research capacity	3
25	Ability to design and manage projects	2
16	Capacity for decision making	2
13	Ability to act in new situations	2
21	Commitment to their socio-cultural milieu	2
11	Ability to search for, process and analyse information deriving from different sources	2
3	Ability to organise and plan time	1

	Competence	Occurrence
5	Social responsibility and citizenship	1
8	Skill in the use of information and communications technologies	1
24	Ability to work autonomously	1
20	Commitment to environmental conservation	1
22	Appreciation and respect for diversity and multiculturalism	1
15	Ability to identify, consider and deal with problems	0
4	Knowledge of the area of study and profession	0
27	Commitment to quality	0
18	Interpersonal skills	0
12	Critical and self-critical capacity	0
19	Ability to motivate and steer towards common aims	0

Table 14
Subject-specific competences mentioned by the interviewees, and their frequency

	Competence	Occurrence
1	Implementing knowledge of Computer Sciences, Information Technology and Organisations in order to develop IT solutions.	6
4	Applying mathematical principles, algorithmic principles and Computer Science theory in order to model and design IT solutions	6
11	Spearheading entrepreneurial ventures in order to create new products and services linked to information technology	5
5	Playing different roles in IT projects within both local and globalised, multidisciplinary and multicultural contexts	4
8	Leading processes that incorporate, adapt, transfer and produce IT solutions in order to support the strategic aims of organisations	4
13	Assimilating emerging technological and social changes	3
2	Conceiving, designing, developing and carrying out IT solutions based on principles of engineering and quality standards.	2
10	Understanding and applying ethical, legal, economic and financial concepts in order to take decisions and manage IT projects	2

	Competence	Occurrence
3	Implementing a systemic approach to analysing and dealing with problems	1
6	Implementing knowledge independently and innovatively in the pursuit of IT solutions, with social responsibility and commitment	1
7	Identifying opportunities in order to remedy redundancy in organisations via the efficient and effective use of IT solutions	1
9	Implementing quality standards in IT solutions development and assessment	1
12	Implementing research methodologies when pursuing, substantiating and preparing IT solutions	1

Some significant comments made by some interviewees concern the *creation of new technological paradigms, greater virtualisation of relations between people and between organisations,* and the *moral and ethical degradation of society.* Education, in a broad sense, must be the agent of change. It must regain its social function with regard to the development of values which allow the foundations to be rebuilt for a society that gives everyone the chance to develop their abilities and interests within an environment of respect and solidarity.

4

Student academic workload

The Tuning Latin America project included the definition of a credit reference system for Latin America which reflects effort in terms of the time that students set aside for the curricular activities of their degree programme, whether they be those performed with support from lecturers and tutors or those performed individually and autonomously or in groups. In 2012, a study was carried out on the time students devoted to their different subjects throughout one semester, in the countries represented in the group. A semester was chosen that was neither at the beginning nor the end of the programme, such as the fifth or sixth semester. Using a system of questionnaires distributed to students and teaching staff, each country's representative determined the time spent by students on their academic activities during the chosen semester. The layout of the questionnaire was the same for all subject areas and countries taking part in the Latin America project, and included questions on: the number and duration of contact sessions; the number of lectures students failed to attend; time devoted to non-face-to-face activities, etc. The non-face-to-face activities that were assessed are as follows:

a) Reading texts or bibliography.

b) Preparing and developing assignments.

c) Fieldwork.

d) Laboratory.

e) Preparing and developing written assignments.

f) Virtual activities.

g) Studying for assessment purposes.

h) Others to be specified.

Lecturers teaching the chosen subjects were also asked about their estimations regarding the number of non-contact hours their students should devote to the subject, and whether these contrasted with their students' estimations, in addition to other questions.

The total number of completed questionnaires in the project was 10,086 from a total of 189 establishments. Of these, 892 questionnaires from 14 degree programmes were received in the subject area of Computer Science, with an average of 64 questionnaires per establishment or country. The results provide an overall approximation of the time students claim they spend and the time lecturers estimate students set aside for academic work in their subjects.

