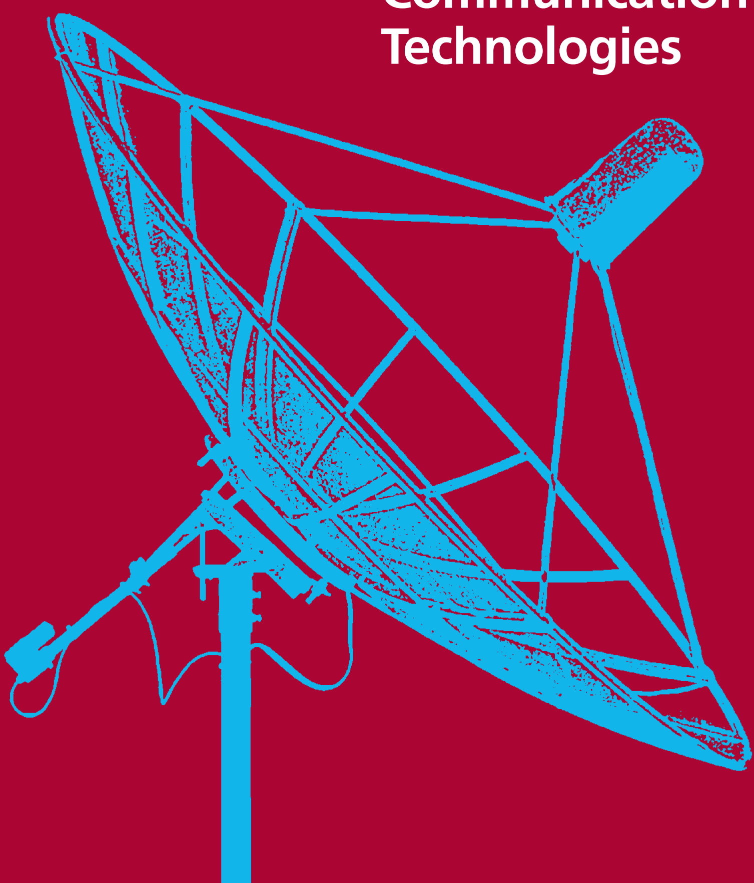
Tuning

Russia

# Reference Points for the Design and Delivery of Degree Programmes in Information and Communication Technologies



# Reference Points for the Design and Delivery of Degree Programmes in Information and Communication Technologies

© University of Deusto - ISBN 978-84-15772-25-5

Tuning Russia

# Reference Points for the Design and Delivery of Degree Programmes in Information and Communication Technologies

2013
University of Deusto
Bilbao

**Reference Points for the Design and Delivery of Degree Programmes in Information and Communication Technologies**

Reference Points are non-prescriptive indicators and general recommendations that aim to support the design, delivery and articulation of degree programmes in Information and Communication Technologies. The document has been developed by subject area group, including experts from Russian and European universities, in consultation with different stakeholders (academics, employers, students and graduates).

This publication has been prepared within Tuning Russia project 51113S-TEMPUS-I-2010-1-ES-TEMPUS-JPCR. This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Editors:
Dyukarev Ivan, University of Deusto (Spain)
Rayon Alex, University of Deusto (Spain)
Karavaeva Evgeniya, Association of the Classical Universities of Russia (Russia)

Authors:
Petrova Irina, Astrakhan State University (Russia)
Zaripova Viktoriya, Astrakhan State University (Russia)
Ishkina Evgeniya, Astrakhan State University (Russia)
Militskaya Svetlana, Astrakhan State University (Russia)
Malikov Andrei, North-Caucasus Federal University (Russia)
Kurmishev Nikolai, Yaroslav-the-Wise Novgorod State University (Russia)
Kuzenkov Oleg, N.I.Lobachevsky State University of Nizhni Novgorod (Russia)
Varfolomeev Viktor, Moscow State University of Railway Engineering (Russia)
Zakharova Irina, Tver State University (Russia)


P. Box 1 - 48080 Bilbao
e-mail: publicaciones@deusto.es

ISBN: 978-84-15772-25-5

Legal deposit: BI - 1.798-2013

Printed in Spain

# Content

© University of Deusto - ISBN 978-84-15772-25-5

# Preface

Tuning started as a project in 2000, initiated by higher education institutions and their academics, and strongly supported morally and financially by the European Commission. Over time Tuning has moved beyond the EU and gradually transformed itself into a global methodological system covering educational sectors in many regions of the world.

Androulla Vassiliou, the European Commissioner for Education, Culture, Multilingualism and Youth, underlined when closing the "Tuning in the World: New Degree Profiles for New Societies" Conference in Brussels on 21 November 2012, that whilst Tuning started as an attempt to solve a strictly European problem, it has become a methodology that can be adapted to different higher education structures in very different cultural contexts and that the commitment of the universities, the associations and the national authorities involved is key to the continuing success of this initiative.

The Tuning Russia project has been designed as an independent university-driven project with contributions of university staff members from different countries. The Tuning Russia project reflects the idea that universities do not look for the harmonisation of their degree programmes or any sort of unified, prescriptive or definitive curricula; but, simply for points of convergence and common understanding. The protection of the rich diversity of education has been paramount in the Tuning project from the very start and the Tuning Russia project in no way seeks to restrict the independence of academic and subject specialists, or damage local and national academic authorities. The objectives are completely different. Tuning looks for common reference points. The Reference points are non-prescriptive indicators that aim to support the articulation of degree programmes.

The publication of the "Tuning Russia Reference Points" series became a reality due to collective work of Subject Area Groups and project teams at participating European and Russian universities, their academic and administrative personnel to whom we would like to express our sincere gratitude. We stress our deep appreciation to all European and Russian experts who have made a significant contribution to the development of reference points for the design and delivery of degree programmes in various subject areas.

The Tuning process in Russia has been supported by the National Tempus Office in the Russian Federation from the very beginning of the project. Our special thanks go to Director Olga Oleynikova, whose support and recommendations were invaluably important during the implementation of the project. The project and this publication would not have been possible without the coordination and recommendations of Tuning General Co-Coordinators Julia González and Robert Wagenaar.

We hope that readers will find this book both useful and interesting.

*Pablo Beneitone*
Director of the International Tuning Academy,
University of Deusto (Spain)

*Ivan Dyukarev*
Tuning Russia Project Manager, International Tuning Academy,
University of Deusto (Spain)

*Evgeniya Karavaeva*
Tuning Russia Co-Manager, ACUR Executive Director,
Association of the Classical Universities of Russia (Russia)

*Artur Demchuk*
ACUR Coordinator for Academic Mobility,
Association of the Classical Universities of Russia (Russia)

# 1

# General Introduction

The convergence of national educational systems within the EU is an important milestone in the global development of modern higher education in the 21st century. The day when the Bologna Declaration[1] was signed (19 June 1999), is considered the official starting point of the harmonization process of higher education systems within Europe, a process whose end aim consists in the creation of the European Higher Education Area (EHEA). Russia joined the Bologna process in September 2003 at the Berlin Conference of European Ministers in charge of Higher Education.

Signing the Bologna Declaration has led to a series of reforms in the educational systems of the majority of European countries. For higher education institutions (HEIs) these reforms consist in tuning basic teaching programmes in terms of both the structure and the outcomes of degrees. A prominent role should be given to the graduate and degree profiles so that they meet the needs of both the labour market and society, as well as to the specific tasks an academic community has to solve. Therefore, it is particularly important to express all the various educational levels in terms of competences and learning outcomes.

## 1.1. The contribution of universities to the Bologna Process and Tuning

It is well known that the Tuning Project —"Tuning educational structures"— has developed within the broader context of continuous

---

[1] The Bologna Declaration on the European space for higher education. http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf

reforms of European higher education systems, when society at large has been undergoing rapid changes. The name Tuning was chosen for the project to reflect the idea that universities do not look for uniformity in their degree programmes or any sort of unified, prescriptive or definitive European curricula but simply for points of reference, convergence and common understanding. The protection of the rich diversity of European education has been paramount in the Tuning Project from the very start and the project in no way seeks to restrict the independence of academic and subject specialists, or undermine local and national academic authority.

Tuning Educational Structures in Europe[2] started in 2000 as a project to link the political objectives of the Bologna Process and at a later stage the Lisbon Strategy to the higher educational sector. Over time, Tuning has developed into a Process, an approach to (re-) design, develop, implement, evaluate and enhance quality first, second and third cycle degree programmes. The Tuning Project and its methodology constitute one of the academic tools for creating the EHEA. The need for compatible, comparable and competitive higher education in Europe reflects the students' requirements. As student mobility increases, so does the demand for reliable and objective information on the degrees offered by different HEIs. Apart from this, employers both within and outside Europe require reliable information on qualifications awarded and on what these qualifications mean in practice and in the labour market context. Therefore, the process of creating national qualification frameworks is inseparable from the EHEA development process.

Tuning aims to meet the needs of educational institutions and structures and to offer a concrete approach to implementing the Bologna Process at the level of higher education institutions and subject areas. The Tuning approach proposes a methodology to (re-) design, develop, implement and evaluate study programmes for each of the higher education cycles. Furthermore, Tuning serves as a platform for developing reference points at subject area level. These are relevant to making study programmes comparable, compatible and transparent. The agreed-upon reference points for subject areas and their degree programmes are expressed in terms of competences and learning outcomes.

Tuning in general has emerged from the understanding that the Bologna Process is about universities, their students, academic and non-academic

[2] Tuning Educational Structures in Europe. http://www.unideusto.org/tuningeu/

staff. It is they, with all their knowledge and experience, who should be deciding upon higher education innovation strategies. Tuning is a university-driven project and movement, which came into being as a reaction of HEIs to new challenges and new opportunities that emerged within the process of European integration and the creation of the EHEA.

## 1.2. Tuning in Russia

The Tuning methodology, which allowed European Universities to cooperate successfully and coordinate their activities aimed at creating unified educational cycles, uniform requirements for the structure of programmes, the development of common approaches to comparison and the assessment of learning outcomes, has become a "road map" for the Bologna process. Developed within the framework of the "Tuning educational programmes in European universities" project, the Tuning methodology as a universal tool for modernizing curricula in the context of achieving professional competences, has today gone beyond the borders of the EU and has acquired international significance. Universities in different countries and continents in expanding cooperation have increasingly resorted to using it to build joint programmes involving academic mobility, integrated education, introduction of a credit system, the exchange of educational modules and the mutual recognition of qualifications.

Russian Universities are also mastering the principles of the Tuning methodology through incorporating generic and subject specific competence descriptions into educational planning at the level of full degrees and individual degree components. Upon the implementation of the third-generation Federal State Educational Standards[3] based on principles compatible with the Tuning methodology —namely, making use of a credit-modular system, increasing the variety and number of elective courses, placing more emphasis on quality, taking into account professional qualification requirements, etc.— the interest in actively using the Tuning methodology to design educational programmes in different areas has increased significantly.

The first Russian HEIs that supported the need to develop the Tuning methodology were the Higher School of Economics, People's Friendship

[3] Federal State Educational Standards. http://xn--80abucjiibhv9a.xn--p1ai/документы/336

University of Russia and the Tomsk State University. In 2006-2008, within the framework of the "Tuning educational programmes in Russian universities"[4] TEMPUS project, these three centres designed bachelor and master degree programmes in the areas of «European Studies» and «Applied Mathematics».

The next step in the promotion of competence-oriented techniques within the system of higher education in Russia was the participation of Moscow State University, the Russian State University for the Humanities, St. Petersburg State University and Chelyabinsk State University along with the EU partners (2007-2008) in the "Russian Tuning-ECTS based model for the Implementation of the Bologna Process in Human Sciences" (RHUSTE)[5] TEMPUS project. Lists of generic and subject-specific competences and Bachelor's and Master's degree programmes in the areas of *History* and *Cultural Studies* were an outcome of that project. The experience of the reform of higher education in Russia in accordance with the principles of the Bologna process was summed up; Tuning methodology was analysed and recommendations on its implementation within the framework of Russian higher education system were advanced.

The "Tuning Russia"[6] project (TEMPUS, 2010-2013), which has brought together four EU universities (the project coordinator - University of Deusto, Bilbao, Spain; University of Groningen, Groningen, Netherlands; Trinity College Dublin, Dublin, Ireland; University of Padua, Padua, Italy), 13 Russian Universities (Astrakhan State University; Don State Technical University; Moscow State Academy of Business Administration; Moscow State Oblast (Region) University; Lomonosov Moscow State University; Moscow State University of Railway Engineering; N.I. Lobachevsky State University of Nizhni Novgorod; Yaroslav-the-Wise Novgorod State University; Russian State University for the Humanities; North Caucasus Federal University; Tver State University; Lev Tolstoy Tula State Pedagogical University; Udmurt State University) and the Association of the Classical Universities of Russia, tries to institutionalise the use of the Tuning methodology in the Russian Federation's educational practice. Its aim is to create a network of Tuning Centres in Russia and to develop a common

---

[4] Tuning educational programs in Russian universities. http://www.hse.ru/org/hse/iori/pr15

[5] Russian Tuning-ECTS based model for the Implementation of the Bologna Process in Human Sciences (RHUSTE) http://ru-ects.csu.ru/

[6] Tuning Russia. http://tuningrussia.org/

list of generic and subject-specific competences which will be used later on in the process of structuring and describing higher education degree programmes of all levels in the following subject areas: Ecology, Economics and Management, Education, Environmental Engineering, Information and Communication Technologies, Languages, Law, Social Work, and Tourism.

This book contains the key general findings of the Subject Area Group within the Tuning Russia project. These reflect in synthesis the consensus reached by the group members and international experts on the subjects mentioned above. We hope and believe that the material contained in this book will be very useful for all higher education institutions wishing to implement the Bologna Process, and that it will help them to find and use the most suitable tools for adapting or creating higher education programmes in order to respond to the needs of today's society.

*Julia González* and *Robert Wagenaar*
Tuning General Co-Coordinators

# 2

# Introduction to the subject area ICT

## 2.1. Definition of the subject area

The history of ICT subject area is systematically presented in the papers of P.J. Denning [1], V.A. Sukhomlin [2], V.E. Wolfengagen [3,4] as well as in papers [5,7-11] of the joint expert group of international professional organizations of ACM (Association for Computing Machinery) and IEEE-CS (Computer Society of the IEEE, or IEEIL-CS), AIS (The Association for Information Systems) and AITP (The Association for Information Technology Professionals). The most generalized and methodologically verified of these papers is Computing Curricula 2005 (CC2005) [5]. Thus, in international education, since 1989 the IT staff-training domain has been called Computing. A modern and very general definition of the Computing term is given in the CC2005 report: it is defined as any kind of technical activity involving computers. For example, hardware and software design and development; data processing, structuring and management; carrying out research using computers; intelligent computer systems development; creating and using communication and multimedia environments; retrieve and accumulation of relevant information for a specific purpose, etc.

Computing as an academic discipline is considered as an integral discipline covering a wide range of more specialized scientific and applied disciplines such as computer science, artificial intelligence, computer networks, computational mathematics, database technologies, information systems, multimedia, bioinformatics, etc.

This is the breadth of information and communication technologies (or computing) area as well as of its applications, which predetermines the necessity to build a multi-disciplinary system for IT professionals training.



© University of Deusto - ISBN 978-84-15772-25-5

Therefore, we attempt in this paper to systematize the different areas of ICT training in Russia, to identify their common ground and to select the common "core" disciplines in the ICT training field.

There are many definitions of information technology and information and communications technology. Some of them are presented below.

Information Technology (IT): processes and methods of information retrieve, acquisition, storage, processing, delivery, and the ways of these processes and methods implementation [12].

Information Technology (IT) – the technology used for the study, understanding, planning, design, construction, testing, distribution, support and operations of software, computers and computer related systems that exist for the purpose of Data, Information and Knowledge processing [6].

Information and Communication Technology (ICT): information processes and methods of information processing implemented using computers and telecommunications [12].

Information and communication technology (ICT) – originally was another IT notion. Now that definition has been expanded to include unified communication technologies (UC) and more. ICT refers to the integration of telecommunications, computers, middleware and the data systems that support, store and transmit UC communications between systems [13].

Information and telecommunication systems is one of prior areas in Russian Federation. The list of prior areas is regularly approved by Presidential Decree. It is one of the main instruments of State policy of Russian Federation for science and technology development. The last version of the list was issued on July 7, 2011. The corresponding critical technologies are the following:

- Technologies of access to broadband multimedia services.
- Technologies of information, control and navigation systems.
- Technologies and software of distributed and high performance computing systems.
- Computer modelling of nanomaterials, nanodevices and nanotechnology.
- Nano-, bio-, information and cognitive technologies.

In the ICT field much scientific research is being carried out in the world, this research being applied as well as fundamental for the evolution of mankind. ICTs are important in interdisciplinary research projects.

## 2.2. Market needs for IT-specialists in Russia

In 2009 the Association of Information Technology and Computer Enterprises with the participation of REAL-IT analytical research centre carried out the research "IT staff 2010". The results of this research contain the number of IT staff in the Russian economy in 2009 and forecast the demand for IT staff for 2010-2015. [14]

The total number of IT specialists in Russia was about 1 million in 2009. According to the Federal State Statistics Services it corresponds to 1,47% of all employees or to 1,34% of the able-bodied population. For comparison, the latter index is 3,74% in USA, 3,16% in UK, and 3,14% in Germany.

Even if we consider the reduction of market needs in new IT-specialists, all graduates in ICT (and related disciplines) stay heavily in demand in the IT industry and Economics of the Russian Federation.

Considering the implementation of a modernization development scenario in the Russian Federation, the required number of IT specialists in the coming years will be several times higher than the number of graduates in corresponding disciplines in Russian universities, and this failure to meet demand will be the main limiting factor for Russia's development.

Structural market changes within the modernization scenario towards IT services and software sectors will shift the demand for specialists of software development, deployment and maintenance, as well as for towards web development and information security specialists.

## 2.3. International professional education standards in the ICT subject area

In international educational practice, IT-staff training has been called Computing since 1989. According to international professional educational standards in the field of ICT called Computing Curricula (CC2005) this domain is divided into 5 separate and independent sub-disciplines which serve as a basis for the corresponding professions [5]:

1. Computer Science,
2. Computer Engineering,
3. Software Engineering,

4. Information Systems,
5. Information Technology.

For the last sub-discipline there is a remark concerning IT concept interpretation. In a wide notion, the IT concept refers to the entire scope of the Computing concept. In the narrow notion the IT concept refers to IT systems forming a modern business information infrastructure. Thus, this sub-discipline focuses on the training of system integrators, developers and maintainers of information infrastructure, their components and networks at enterprises.

The correspondence between degrees in ICT according to the 3rd generation of the Federal State Educational Standards (FSES-3) [15] in Russia and these sub-disciplines of ICT according to Computing Curricula, is presented in table 1.

**Table 1**

Matching of degrees (FSES-3) with professional ICT sub-disciplines (CC2005)

| CC2005 | Federal State Educational Standards for degrees in ICT |
|---|---|
| Computer science | 010200 Mathematics and Computer Science<br>010300 Fundamental Computer Science and Information Technologies<br>010400 Applied Mathematics and Computer Science |
| Information systems | 080500 Business Informatics<br>230700 Applied Computer Science<br>230400 Information Systems and Technologies |
| Software engineering | 010500 Software and Information Systems Management<br>231000 Software Engineering |
| Information technology | 210700 Information and Communication Technologies and Communication Systems<br>230100 Computer Science and Computer Engineering<br>230400 Information Systems and Technologies<br>090900 Information Security<br>090301 Computer Security<br>090302 Information Security of Telecommunication Systems<br>090303 Information Security of Automated Systems<br>090305 Information Analysis Security Systems |
| Computer engineering | 230100 Computer Science and Computer Engineering |

## 2.4. Core knowledge

The concept of core knowledge refers to the minimum required educational content, the implementation of which in all related degree profiles ensures the unity of the educational space, student mobility within the same degree profile or linked profiles, the guarantee of basic training quality.

In [16] the core knowledge for ICT degrees is defined. It includes the following subjects: mathematics, computer science, physics, electrical technology and electronic engineering, metrology, standardization and certification, data management, information network, theory of control, system modelling, software and hardware architecture, operational systems, programming technologies, computer graphics, knowledge representation in information systems. These core subjects focus on training in algorithmics, programming languages, software and hardware architectures.

It should be noted that subjects such as electrical technology and electronic engineering, metrology, standardization and certification, computer graphics were not finally included in the FSES-3 230400 "Information systems and technologies".

The curriculum guide for bachelor degrees in IT published in 2008 by ACM and IEEE CS [11] defines the following core courses: Information Technology Fundamentals, Human Computer Interaction, Information Assurance and Security, Information Management, Integrative Programming & Technologies, Maths and Statistics for IT, Networking, Programming Fundamentals, Platform Technologies, System Administration and Maintenance, System Integration and Architecture, Social and Professional Issues, Web Systems and Technologies.