In the subject area of Computer Science, students stated that on average they devoted a total of 691 hours during the semester, and lecturers stated that students should spend an average of 664 hours. The average number of weeks per semester was 14.2 weeks, which works out at an average of 46 hours per week according to student data, and 44.3 hours according to lecturers. These values proved to be quite close, with the time stated by students being only 4% longer than that stated by lecturers.

The data obtained in the 15 project areas was used to establish and form a basis for the definitions of the credit reference system for Latin America, whose details can be found in the publication CLAR: Crédito Latinoamericano de Referencia, recently published by the University of Deusto (CLAR, 2013), and on the website: http://www.tuningal.org/es/publicaciones

5

Teaching, learning and assessment strategies for competences

Degree programmes must ensure that the professionals they train develop the competences defined in the graduate profiles. Within this context, the group analysed the teaching and learning strategies which most encourage students to acquire meta-profile competences. Furthermore, assessment strategies were identified that report on the progress and development level students achieve in their degree courses.

The competences most needed by industry and society were analysed in the Computer Science group, and two competences were chosen (one generic and one subject-specific) to help to describe teaching, learning and assessment strategies suited to the development of these competences.

The first step was to determine the learning results associated with each competence, taking into consideration the definition of the following learning levels:

- *Knowledge*: The student understands a concept and its meaning.
- *Application*: The student specifically applies a concept to a particular context.
- *Assessment*: The student considers a concept from different points of view and justifies the selection of a technique or method in order to deal with a problem.

5.1. Definition of competences and learning results

5.1.1. *Example of a generic competence*

Competence

Social Responsibility and Civil Commitment (G5)

Description

Students use knowledge and sensitivity towards social, economic and political realities in order to act with solidarity and civic responsibility so as to improve their community's quality of life, particularly in the most deprived areas. Moreover, they manage the impact caused by technological development with the aim of narrowing the digital gap.

Learning results

- Developing knowledge, attitudes and abilities in order to engage in dealing with problems concerning the community that are relevant to its social, economic and political reality (knowledge).
- Identifying ICT intervention opportunities in coordinated action in order to deal with problems concerning their community in a caring and participative way (application).
- Undertaking specific action in order to narrow the digital gap, whilst respecting multiculturalism (application).
- Arguing the impact of applying their expertise to their environment (assessment).
- Respecting community rules and the pursuit of common wellbeing (application).

5.1.2. *Example of a competence*

Competence

Applying quality standards to the development and assessment of IT solutions (S8).

Description

Students are to apply methodologies, tools and international standards in software development and the assessment of IT solutions.

Learning results

- Describing the role of quality assurance activities in the development process of IT solutions (knowledge).
- Explaining different process improvement models (knowledge).
- Applying quality standards to the development process (analysis, design, encryption, trials, documentation), whilst taking into account the different programming paradigms (application).
- Using a process improvement model, such as PSP, to assess a software development effort, and recommending approaches for improvement (application).
- Performing assessment and audit processes using recognised tools and reference frameworks (application).
- Defending the quality model selected for the IT solution (assessment).

5.2. Teaching, learning and assessment strategies

Teaching and learning strategies were identified in order to carry out this analysis, as were appropriate assessment techniques and tools, so that students could achieve the respective learning results. The teaching and learning strategies are listed and described below.

5.2.1. *Teaching and learning strategies*

Master class

Explanatory method, where the lecturer is responsible for instruction.

Case studies

In case-based learning, students learn on the basis of real-life experiences and situations. This enables them to build their own learning with elements within a context that draws them closer to their environment. It is a link between theory and practice. Lecturers must ensure that students have a sound theoretical grounding to work with and that they transfer their expertise to a real situation.

Problem-based learning (PBL)

This is an educational approach aimed at learning and instruction, whereby students address problems in small groups under a tutor's supervision.