The results of the comparison of disciplines corresponding to the core knowledge in Russian FSES 230400 "Information systems and technologies" and in the "Information Technology - IT2008" guide of ACM and IEEE CS [11] is presented in table 2.

**Table 2**
Core knowledge comparison in Russian FSES 230400 "Information systems and technologies" and in "Information Technology - IT2008" guide of ACM and IEEE CS

| Mathematics | Maths and Statistics for IT |
|---|---|
| Informatics | Information Technology Fundamentals |
| Physics | |
| Theory of information processes and systems | Information Technology Fundamentals |
| Information Technologies | Information Technology Fundamentals<br>Information Assurance and Security |
| Information systems architecture | Platform Technologies<br>System Administration and Maintenance |
| Programming technologies | Programming Fundamentals<br>Integrative Programming & Technologies |
| Data management | Information Management |
| Information processing technologies | Web Systems and Technologies<br>Human Computer Interaction |
| Intelligent Systems and Technologies | |
| Information systems tools | |
| Information and communication systems and networks | Networking |
| Information systems and technologies design methods and tools | System Integration and Architecture |

It should be noted that the "Social and Professional Issues" section of the "Information Technology – IT2008" guide of ACM and IEEE CS [11] corresponds to the human and social cycle and economic cycle of disciplines in FSES. However, the importance of these issues at the present stage would be difficult to overestimate in the generic competences development for ICT specialists, so below is the content of this section [11]:

*Social and Professional Issues (23 core hours)*

1. SP. Professional Communications (5)
2. SP. Teamwork Concepts and Issues (5)
3. SP. Social Context of Computing (3)
4. SP. Intellectual Property (2)
5. SP. Legal Issues in Computing (2)
6. SP. Organizational Context (2)
7. SP. Professional and Ethical Issues and Responsibilities (2)
8. SP. History of Computing (1)
9. SP. Privacy and Civil Liberties (1)

Professional Communication, teamwork and leadership skills, intellectual property protection issues in ICT professional area, ethical issues represent essential requirements to a set of generic competencies in ICT.

Engineering skills and knowledge in the field of ICT include all aspects of such systems designing and to develop them applied disciplines are used. Courses including practice-oriented modules are aimed at the implementation of the technologies to develop project solutions and to achieve the required result in the most efficient way.

Education in the field of information technologies is to accomplish the following tasks:

1. World view task: to develop a system approach for the problem solving, i.e. the ability to present any object or process as a collection of elements, to detect mechanisms and interrelations between them for the purpose of their more efficient usage.
2. Algorithmic task: to develop the ability to describe precisely the process as a sequence of actions to achieve some results (relating to technical, technological, as well as economic and social processes);
3. Professional task: to develop practical skills for working in the professional sphere and interest in life-long learning.

### 2.5. The relationship of the subject area with other degree programmes

Nowadays specialists in all branches of Economics should have additional competences, particularly in ICT, in order to be able effectively to start or to continue effectively their professional activities in continuous evolution. Therefore, almost all FSES of the third generation include mandatory computer science courses in the science disciplines cycle, as well as special courses on the application of information technologies and systems in any professional field (e.g. IT in medicine, law, journalism etc.). The modernization of higher education programmes, particularly by creating specific educational programs in the field of applied computer science and other disciplines, is the key element of correspondence to the actual needs for specialists. Promoting ICT research is not sufficient, there is a need for the penetration of ICT into other fields and their use for the benefit of society.

ICT plays an important role in research in almost all areas of knowledge. They are physics, mathematics, chemistry, economics, sociology, philosophy, history, language and speech, psychology, and many others.

In turn, there is a significant inverse effect, since knowledge of these areas of science are needed both in the preparation of IT professionals, and in fundamental and applied research in the field of ICT.

# 3

# Qualifications in ICT

The implementation of higher education in the ICT field in international education systems is presented at the following diagram (Fig. 1).

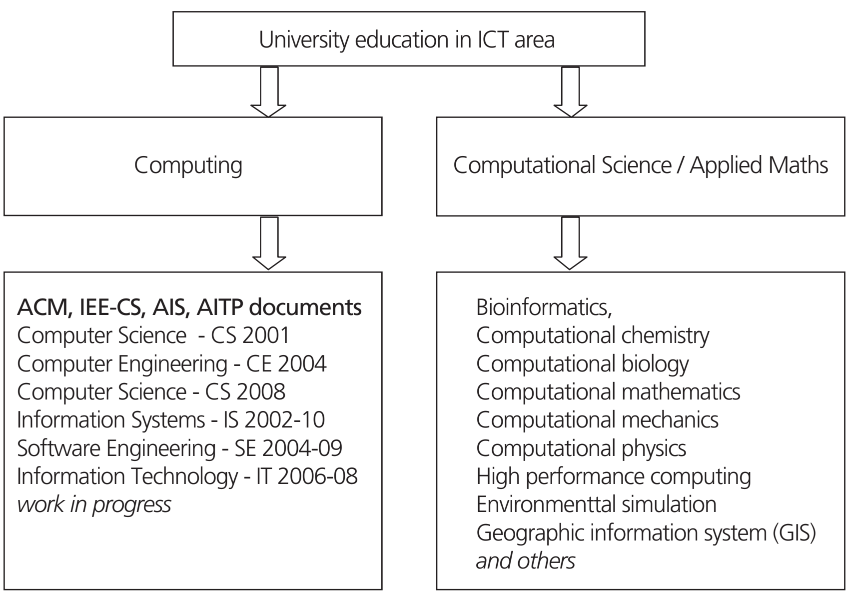



**Figure 1**
The architecture of the international university IT education

In this paper we consider only the sub-disciplines related to computing in accordance with the papers of the ACM, IEEE-CS, AIS, and AITP expert group.

The typical degrees offered within this subject area in the Russian Federation are presented in table 3.

**Table 3**
Typical degrees in ICT

| Cycle | Degree | Qualification awarded | ECTS credits |
|---|---|---|---|
| 1st cycle | 010000 PHYSICAL AND MATHEMATICAL SCIENCE | | |
| | 010200 Mathematics and Computer Science | Bachelor | 240 |
| | 010300 Fundamental Computer Science and Information Technologies | Bachelor | 240 |
| | 010400 Applied Mathematics and Computer Science | Bachelor | 240 |
| | 010500 Software and Information Systems Management | Bachelor | 240 |
| | 080000 ECONOMICS AND MANAGEMENT | | |
| | 080500 Business Informatics | Bachelor | 240 |
| | 210000 ELECTRONIC ENGINEERING, RADIO TECHNOLOGY AND COMMUNICATION | | |
| | 210700 Information and Communication Technologies and Communication Systems | Bachelor | 240 |
| | 230000 COMPUTER SCIENCE AND COMPUTER ENGINEERING | | |
| | 230100 Computer Science and Computer Engineering | Bachelor | 240 |
| | 230400 Information Systems and Technologies | Bachelor | 240 |
| | 230700 Applied Computer Science | Bachelor | 240 |
| | 231000 Software Engineering | Bachelor | 240 |
| | 231300 Applied Mathematics | Bachelor | 240 |
| | 090000 INFORMATION SECURITY | | |
| | 090900 Information Security | Bachelor | 240 |

| Cycle | Degree | Qualification awarded | ECTS credits |
|---|---|---|---|
| 2nd cycle | 010000 PHYSICAL AND MATHEMATICAL SCIENCE | | |
| | 010200 Mathematics and Computer Science | Master | 120 |
| | 010300 Fundamental Computer Science and Information Technologies | Master | 120 |
| | 010400 Applied Mathematics and Computer Science | Master | 120 |
| | 010500 Software and Information Systems Management | Master | 120 |
| | 080000 ECONOMICS AND MANAGEMENT | | |
| | 080500 Business Informatics | Master | 120 |
| | 210000 ELECTRONIC ENGINEERING, RADIO TECHNOLOGY AND COMMUNICATION | | |
| | 210700 Information and Communication Technologies and Communication Systems | Master | 120 |
| | 230000 COMPUTER SCIENCE AND COMPUTER ENGINEERING | | |
| | 230100 Computer Science and Computer Engineering | Master | 120 |
| | 230400 Information Systems and Technologies | Master | 120 |
| | 230700 Applied Computer Science | Master | 120 |
| | 231000 Software Engineering | Master | 120 |
| | 231300 Applied Mathematics | Master | 120 |
| | 090000 INFORMATION SECURITY | | |
| | 090900 Information Security | Master | 120 |
| 2nd cycle | 090300 INFORMATION SECURITY OF COMPUTING, AUTOMATED AND TELECOMMUNICATION SYSTEMS | | |
| | 090301 Computer Security | Specialist | 330 |
| | 090302 Information Security of Telecommunication Systems | Specialist | 330 |
| | 090303 Information Security of Automated Systems | Specialist | 300 |
| | 090305 Information Analysis Security Systems | Specialist | 330 |

# 4

# Typical occupations of the graduates in ICT

The field of Bachelor professional activity includes informational systems and technologies developing, implementing and maintaining.

The objects of Masters  professional activity are not only production, but also research and development projects, experimental and constructing projects.

The description of sphere, tasks and objects of professional activity of bachelors and masters in ICT in Russia in accordance with the list of degrees FSES-3 used for the analysis (degrees, implemented in universities of the ICT subject area group) is presented in table 4.

**Table 4**
Description of sphere, tasks and objects of professional activity of bachelors and masters in ICT

| Sphere and tasks of professional activity | Objects of professional activity |
|---|---|
| 010300 Fundamental Computer Science and Information Technologies | |
| Creation, use, maintenance and development of systems and processes of information accumulation, processing, storage, transmission and protection on the basis of computer technologies and telecommunications, as well as the software.<br><br>Tasks of professional activity:<br>• The development and use of information theory as a fundamental scientific basis of information technologies;<br>• The development and application of computer sciences (including computing technologies, supercomputing, computer geometry and graphics);<br>• The creation, maintenance, and operation of information systems (including intelligent, open, telecommunication systems) on the hardware and software levels;<br>• The development of new and effective use of existing architectural solutions in hardware and software (including system administration, multimedia technology, parallel and distributed systems, web, network and telecommunication technologies, databases);<br>• Development of information and software for specific subject areas (including bioinformatics, geoinformatics, automation of scientific research, management and design). | • Systems and processes of information accumulation, storage, processing, transmission, use and protection;<br>• Research and development projects in the field of computer science and applied mathematics as well as in the development of new information technologies;<br>• Mathematical, information, simulation models of systems and processes;<br>• Software and information support of computer tools, networks and systems;<br>• Algorithms, libraries and software packages;<br>• Systems, products, and information technology services, including databases and knowledge bases, information content, digital libraries (collections), network applications, system and application software products;<br>• E-learning tools, technologies, resources, services;<br>• Standards, profiles, open specifications and architectural methodologies for systems and information technology services design;<br>• Programming languages, languages of description of information resources, specification languages and tools for design and development of systems, products and information technology services;<br>• Documentation on systems, products, and services of information technology systems, documentation on algorithms and programmes;<br>• Digital image processing and computer-aided design systems;<br>• Standards, procedures and tools for administration and security management of information technology;<br>• Projects for the development and implementation of information technology, the corresponding design documentation, standards, processes, procedures, and life cycle support of information technology;<br>• Sets of tests to establish compliance of systems, products and information technology services with standards and profiles, as well as to analyze the performance and other characteristics of the implementation of information technology. |

| Sphere and tasks of professional activity | Objects of professional activity |
|---|---|
| 230400 Information Systems and Technologies | |
| Research, design, development and implementation of information technologies and systems.<br><br>Tasks of professional activity:<br>• Preliminary design, system analysis of the subject area;<br>• Conceptual design of information systems and technologies, defining design objectives, performance criteria, application limits;<br>• Searching for compromises between the different requirements, searching for the optimal solutions;<br>• Research and development of theoretical and experimental models of objects of professional activity in different areas;<br>• Design of fundamental and applied information technologies; development and implementation of information technologies (methodical, information, mathematical, algorithmic, hardware and software);<br>• Development, validation and release of all kinds of project documentation. | • Information processes, technologies, systems and networks, the corresponding tools (programming, technical, organizing);<br>• Methods of design, adjustment, production and application of information technologies and systems in such areas as: engineering, instrument engineering, science, techniques, education, medical science, administration management, law, business, entrepreneurship, commerce, management, banking systems, security of information systems, production control, mechanics, applied physics, energetics, nuclear engineering, power electronics, metallurgy, building, transport, railway services, communication, telecommunications, management of information communications, mail service, chemical industry, agriculture, fabric and light industries, food industry, medical and biological technologies, mining engineering, security protection of underground enterprises and production, geology, oil-and-gas branch, geodesy and mapping, forest complex, chemical and forest complex, ecology, service, mass media, design, media industry, as well as the enterprises of different profiles and all the activity types in conditions of the information society economy. |

| Sphere and tasks of professional activity | Objects of professional activity |
| --- | --- |
| 230700 Applied Computer Science | |
| Design, implementation, deployment, operation and maintenance of information systems for various purposes.<br><br>Tasks of professional activity:<br>• System analysis of information systems application fields, formalizing problems and decision making scenarios;<br>• The development of requirements for the creation and development of information systems and their components;<br>• Preliminary design, development of technical and development projects of information systems for concrete application area;<br>• Feasibility evaluation of design solutions;<br>• Implementation of design solutions using modern information and communications technology and programming;<br>• development and use of the basic principles of information systems, including intelligent information systems based on knowledge-based concepts and neural network technology for decision making;<br>• Implementation, integration, operation, and maintenance of information systems;<br>• Providing quality of practical solutions and information systems functioning in general;<br>• Training and consulting on the applications formalization, information systems architectures, their operation and maintenance. | • Data and knowledge as categories of tasks information basis;<br>• Models of data and knowledge representation;<br>• Models, methods and technologies of gathering, storage, processing, transmission, and use of information;<br>• Preliminary design, technical and development projects of information systems for different purposes;<br>• Linguistic, information and software of information systems;<br>• Methods and tools for providing security and life cycle support of information systems. |
| 230100 Computer Science and Computer Engineering | |
| • Computing devices, systems and networks;<br>• Automated information processing and control system;<br>• Computer-aided design and product information support systems;<br>• Software of automated systems. | • Computer engines, complexes, systems and networks; automated systems of information processing and control;<br>• Computer-aided design systems and systems for information support of industrial product life cycle;<br>• Software of computer equipment and computer-aided systems;<br>• Mathematical, information, technical, linguistic, programming, ergonomic, organizing and legal support of the above mentioned systems. |

# 5

# Competences

## 5.1. Definition of competences and learning outcomes

The introduction of a two or three cycle system makes it necessary to revise all existing study programmes which are not based on the concept of cycles. In practice these programmes have to be redesigned because in a cycle system each cycle should be seen as an entity in itself. Each cycle should not only give access to the following cycle but also to the labour market. This demonstrates the relevance of using the concept of competences as a basis for learning outcomes.

Tuning makes the distinction between learning outcomes and competences in order to distinguish the different roles of the most relevant players: academic staff and students/learners. Expected learning outcomes of a process of learning are formulated by the academic staff, on the basis of input from internal and external stakeholders and academic judgement, preferably involving student representatives during the process. Competences are developed during the process of learning by the student/learner.

Competences are defined in Tuning as a dynamic combination of knowledge, understanding, skills and abilities. Fostering competences is the object of educational programmes. Competences will be formed in various course units and assessed at different stages. As a rule, competences cannot be fully developed within one particular discipline. Competences are normally developed in an integrated and cyclical manner throughout a programme, sensitive not only to the content of learning but to the teaching format and methodology. Yet, in some systems (e.g. in a modular system) it is also feasible to develop a certain subject specific competence during one module focused on this particular competence. To make levels of learning comparable, the cycle (level) descriptors are developed for specific subject areas and are also expressed in terms of competences.

Learning outcomes are statements of what a learner is expected to know, understand and be able to demonstrate after the completion of a learning experience. According to Tuning, learning outcomes are demonstrated by the students and can be assessed. They can refer to a single course unit or module or else to a period of studies, for example, a first, a second and a third cycle programme. Learning outcomes specify the requirements for the award of a credit. Learning outcomes and assessment criteria together determine the credit allocation requirements, while a grade is given on the basis of students' achievements, which might be above or below the credit-allocation benchmark.

The *Tuning Russia* project defines "learning outcomes" as measurable and assessable competence "components" which are formulated by the teaching staff. Students are expected to be able to reach and demonstrate these learning outcomes at the end of an educational programme or a component of an education programme. Learning outcomes are described with active verbs (be able to do/demonstrate/will have completed…). To reiterate, learning outcomes may belong to a whole programme or to a programme element (unit). Learning outcomes can also belong to one particular thematic (didactic) discipline unit (module). Statements of learning outcomes form the basis for workload calculation and, therefore, for credit (ECTS) allocation between structural units of a degree programme. It is necessary to achieve the intended learning outcomes in order to be awarded the corresponding number of ECTS credits.

Competences are divided into generic and subject specific. Although Tuning fully recognises the importance of subject-specific competences, it has been found that considerable time and effort should be devoted to developing generic competences. Competences described by the *Tuning Russia* project should be used as *reference points* by programme developers but are not meant to be interpreted as prescriptive. In other words, programme development flexibility and autonomy is preserved, while a common language for formulating programme aims and objectives is made available.

The use of learning outcomes allows for much more flexibility than is the case in more traditionally designed study programmes based only on the acquisition of knowledge, because they show that different pathways can lead to comparable outcomes; outcomes which can be much more easily recognized as part of another programme or as the basis for entrance to a higher cycle programme. Their use fully respects the autonomy of other institutions as well as other educational cultures. Therefore this approach allows for diversity, not only in a global, European, national or institutional framework, but also in the context of a single programme.

## 5.2. List of competences

### *5.2.1. Selecting competences in accordance with the Tuning methodology*

Introducing a more student-centred approach means that the focus is shifted from the educational process to learning outcomes, that the learner's and the teacher's roles change and that the learner becomes the centre of attention. It also becomes crucial to check constantly what generic and specific competences are required by society. Therefore, consultations with different stakeholders need to be conducted and lists of competences considered relevant should be regularly revised. Since the language of competences has come from outside the world of education, it best suits the need for consultation by allowing easy dialogue with stakeholders not involved directly in academic activity. The competence discourse permits the design of new degrees and the elaboration of mechanisms for improving those degrees that already exist.

Therefore, within the *Tuning Russia* project a consultation process including employers, graduates and academic staff/faculty was organised in order to identify the most important generic and subject-specific competences that might be the focus for different degree programmes. As a result, lists of generic and subject-specific competences for the selected subject areas have been produced (cf. 5.2.2 and 5.2.3).

Consultation on generic and subject-specific competences was carried with the help of a questionnaire. The aims were to:

- Initiate an all the Russian group in general debate on competences based on consultations carried out with the different stakeholders: employers, students, graduates and academics;
- Collect up-to-date information in order to get a snapshot of the current situation in Russia and possibly to detect current tendencies and changes;
- Based on this information, judge how different or similar the perspectives of different stakeholder may be, always using precise language comprehensible to all those involved;

- Limit the topic of debate to three different levels: the institutional (the basic and first level of discussion), the level of subject areas (reference points for HEIs) and the generalised level (related to the general situation in Russia);
- Compare the results with data obtained through similar consultations carried out in Europe and other countries, in order to determine any possible common tendencies and/or regional and/or subject-area peculiarities.

Respondents were asked 1) to indicate the level of importance and development of a competence and 2) to rank the five most important competences. For each competence, a person filling out the questionnaire had to indicate (1) the level of its importance for future professional work and (2) the level up to which this competence was deemed to be developed within a particular degree programme already in place. A four-point scale was used with 1 being equal to "zero" importance/development level and 4 being equal to "high" importance and/or development.

The lists of generic and subject-specific competences were drawn up by each *Tuning Russia* Subject Area Group (SAG) in the following way:

a) The Russian labour market and Russian Federation Professional Standards for the occupational area were analysed;
b) The requirements for the basic outputs of Bachelor and Master degrees stipulated in Russian Federation State Educational Standards were analysed;
c) Existing international professional standards for the occupational area were analysed;
d) *Tuning Europe* procedures for selecting generic and subject-specific competences were analysed and adapted;
e) Russian and EU experts were consulted;
f) Initial lists of generic competences suggested by the various Subject Area Groups in the project (SAGs) were discussed and the common core within the lists was identified;
g) Russian employers, students, academics and graduates were consulted about the resulting lists of generic and subject-specific competences;
h) Finally, lists of generic and subject-specific competences were compiled after analysing the results of the stakeholder-consultation process.

The list of generic competences comprises 30 items (section 5.2.2) and special lists of subject-specific competences have been developed for nine subject areas: Ecology, Economics and Management, Education, Environmental Engineering, Information and Communication Technologies, Languages, Law, Social Work, and Tourism (section 5.2.3). Lists of subject-specific competences can be consulted in separate publications (like this one) –Reference Points– prepared by the SAGs on the basis of discussions in groups, thematic and subject networks and professional communities. These lists account for the results of the consultations with all the stakeholders. Since every subject area has its own peculiarities, each SAG used slightly different approaches. Nonetheless, in order to obtain comparable results, a basic common procedure was used by all SAGs. In each case, the list was drawn after a consensus had been reached in the group discussion and after studying the ways the subject degrees are organised in the different regions of Russia and in other countries. It should be borne in mind that the resulting documents may still be amplified and amended.