Project-oriented learning (POL)

POL is a strategy involving students in projects, and focuses on the concepts and principles of one or several disciplines in order to deal with problems or undertake other important tasks. A project is an effort made during a specific period of time in order to achieve the specific aim of creating a unique service or product by undertaking a number of tasks and using resources effectively.

Collaborative learning (CL)

Collaborative work is defined as a group's intentional processes in order to achieve specific aims, plus the tools designed to give support and make the job easier. Collaborative learning is a didactic technique that needs to address aspects such as respect towards group members' individual contributions and abilities in order to ensure learning and achieve the set aims.

Graphic Organisers (mind maps, concept maps)

These are active learning techniques whereby concepts are represented by visual aids.

National and international internship

This is professional placement or work placement which students undertake after having completed a certain proportion of the programme. It is aimed at allowing students to gain real experience in their professional field of work. Internships can be either national or international. This is closely related to

Professional Practice

Professional Practice consists of a guided and supervised assignment in a company or organisation, where the expertise acquired during students' educational process is brought into play. It allows students to substantiate theories by applying them to actual problem situations.

Integrative Project

A project carried out every block of academic periods (3 or 4) in order to integrate knowledge from the subjects studied up to that time. This project must have curricular value (academic workload) and be supervised by a lecturer so that occasional guidance can be given on the competences that students wish to develop in the project and the knowledge they intend to integrate - for example, developing a video game that combines expertise in Mathematics, Physics, Programming, and has a sustainable approach to development (ecology).

Workshops

Learning experiences in small groups where theory and practice are combined.

Forums

Everyone attending a meeting has the chance to take part in forums, organised to address and discuss a certain topic or issue. They can be conducted following an activity deemed by the audience to be of general interest.

Tutorial

A didactic technique enabling students to be assisted individually in order to answer their queries.

Laboratory

This is an educational strategy where the predominant activity is the experimentation and verification of working hypotheses.

Learning and service

A Social Responsibility project developed within a subject with academic content, projects on specialisation can aim at dealing with a specific problem in a community by applying specific expertise from the subject. The way of measuring this type of project is via community satisfaction and project impact.

Community work or social service

Social service is understood as referring to the theoretical and practical application of knowledge in activities that affirm and broaden academic education and foster awareness of solidarity with the local community, which is reflected in benefits for society.

End-of-degree assignment: Thesis

A thesis is a postulate which, following a research process, can be upheld as a truth, and which may be scientific, depending on the assignment's field and scope. Theses are normally conducted in order to obtain certain academic qualifications by responding to certain research issues.

End-of-degree assignment: Degree Assignment

A project that systematically targets the specific needs or problems of a certain degree course area, generally required in order to complete pre-graduate studies.

Monograph

In broad terms, a monograph could be defined as a piece of work consisting of an argumentative text with an informative function, arranged according to the data obtained based on the chosen subject, and which conducts a full analysis by taking information from several sources and giving a critical reflection on the subject. The assignment is performed in writing, with clear, precise language and correct spelling, and may be explained or defended orally in front of a group of listeners, using correct expressions and clear vocabulary and ideas.

5.2.2. *Assessment techniques and tools*

In order to assess learning results, the following should be taken into account: who is responsible for assessment and what assessment techniques and tools will be used. According to those responsible, three types of assessment are taken into consideration:

- Teacher-assessment: the assessment the lecturer makes of the student.
- Peer-assessment: the assessment where students assess one another.
- Self-assessment: the assessment the actual student makes of him or herself.

Each technique consists of a set of tools, as summarised in Table 15.

Table 15
List of assessment techniques and tools

Technique	Tool
Observation	Observation sheet; Check list; Questionnaire
Interview	Individual/group interview sheet
Questionnaire	Written or oral test
Task analysis	Technical report; Assignment presentation (oral and/or written); Concept maps; Assessment centre

In addition to the tools shown in Table 15, the rubrics are included, which can be applied in conjunction with some tools as a complement. A brief description of the tools is given below.

Observation sheets

These allow information to be collected on students' everyday behaviour. It is important to record conduct systematically so as to be able to assess the information gathered appropriately.

Check lists

These lists are especially useful to express abstract concepts in terms of observable conduct. Check lists are used to determine whether a type of conduct exists or not among students.

Questionnaire

A questionnaire is an observational study in which the researcher aims to obtain data by means of a pre-designed questionnaire. It does not modify the environment or control the process under observation.

Individual/group interview sheet

This allows information to be collected by means of questions on certain aspects (expertise, attitudes, beliefs and interests) that wish to be known for assessment purposes, according to different aims. It should be used frequently in ongoing assessments throughout the learning process, and also to explore expectations, knowledge and experiences prior to commencement of a learning period.

Written or oral test

This is a questionnaire allowing information to be collected on student learning, abilities, attitudes and so on. It can be carried out orally or in writing.

Technical reports

A technical report is a written statement of facts observed via questionnaires or experiments on the question posed, with detailed explanations proving what is stated.

Assignment presentation (oral and/or written)

A written assignment is a comprehensive document that follows an established script and addresses one or several topics related to each other where, by way of a summary, the most important aspects are set out. It is normally laid out with a title, introduction, well-founded framework, results and bibliography. This assignment may also be presented orally.

Concept maps

These are used to represent knowledge graphically that is generally expressed by means of a concept network. In the network, the nodes represent concepts and the links, relationships between concepts.

Assessment centre

This is a mechanism which has been designed to assess competences by observing the behaviour displayed by students in the final semesters when faced with situations similar to those that they will need to face in the work environment. Unlike other assessment methods, the assessment centre is not interpretative, as its objectivity is based on being able to assess students' reactions, responses and solutions when interacting with other students.

Rubric

This is a tool used to measure a task or activity's level and quality. Rubrics give descriptions of the criteria for assessing work and the scores awarded to each criterion.

Tables 16 and 17 give a summary of the teaching and learning techniques, and the assessment tools associated with the learning results of the generic and subject-specific competences selected, respectively.

Table 16
Teaching and learning techniques, and assessment tools associated with the learning results (generic competence)

Generic competence: *social and civil commitment (GS)* **Teaching, learning and assessment →** **Vs. Learning results ↓**	**Teaching and learning techniques**							**Assessment tools**							
	Master class	**Learning and service**	**Case studies**	**Community work**	**Internships**	**Pre-professional vocational education**	**End-of-degree assignment**	**Observation sheets**	**Check list**	**Individual/group interview sheet**	**Written or oral test**	**Technical report**	**Assignment presentation (oral and/or written)**	**Concept maps**	**Questionnaires**
G5.1 Developing knowledge, attitudes and abilities in order to engage in dealing with problems concerning the community that are relevant to its social, economic and political reality (knowledge)	X		X								X		X	X	
G5.2 Identifying ICT intervention opportunities in coordinated action in order to deal with problems concerning their community in a caring and participative way (application)		X		X	X	X	X	X	X	X		X	X		
G5.3 Undertaking specific action in order to narrow the digital gap, whilst respecting multiculturalism (application)		X		X	X	X		X	X			X	X		X
G5.4 Arguing the impact of applying their expertise to their environment (assessment)	X	X	X									X	X		X
G5.5 Respecting community rules and the pursuit of common wellbeing (application)		X		X	X	X		X	X	X					X

Table 17

Teaching and learning techniques, and assessment tools associated with the learning results (specific competence)