The use of learning outcomes and competences is necessary in order to make study programmes and their course units or modules student centred/output oriented. This approach requires that the key knowledge and skills that a student needs to achieve during the learning process determine the content of the study programme. Competences and learning outcomes, in turn, focus on the requirements both of the discipline and of society in terms of preparing for citizenship and employability.

In an output-based study programme the main emphasis lies on the degree or qualification profile. This profile is determined by the academic staff and endorsed by the responsible authorities. The profile should be based on an identified and recognized needs by society. Although every programme profile is unique and based on the judgements and decisions of the academic staff, the staff has to take into account specific features which are seen as being crucial for the subject area concerned. In the *Tuning Russia* project, the academics involved identified specific features of their own subject area. These are reflected in so-called meta-profiles, which are, in turn, based on the lists of generic and subject specific competences for each focus subject area (section 5.2.4).

### *5.2.2. Generic competences*

One of the main aims of the *Tuning Russia* project has been that of compiling a unified list of generic competences relevant to degrees in many subject areas. In order to determine which generic competences appeared to be the most important ones, broad consultations have been carried out with graduates, students, employers and academics as outlined above. In order to identify the list of competences to be used as the basis of the wider consultation, the following process was carried out by the participants in the Tuning Russia project.

1. The Russian members of each SAG drew up initial lists of the generic competences they considered to be the key ones.
2. The lists were discussed by Russian members of each SAG and with EU experts and were amended if it was considered as necessary.
3. The lists proposed by the SAGs were compared and the following categories of competences were distinguished: the common core of generic competences selected by all SAGs; competences selected by the majority of SAGs; those selected only by some SAGs; and those selected by only one SAG.
4. The list of 30 generic competences was agreed and its Russian and English versions were established in order to be used during the consultation process.
5. Students, employers, graduates and academics were consulted.
6. The questionnaires were analysed and the final list of generic competences, common for all the Project SAGs was drawn. The results were discussed by all SAGs.

The final list comprises the following 30 competences:

**Table 5**
Full list of generic competences

| Competence code | Competence |
|---|---|
| [GC-01] | Ability for abstract thinking, analysis and synthesis |
| [GC-02] | Ability to work in a team |
| [GC-03] | Capacity to generate new ideas (Creativity) |
| [GC-04] | Ability to identify, pose and resolve problems |
| [GC-05] | Ability to design and manage projects |
| [GC-06] | Ability to apply knowledge in practical situations |

| Competence code | Competence |
|---|---|
| [GC-07] | Ability to communicate in a second language |
| [GC-08] | Skills in the use of information and communication technologies |
| [GC-09] | Capacity to learn and stay up-to-date with learning |
| [GC-10] | Ability to communicate both orally and in written form in the native language |
| [GC-11] | Ability to work autonomously |
| [GC-12] | Ability to make reasoned decisions |
| [GC-13] | Ability for critical thinking |
| [GC-14] | Appreciation of and respect for diversity and multiculturality |
| [GC-15] | Ability to act with social responsibility and civic awareness |
| [GC-16] | Ability to act on the basis of ethical reasoning |
| [GC-17] | Commitment to the conservation of the environment |
| [GC-18] | Ability to communicate with non-experts of one's filed |
| [GC-19] | Ability to plan and manage time |
| [GC-20] | Ability to evaluate and maintain the quality of work produced |
| [GC-21] | Ability to be critical and self-critical |
| [GC-22] | Ability to search for, process and analyse information from a variety of sources |
| [GC-23] | Commitment to safety |
| [GC-24] | Interpersonal and interactional skills |
| [GC-25] | Ability to undertake research at an appropriate level |
| [GC-26] | Knowledge and understanding of the subject area and understanding of the profession |
| [GC-27] | Ability to resolve conflicts and negotiate |
| [GC-28] | Ability to focus on quality |
| [GC-29] | Ability to focus on results |
| [GC-30] | Ability to innovate |



© University of Deusto - ISBN 978-84-15772-25-5

### *5.2.3. Subject specific competences*

In order to form a synthesized list of professional competences for the ICT subject area, the educational standards for degrees being implemented in the universities of ICT subject area group were analysed.

We considered the Federal State Educational Standards (FSES) as well as the Universities Educational Standards (UES) for National Research Universities:

| Type | Degree | University implementing degree (in SAG) |
|---|---|---|
| FSES | 010300 Fundamental Computer Science and Information Technologies | N.I. Lobachevsky State University of Nizhniy Novgorod |
| UES | 010300 Fundamental Computer Science and Information Technologies | N.I. Lobachevsky State University of Nizhniy Novgorod |
| FSES | 230100 Computer Science and Computer Engineering | Yaroslav-the-Wise Novgorod State University |
| FSES | 230400 Information Systems and Technologies | Astrakhan State University |
| FSES | 230700 Applied Computer Science | North Caucasus State Technical University |

The list of 16 synthesized professional competences which is presented in table 6, is the result of a comparative analysis of professional competences, regrouping connected competences, a comparative analysis of educational degrees being implemented in Russian universities with international professional educational standards in the ICT area called Computing Curricula.

**Table 6**
Full list of subject specific competences

| Competence code | Competence |
|---|---|
| [SSC-01] | To analyze subject area, identify, classify and describe problems; find the methods and approaches for solving them; define requirements |

| Competence code | Competence |
|---|---|
| [SSC-02] | To design ICT systems, including modelling (formal description) of structure and processes |
| [SSC-03] | To develop and implement ICT systems |
| [SSC-04] | To deploy, install, integrate, put into service and maintain ICT systems and their elements |
| [SSC-05] | To guarantee the quality of information systems according to the requirements |
| [SSC-06] | To develop and bring into effect new competitive ideas in the area of ICT |
| [SSC-07] | To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations |
| [SSC-08] | To analyze, choose and apply methods and aids to provide information security |
| [SSC-09] | To manage economic, human, technological and other resources efficiently |
| [SSC-10] | To train ICT users and provide them with technical support |
| [SSC-11] | To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful problem solving |
| [SSC-12] | To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems |
| [SSC-13] | To know and apply core ICT theoretical and practical knowledge, principles and tools |
| [SSC-14] | To appreciate the social considerations and ethical issues affecting the professional practice |
| [SSC-15] | To estimate and appreciate economic and commercial issues affecting the professional practice |
| [SSC-16] | To collect, process and systematize professional knowledge in information technology and appreciate the importance of life-long learning (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society |

### *5.2.4. Key competences*

Within the framework of the project a survey of targeted focus groups (employers, academics, graduates and students) was carried out in order to identify expert opinions and to rank competences by their importance and the level of their achievement in universities (see paragraph 5.2.1). Russian colleagues in the universities belonging to the ICT subject group, surveyed 134 employers, 168 academics, 165 graduates and 242 students. After an analysis of the survey results the initial set of competences was reduced to the final list of 20 key competences consisted of a 10 generic competences and 10 subject-specific ones.

In Fig. 2 the results of the survey on generic competences for all the subject area groups are presented. The points on the graph correspond to the mean importance of a particular competence for a certain category of respondents.

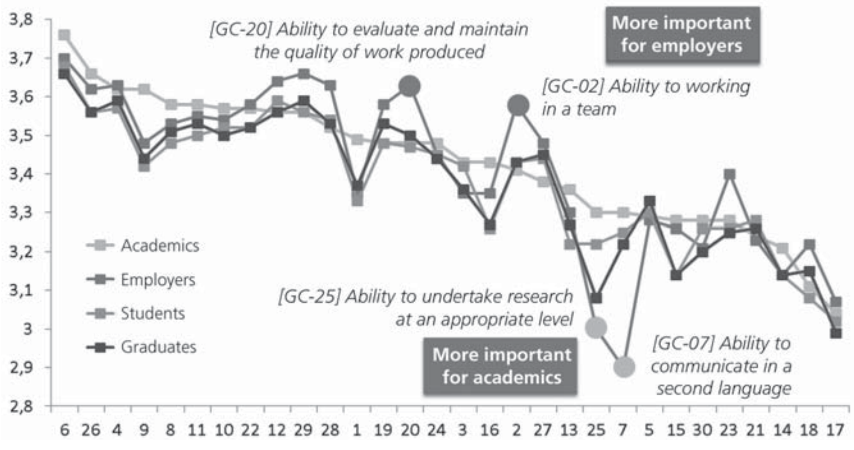



**Figure 2**

Survey results for generic competences for all subject area groups (by estimates of the level of importance)

The figure also indicates the competences on the importance of which academics and employers disagree the most.

The Fig. 3 represents the same diagram but it only considers the survey results for the ICT subject area group.

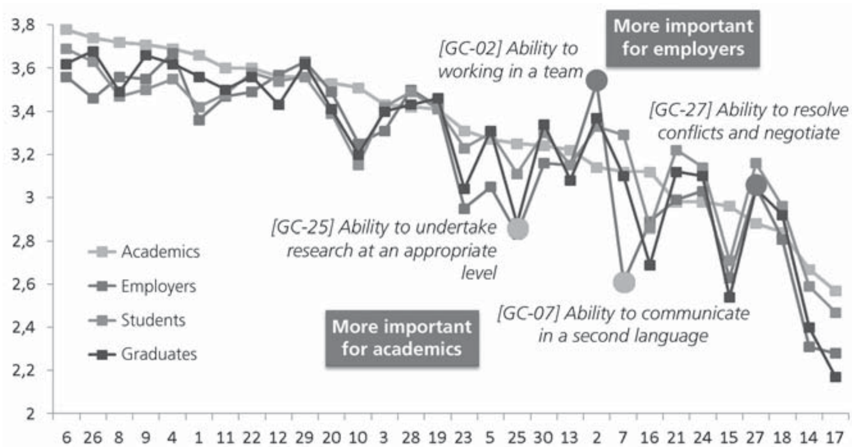



**Figure 3**
Survey results for generic competences for ICT subject area group
(by estimates of the level of importance)

For each category of respondents the list of generic competences was sorted by the average value of importance level in descending order, then in accordance with these ranks competences were mapped to the ranks in the range [1.30]. The results of this procedure taking into consideration only the survey data for the ICT subject area group are presented in Fig. 4. The five most important competences for each group of respondents are highlighted with dark grey colour, and the five least important competences for each group of respondents are highlighted with light grey color.