Specific competence: ***applying quality standards in the development and assessment of IT solutions (SS)*** **Teaching, learning and assessment →** **Vs.** **Learning results** **↓**	**Teaching and learning techniques**														**Assessment tools**							
	Master class	**Case studies**	**Problem-based learning (PBL)**	**Project-based learning (PBL)**	**Collaborative learning (CL)**	**Graphic organisers (concept maps)**	**National and international internships**	**Integrative project**	**Workshops**	**Forums**	**Tutorials**	**Laboratory**	**Pre-professional vocational education**	**End-of-degree assignment**	**Observation sheets**	**Check lists**	**Individual/group interview sheet**	**Written or oral test**	**Technical report**	**Assignment presentation (oral and/or written)**	**Concept maps**	***Assessment Centre***
EB.1 Describing the role of quality assurance activities in the development process of IT solutions (knowledge)	X				X	X				X	X							X			X	
EB.2 Explaining different process improvement models (knowledge)	X	X			X	X				X	X							X		X	X	
EB.3 Applying quality standards to the development process (analysis, design, encryption, trials and documentation), taking into account the different programming paradigms (application)	X		X	X	X	X	X	X	X			X	X	X	X	X	X		X	X		X
EB.4 Using a process improvement model, such as PSP, to assess a software development effort, and recommending approaches for improvement (application)	X		X	X	X	X	X	X					X	X	X	X	X			X		X
EB.5 Performing assessment and audit processes using recognised tools and reference frameworks (application)		X	X	X	X		X	X					X		X	X	X		X	X		X
EB.6 Defending the quality model selected for the IT solution (assessment)		X		X	X									X	X	X	X			X		X

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Conclusions

The meta-profile for the Area of Computer Science in the Tuning Latin America project is the result of collaborative work carried out on a Latin American scale in order to determine the qualities expected of computer science students at the time of completing their degree studies. Even though two important countries in computer and industrial education (Argentina and Venezuela) did not participate in the work carried out on the area, the group represented 81% of the Latin American population. There will be no difficulty in sharing the project results with our Argentine and Venezuelan colleagues, and including their views on the discipline.

Having an agreed and representative profile available is also a concrete step towards the curricular convergence of the subject area of Computer Science in Latin America, which will facilitate the recognition of different countries' degree programmes, expanding and diversifying with it the range of education and facilitating the recognition of learning and qualifications obtained in different educational establishments and countries. This will also facilitate mobility and student and academic collaboration. Benefits are also envisaged for curricular updating processes, where the results achieved in the area could be used as important references.

The result of the meta-profile competence comparisons with the profiles of prominent degree courses in the countries in the area is auspicious, since most of the abilities and skills that act as the basis of the meta-profile are present in most of the profiles analysed. It should be taken into account that many higher educational establishments are redefining their educational models and adjusting their outlooks on vocational education in the face of the new social, political, economic and technological scenarios emerging in society, and it is highly likely that competences which have little presence today will be included in new graduate profiles.

The teaching, learning and assessment strategies put forward for the development of competences are presented as recommendations which lecturers might consider implementing in their teaching activities. They highlight teaching methodologies for active, collaborative learning, particularly the study and discussion of cases, learning based on problem-solving and project-based learning. A task that remains to be carried out is to continue work on determining learning results, teaching strategies and ways of assessing all the meta-profile competences, which will greatly contribute towards developing and updating degree programmes. Significant progress has been made in the knowledge and experience of active and collaborative learning methodologies in this field over the past few decades, but little in competence assessment and certification, particularly «barely visible» or «barely tangible» competences, such as creativity, innovation, abstraction, leadership, ethical education and others. This field is still undoubtedly the haziest with regard to education aimed at competence development.

On the other hand, Computer Science continues to evolve and new areas of application emerge daily. Similarly, social, political and economic contexts are also constantly changing, giving rise to a great deal of uncertainty among people with regard to the near future. Hence, it is important that Computer Science professionals constantly update and further their expertise and competences so as to adapt to the increasingly dynamic, complex and unpredictable scenarios that characterise the contemporary, globalised world. Within this context, it must be remembered that Computer Science knows no borders and its professionals must prepare themselves to work with the entire planet as their workplace. This is undoubtedly one of the major challenges facing educational establishments with regard to educating professionals.

It is hoped that the results of the work carried out by the Computer Science Area members, within the context of the Tuning Latin America project, will provide specific contributions that may produce better curricular proposals for educating Computer Science professionals and create a Latin American Higher Education Area.

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