| Competences | Academics | Employers | Students | Graduates |
|---|---|---|---|---|
| [GC-06] | 1 | 4 | 1 | 4 |
| [GC-26] | 2 | 12 | 2 | 1 |
| [GC-08] | 3 | 5 | 10 | 9 |
| [GC-09] | 4 | 6 | 7 | 2 |
| [GC-04] | 5 | 1 | 5 | 5 |
| [GC-01] | 6 | 14 | 11 | 6 |
| [GC-22] | 7 | 10 | 3 | 7 |
| [GC-11] | 8 | 11 | 9 | 8 |
| [GC-12] | 9 | 3 | 6 | 12 |
| [GC-29] | 10 | 2 | 4 | 3 |
| [GC-20] | 11 | 9 | 14 | 13 |
| [GC-10] | 12 | 16 | 23 | 18 |
| [GC-03] | 13 | 15 | 12 | 14 |
| [GC-28] | 14 | 8 | 8 | 11 |
| [GC-19] | 15 | 13 | 13 | 10 |
| [GC-23] | 16 | 23 | 19 | 23 |
| [GC-05] | 17 | 19 | 16 | 17 |
| [GC-25] | 18 | 25 | 25 | 26 |
| [GC-30] | 19 | 17 | 17 | 16 |
| [GC-13] | 20 | 18 | 22 | 22 |
| [GC-02] | 21 | 7 | 15 | 15 |
| [GC-16] | 22 | 24 | 27 | 27 |
| [GC-07] | 23 | 28 | 18 | 21 |
| [GC-24] | 24 | 21 | 24 | 20 |
| [GC-21] | 25 | 22 | 20 | 19 |
| [GC-15] | 26 | 27 | 28 | 28 |
| [GC-27] | 27 | 20 | 21 | 24 |
| [GC-18] | 28 | 26 | 26 | 25 |
| [GC-14] | 29 | 29 | 29 | 29 |
| [GC-17] | 30 | 30 | 30 | 30 |

**Figure 4**
Survey results for generic competences for ICT subject area group
(by estimates of the level of importance)

Fig. 4 clearly shows for which competences the respondents agree or disagree with their evaluation importance (see table 7).

**Table 7**
Agreements and disagreements of respondents in identifying the most and the least important competences

| | Respondents agree | Respondents disagree |
|---|---|---|
| The most important competences | [GC-06] Ability to apply knowledge in practical situations<br>[GC-04] Ability to identify, pose and resolve problems | [GC-26] Knowledge and understanding of the subject area and understanding of the profession<br>[GC-12] Ability to make reasoned decisions<br>[GC-29] Ability to focus on results |
| The least important competences | [GC-17] Commitment to the conservation of the environment<br>[GC-14] Appreciation of and respect for diversity and multiculturality<br>[GC-18] Ability to communicate with non-experts of one's field<br>[GC-15] Ability to act with social responsibility and civic awareness | [GC-27] Ability to resolve conflicts and negotiate<br>[GC-07] Ability to communicate in a second language<br>[GC-25] Ability to undertake research at an appropriate level |

In Fig. 5 the survey results on evaluating the level of achievement of generic competences in all subject area group are presented. As it can be seen on this figure, academics and employers have similar estimations, and the same is true for students and graduates. The first pair of respondents is more pessimistic for the most number of competences than the second one.

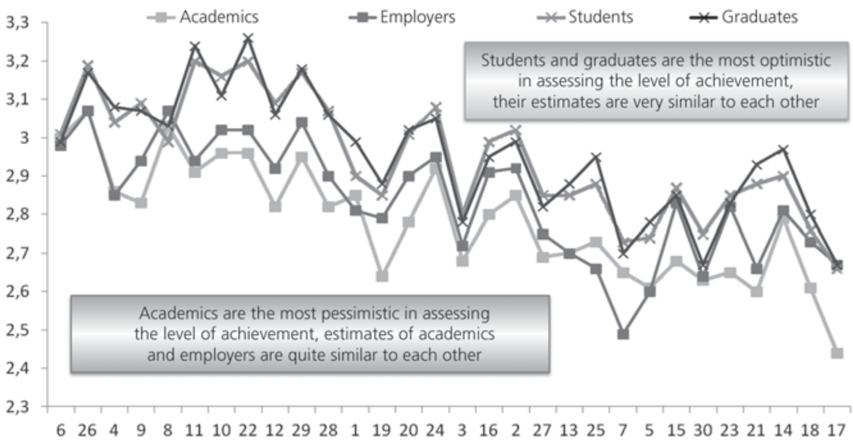



**Figure 5**

Survey results for generic competences for all subject area groups (by estimates of the level of achievement)

Taking into consideration the survey results, a further analysis of competences was conducted, and 30 generic competences were distributed between four groups related to their importance for an educational degree in ICT area, each group having a rank from the range [1..4], where 1 corresponds to the highest level of importance. The same was done for subject-specific competences. Then, in order to compose a list of key competences, the generic competences with rank 1 and the subject-specific competences with ranks 1 and 2, were selected. The list was then completed with 3 additional competences with lower rank – two generic competences and 1 subject-specific one. The results of selection procedure are presented in table 8.

**Table 8**
Results of key competences selection

| Generic competences | Subject specific competences |
|---|---|
| Key competences | Key competences |
| *Rank 1*<br>[GC-01] Ability for abstract thinking, analysis and synthesis<br>[GC-02] Ability to work in a team<br>[GC-04] Ability to identify, pose and resolve problems<br>[GC-06] Ability to apply knowledge in practical situations<br>[GC-09] Capacity to learn and stay up-to-date with learning<br>[GC-22] Ability to search for, process and analyse information from a variety of sources<br>[GC-26] Knowledge and understanding of the subject area and understanding of the profession<br>[GC-29] Ability to focus on results<br><br>*Rank 2*<br>[GC-07] Ability to communicate in a second language<br>[GC-10] Ability to communicate both orally and in written form in the native language | *Rank 1*<br>[SSC-01] To analyse subject area, identify, classify and describe problems; find the methods and approaches for their solving; define requirements<br>[SSC-02] To design ICT systems, including modelling (formal description) of structure and processes<br>[SSC-03] To develop and implement ICT systems<br>[SSC-04] To deploy, install, integrate, put into service and maintain ICT systems and their elements<br>[SSC-05] To guarantee the quality of information systems according to the requirements<br><br>*Rank 2*<br>[SSC-07] To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations<br>[SSC-10] To train ICT users and provide them technical support<br>[SSC-11] To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful solving problems<br><br>*Rank 3*<br>[SSC-08] To analyse, choose and apply methods and aids to provide information security |

| Generic competences | Subject specific competences |
|---|---|
| Other competences | Other competences |
| *Rank 2*<br>[GC-11] Ability to work autonomously<br>[GC-19] Ability to plan and manage time<br>[GC-23] Commitment to safety<br><br>*Rank 3*<br>[GC-05] Ability to design and manage projects<br>[GC-03] Capacity to generate new ideas (creativity)<br>[GC-28] Ability to focus on quality<br>[GC-25] Ability to undertake research at an appropriate level<br><br>*Rank 4*<br>[GC-30] Ability to innovate<br>[GC-21] Ability to be critical and self-critical<br>[GC-08] Skills in the use of information and communications technologies<br>[GC-12] Ability to make reasoned decisions<br>[GC-13] Ability for critical thinking<br>[GC-14] Appreciation of and respect for diversity and multiculturality<br>[GC-15] Ability to act with social responsibility and civic awareness<br>[GC-16] Ability to act on the basis of ethical reasoning<br>[GC-17] Commitment to the conservation of the environment<br>[GC-18] Ability to communicate with non-experts of one's field<br>[GC-20] Ability to evaluate and maintain the quality of work produced<br>[GC-24] Interpersonal and interaction skills<br>[GC-27] Ability to resolve conflicts and negotiate | *Rank 3*<br>[SSC-09] To manage economic, human, technological and other resources efficiently<br><br>*Rank 4*<br>[SSC-12] To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems<br>[SSC-13] To know and apply core ICT theoretical and practical knowledge, principles and tools<br>[SSC-14] To appreciate the social considerations and ethical issues affecting the professional practice<br>[SSC-15] To estimate and appreciate economic and commercial issues affecting the professional practice<br>[SSC-16] To collect, process and systematize professional knowledge in information technology and appreciate the importance of learning throughout life (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society |

### *5.2.5. Meta-profile*

The meta-profile reflects the structure and interrelation of competences that characterise a particular subject area. Meta-profiles are used for reference, depict mental models and should demonstrate the variety of possible and existent degree profiles within a particular subject area. Meta-profiles are determined by analysing stakeholder-consultation results through re-categorising the competence list. Such re-categorisation can be done differently in different subject areas and should reflect the subject area unique characteristics.

#### 5.2.5.1. Meta-competences

The list of key competences was analyzed in order to identify "clusters" of competences, i.e. meta-competences which consist of interconnected competences. Meta-competences form the core of educational programmes in the ICT area.

The following approach was chosen. The 20 key competences defined at the previous stage (paragraph 5.2.4) were analysed one by one. Each competence was put into the cluster of competences with which it was the most closely connected, or, if no such cluster, a new cluster was created for this competence. By applying this procedure, the following five groups of competences were formed:

- [MGC-1] Ability to perceive, analyze and synthesize information;
- [MGC-2] Ability for self-development and self-improvement;
- [MGC-3] Ability to join the professional community;
- [MSSC-1] Ability to understand, apply and develop mathematical knowledge, basic laws of natural science, knowledge in problem domain (related to professional activity) and fundamentals of information technologies;
- [MSSC-2] Ability to design, develop, implement and manage life cycle processes of information systems and technologies.

The non-key competences were also distributed between these five clusters. The content of the meta-competences is presented in table 9.



© University of Deusto - ISBN 978-84-15772-25-5

**Table 9**
Meta-competences for ICT area

| Key competences | Other competences |
|---|---|
| **[MGC-1] Ability to perceive, analyze and synthesize information** | |
| [GC-07] Ability to communicate in a second language<br><br>[GC-10] Ability to communicate both orally and in written form in the native language<br><br>[GC-22] Ability to search for, process and analyse information from a variety of sources<br><br>[GC-01] Ability for abstract thinking, analysis and synthesis | [GC-04] Ability to identify, pose and resolve problems<br><br>[GC-12] Ability to make reasoned decisions<br><br>[GC-13] Ability for critical thinking |
| **[MGC-2] Ability for self-development and self-improvement** | |
| [GC-09] Capacity to learn and stay up-to-date with learning<br><br>[GC-29] Ability to focus on results | [GC-11] Ability to work autonomously<br><br>[GC-19] Ability to plan and manage time<br><br>[GC-23] Commitment to safety<br><br>[GC-14] Appreciation of and respect for diversity and multiculturality<br><br>[GC-15] Ability to act with social responsibility and civic awareness<br><br>[GC-21] Ability to be critical and self-critical<br><br>[SSC-16] To collect, process and systematize professional knowledge in information technology and appreciate the importance of life-long learning (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society |



© University of Deusto - ISBN 978-84-15772-25-5

| Key competences | Other competences |
|---|---|
| **[MGC-3] Ability to join professional community** | |
| [GC-26] Knowledge and understanding of the subject area and understanding of the profession<br>[GC-02] Ability to work in a team<br>[GC-06] Ability to apply knowledge in practical situations | [GC-25] Ability to undertake research at an appropriate level<br>[GC-30] Ability to innovate<br>[GC-18] Ability to communicate with non-experts of one's field<br>[GC-20] Ability to evaluate and maintain the quality of work produced<br>[GC-27] Ability to resolve conflicts and negotiate<br>[GC-03] Capacity to generate new ideas (creativity)<br>[GC-28] Ability to focus on quality<br>[GC-16] Ability to act on the basis of ethical reasoning<br>[GC-17] Commitment to the conservation of the environment<br>[GC-24] Interpersonal and interaction skills<br>[SSC-14] To appreciate the social considerations and ethical issues affecting the professional practice |
| **[MSSC-1] Ability to understand, apply and develop mathematical knowledge, basic laws of natural science, knowledge in problem domain (related to professional activity) and fundamentals of information technologies (related to Computer Science sub-discipline of CC2005)** | |
| [SSC-11] To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful solving problems<br>[SSC-06] To develop and bring into effect new competitive ideas in the area of ICT<br>[SSC-08] To analyze, choose and apply methods and aids to provide information security | [SSC-13] To know and apply core ICT theoretical and practical knowledge, principles and tools<br>[GC-08] Skills in the use of information and communications technologies |

| Key competences | Other competences |
|---|---|
| [MSSC-2] Ability to design, develop, implement and manage life cycle processes of information systems and technologies (related to Information Systems and Technologies sub-discipline of CC2005) | |
| [GC-05] Ability to design and manage projects<br>[SSC-01] To analyze subject area, identify, classify and describe problems; find the methods and approaches for their solving; define requirements<br>[SSC-02] To design ICT systems, including modelling (formal description) of structure and processes<br>[SSC-03] To develop and implement ICT systems<br>[SSC-04] To deploy, install, integrate, put into service and maintain ICT systems and their elements<br>[SSC-05] To guarantee the quality of information systems according to the requirements<br>[SSC-07] To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations<br>[SSC-10] To train ICT users and provide them technical support | [SSC-09] To manage economic, human, technological and other resources efficiently<br>[SSC-12] To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems<br>[SSC-15] To estimate and appreciate economic and commercial issues affecting the professional practice |

The core element of the final set of meta-competences is the ability to join the professional community (MGC-3). This meta-competence is achieved by mastering:

- generic meta-competences – the ability to perceive, analyse and synthesize information (MGC-1) on the one hand, and the ability for self-development and self-improvement (MGC-2) on the other hand;
- subject-specific meta-competences – the ability to understand, apply and develop mathematical knowledge, basic laws of natural science

and fundamentals of information technologies (MSSC-1), i.e. group of competences related to Computer Science sub-discipline of ICT, on the one hand, and the ability to design, develop, implement and manage life cycle processes of information systems and technologies (MSSC-2), i.e. group of competences related to Information Systems and Technologies sub-disciplines of ICT on the other hand.

The scheme of correspondence of bachelor and master degrees which were taken into analysis in ICT subject area group to Computing Curricula professional standards (based on the scheme presented in [17]) is presented in the fig. 6.

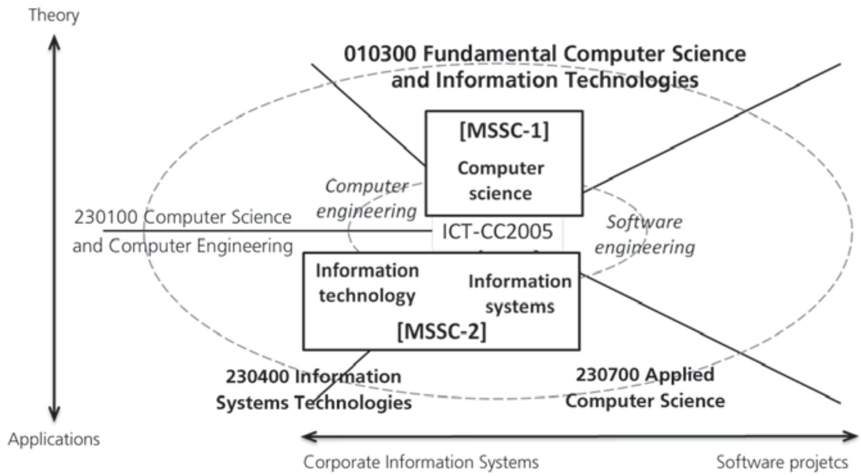



**Figure 6**
Matching of degrees (FSES-3) with professional ICT sub-disciplines (CC2005) and identified ICT meta-competences

Meta-competences are identified to represent the core of degrees in the ICT subject area – this document concerns the following professional sub-disciplines of this large subject area: Computer Science and Information Systems and Technologies. However, the described approach can also be applied to other ICT sub-disciplines.

Meta-competences should be developed up to a certain level by every graduate of any first-cycle degree (Bachelor) within the specific ICT sub-disciplines, regardless of his/her profile, his/her particular degree configuration. Without these key competences a students cannot gain access to any second-cycle (Master) degree in this subject area.

The map of correspondence between ICT sub-disciplines (according to Computing Curricula) and the Russian educational standards in this area is presented in paragraph 2.1. For the concrete programme it is recommended to use the classification of key and non-key competences, presented in table 9, in order to select the programme key competences.

#### 5.2.5.2. Meta-profile diagram

The diagram of the meta-profile for the specific ICT sub-area is presented in figure 7.

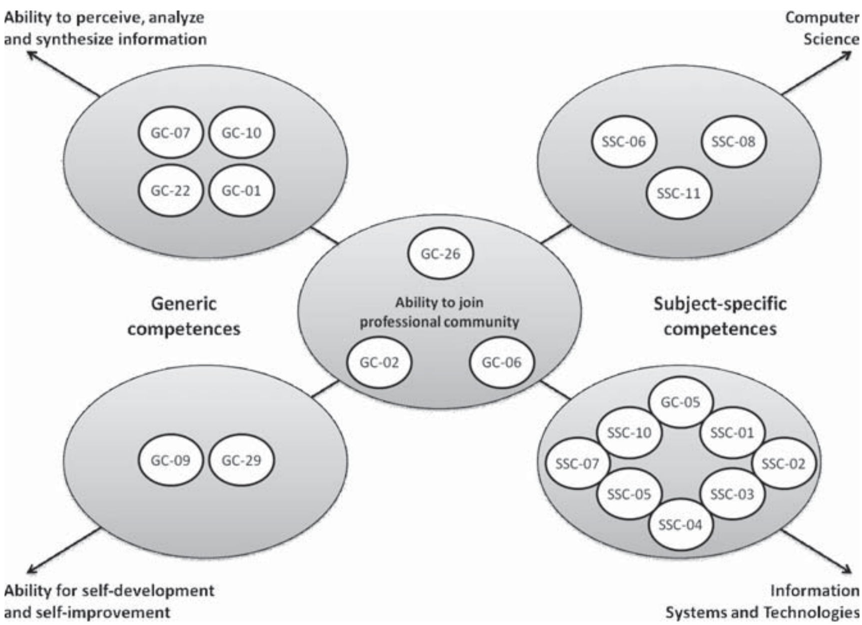



**Figure 7**
Meta-profile diagram



© University of Deusto - ISBN 978-84-15772-25-5

# 6

# Level descriptors and learning outcomes

In a cyclical system each cycle should have its own set of *generalised* learning outcomes formulated in terms of competences. As stated above, learning outcomes are formulated at degree, programme and on individual course unit levels. The learning outcomes of the individual units add to the overall learning outcomes of the programme. Competences are developed in a progressive way. It means that they are developed over a number of course units or modules at different stages of the programme. During the design phase of the programme it has to be decided in which units a particular competence has to be focused on.

The use of cycles automatically includes the introduction of the concept of levels. For each of these, level indicators can be used. They are called level descriptors. As a part of the Bologna Process, a group of experts, the so-called Joint Quality Initiative, has developed sets of general descriptors for each cycle, which are called the Dublin Descriptors. These cycle descriptors have now been endorsed by the European Ministers of Education as part of the report A Framework for Qualifications of The European Higher Education Area. The approaches of Tuning and the JQI are fully compatible and complementary.

Because cycle descriptors are in practice level descriptors which identify the level of a cycle, Tuning has suggested naming these descriptors cycle level descriptors. The Project participants have produced cycle level descriptors at programme level for the first and the second cycles for each of the subject areas included in the project. Below, we present a generalised description of learning outcomes for each level within our subject area.

In a cycle system each cycle should have its own set of learning outcomes formulated in terms of competences. As stated above, learning outcomes are formulated both at programme level and on the level of individual course units or modules. The learning outcomes of the individual units add to the overall learning outcomes of the programme. Competences are developed in a progressive way. It means that they are formed in a number of course units or modules at different stages of the programme. During the design phase of the programme it has to be decided in which units a particular competence has to be formed.

The use of cycles automatically includes the introduction of the concept of levels. For each of these level indicators can be used. They are called level descriptors. As part of the Bologna Process, a group of experts, the so-called Joint Quality Initiative, has developed sets of general descriptors for each cycle, which are called the Dublin descriptors. These cycle descriptors have now been endorsed by the European Ministers of Education as part of the report A Framework for Qualifications of The European Higher Education Area. The approaches of Tuning and the JQI are fully compatible and complementary.

Because cycle descriptors in practice are level descriptors which identify the level of a cycle, Tuning has suggested naming these descriptors cycle level descriptors. The Project participants have produced cycle level descriptors at programme level for the first and second cycle for each of the subject areas included in the project. Below, we present generalised description of learning outcomes for each level within our subject area.

*First-cycle graduates (Bachelors) and the second-cycle graduates (Masters) should*

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-01]<br>To analyse subject area, identify, classify and describe problems; find the methods and approaches for their solving; define requirements | • To know and understand the methods of analysis of problem domain, requirements identification and gathering source data for design;<br>• To carry out an initial investigation (engineering) of the design object, system analysis of a problem domain and the corresponded relationships; | • To know, understand and apply the methods of analysis of problem domain, requirements identification and gathering source data for design;<br>• To carry out an initial investigation (engineering) of the design object, system analysis of a problem domain and the corresponded relationships;<br>• To check, compare, analyze and estimate risks and result of experimental research, draw conclusions on the analysis results;<br>• To evaluate, classify and reasonably choose the methods of identification of information systems requirements, formulate requirements; |
| [SSC-02]<br>To design ICT systems, including modelling (formal description) of structure and processes | • To know, understand and apply the basic design methods and techniques (technical and implementation) of information systems and technologies;<br>• To choose input data for design;<br>• To develop, make agree and deliver all kinds of project documentation;<br>• To carry out modelling of basic information processes and systems;<br>• To carry out activities on computational experiments in order to verify the mathematical models being used, document modelling results; | • To know, understand and apply the basic concepts and methodologies for modelling information processes, document modelling results;<br>• To evaluate and select methods and models of creating, implementing, operating and monitoring information systems at all the stages of their life cycle;<br>• To know, understand and apply the basic design methods and techniques (conceptual, technical and implementation) of information systems and technologies;<br>• To develop and evaluate design strategies of an information system; justify, analyze and evaluate design solutions;<br>• To choose, analyze and evaluate input data for design;<br>• To develop, make agree and deliver all kinds of project documentation;<br>• To carry out modelling of basic information processes and systems;<br>• To plan and carry out activities on computational experiments in order to verify the mathematical models being used, document modelling results;<br>• To analyze, evaluate and select modern tools and computing methods, technologies, algorithmic and software solutions for a concrete professional problem; |

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-03]<br>To develop and implement ICT systems | • To know and understand life cycle processes of information systems;<br>• To develop facilities for implementing information technologies (methodical, informational, mathematical, algorithmic, hardware and software);<br>• To develop facilities for computer-aided design of information technologies;<br>• To develop algorithmic, system and specialized software, database models;<br>• To reasonably select programming concepts and languages for solving applied tasks; to apply in practice the system and specialized tools, systems and software packages; | • To know, understand, develop and monitor life cycle processes of information systems;<br>• To develop facilities for implementing information technologies (methodical, informational, mathematical, algorithmic, hardware and software);<br>• To develop facilities for computer-aided design of information technologies;<br>• To develop algorithmic, system and specialized software, database models;<br>• To reasonably select programming concepts and languages for solving applied tasks; to apply in practice the system and specialized tools, systems and software packages;<br>• To conduct an analytical study on the operating parameters of ICT systems for the validation and verification of their compliance to the task, as well as to analyze and provide a critical evaluation of the methods chosen, the facilities of implementation and computer-aided design; |
| [SSC-04]<br>To deploy, install, integrate, put into service and maintain ICT systems and their elements | • To know, understand and apply techniques of assembling, configuring, debugging, installing software and hardware systems;<br>• To know and understand the methods of integration, interfacing and configuration of ICT, software and hardware;<br>• To participate in verification and operational testing of information systems and their components;<br>• To draw up instructions for operation of information systems and technologies;<br>• To carry out work to ensure the operation and adaptation of information systems at enterprises to the specified functional characteristics;<br>• To participate in the activities on the final design and development of IT processes during the preparation of new products; | • To know, understand and apply techniques of assembling, configuring, debugging, installing software and hardware systems;<br>• To know, understand and apply the methods of integration, interfacing and configuration of ICT, software and hardware;<br>• To plan, organize, lead verification and operational testing of information systems and their components;<br>• To draw up instructions for operation of information systems and technologies;<br>• To carry out work to ensure the operation and adaptation of information systems at enterprises to the specified functional characteristics;<br>• To plan, organize, lead the activities on the final design and development of IT processes during the preparation of new products; |

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-05]<br>To guarantee the quality of information systems according to the requirements | • To know, understand and apply modern models and methods of assessing quality and reliability at all stage of information system life cycle;<br>• To know, understand and apply different methodologies and tools for testing and debugging information systems;<br>• To evaluate the quality and reliability of the design object;<br>• To organize the control of quality of input information; | • To know, understand and apply modern models and methods of assessing quality and reliability at all stage of information system life cycle;<br>• To know, understand and apply different methodologies and tools for testing and debugging information systems;<br>• To evaluate the quality and reliability of the design object;<br>• To analyze results of information systems testing and review design concepts in accordance with these results; |
| [SSC-06]<br>To develop and bring into effect new competitive ideas in the area of ICT | • To formulate, experimentally confirm, justify and implement new competitive ideas, methods, solving techniques under supervision of professors;<br>• To document research results in the form of papers and presentations at scientific conferences; | • To formulate, experimentally confirm, justify and implement new competitive ideas, methods, techniques of solving professional, research, technical tasks including non-typical tasks;<br>• To document research results in the form of papers and presentations at scientific conferences;<br>• To develop scientific, information and educational resources for solving professional and applied tasks related to development and use of information technologies; |
| [SSC-07]<br>To know, follow and assess the degree of compliance with industry specifications, standards, regulations, and recommendations | • To know, understand and apply modern professional standards and other legal documents in the field of ICT; | • To know, understand and apply modern professional standards and other legal documents in the field of ICT; |

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-08]<br>To analyse, choose and apply methods and aids to provide information security | • To formulate the requirements for information security and data integrity;<br>• To know, understand, analyse, choose and apply professionally facilities for providing information security and data consistency according to a given applied task; | • To formulate the requirements for information security and data integrity;<br>• To know, understand, analyse, choose and apply professionally facilities for providing information security and data consistency according to a given applied task; |
| [SSC-09]<br>To manage economic, human, technological and other resources efficiently | • To cooperate with colleagues, to work in team;<br>• To know the essentials of protecting the production staff and population from accidents, catastrophe, natural disasters and their probable consequences; organize and monitor the production processes suiting the requirements of the environment and work safety control systems; | • To find organizational and managerial solutions for non-standard professional situations and take responsibility for them;<br>• To take management decisions in their professional and social activities; to be a project manager;<br>• To know the essentials of protecting the production staff and population from accidents, catastrophe, natural disasters and their probable consequences; organize and monitor the production processes suiting the requirements of the environment and work safety control systems; |
| [SSC-10]<br>To train ICT users and provide them technical support | • To elaborate (or participate in elaboration) instructions for implementation, operation and maintenance of information systems; | • To elaborate organizational and methodological materials, instructions and directive documents for implementation, operation and maintenance of information systems and services, for teaching users to apply software and hardware systems; teach (choose and use existing techniques, mechanisms, explain, report) users to apply software and hardware systems; |

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-11]<br>To apply and develop fundamental and multidisciplinary knowledge, including mathematical and scientific principles, quantitative methods, tools (including software relevant to their engineering discipline) and notations for successful solving problems | • To know , understand and apply basic mathematical concepts, methods of system analysis and mathematical modelling;<br>• To know, understand and apply basic laws of natural sciences;<br>• To understand the essence of the information, estimate quantity and meaning of the information, manipulate with different types of information; | • To know , understand and apply basic mathematical concepts, methods of system analysis and mathematical modelling;<br>• To know, understand and apply basic laws of natural sciences;<br>• To understand the essence of the information, estimate quantity and meaning of the information, manipulate with different types of information; |
| [SSC-12]<br>To prepare technical and methodical materials for presenting ICT system in every stages of the life cycle of information systems | • To develop, finalize, validate and issue all the kinds of design documents on every stage of the information systems life cycle;<br>• To demonstrate project results (ones work results); | • To develop, finalize, validate and issue all the kinds of design documents on every stage of the information systems life cycle;<br>• To analyse, coordinate, compile and evaluate project documentation;<br>• To demonstrate project results (ones work results); to draw up individually or in a team (to make and model due to the plan) presentations, scientific and technical reports on the results of the work conducted; |
| [SSC-13]<br>To know and apply core ICT theoretical and practical knowledge, principles and tools | • To know, understand and apply fundamental concepts and basic principles of functioning of instrumental and computational tools of information technologies, the concepts of syntactical and semantic structure and the methods of application of programming languages of general and special purposes, theoretical and methodical basis of programming technology, analysis and application of algorithmic and software solutions; | • To know, understand and apply fundamental concepts and basic principles of functioning of instrumental and computational tools of information technologies, the concepts of syntactical and semantic structure and the methods of application of programming languages of general and special purposes, theoretical and methodical basis of programming technology, analysis and application of algorithmic and software solutions; |

| Competence | Learning outcomes for Bachelors | Learning outcomes for Masters |
|---|---|---|
| [SSC-14]<br>To appreciate the social considerations and ethical issues affecting the professional practice | • Understand the social importance of their profession;<br>• To know and respect the professional code of ethics; | • To know and respect the professional code of ethics;<br>• To be capable to make judgements on the effect and consequences of his/her professional activity with due account for social, professional and ethic positions; |
| [SSC-15]<br>To estimate and appreciate economic and commercial issues affecting the professional practice | • To calculate the cost-effectiveness; | • To analyse and estimate costs, calculate the cost-effectiveness and draw up a business plan for scientific, technical and applied problems;<br>• To plan, organize and monitor activities at all the stages of information systems life cycle;<br>• To conduct marketing analysis and reasonably choose the aids and methods of production automatization and informatization of production objects; |
| [SSC-16]<br>To collect, process and systematize professional knowledge in information technology and appreciate the importance of learning throughout life (continuing education, retraining, and self-learning) for the necessary adaptation to the evolution of the profession and society | • To apply methods and tools of cognition, learning and self-control for intellectual evolution, raising the level of culture and professional competency. | • To understand, analyze, carry out the targeted search, select scientific and technical resources necessary for the professional scientific and applied problems based on modern science and technology results;<br>• To acquire new scientific and professional knowledge, to predict the development of information systems and technologies. |

# 7

# Teaching, learning and assessment

## 7.1. Teaching methods

### *Lectures*

The lecturer explains to students the different topics in detailed and structured form according to the subject work plan. Ordinary multimedia presentations are used. Support materials (presentations, documents, book chapters, etc.) are usually available for students on a learning platform before class so that they can be better prepared for lectures. Materials are organised by learning cycles.

### *Case study*

Students are given a special case concerning different aspects of the subject. These cases may be discussed by all the students together with the teacher's guidance, or the teacher can form smaller groups. Students can also work alone on cases. Discussion of various alternatives for solving the given problem develops critical thinking and fosters discussions for selecting the most appropriate solution.

### *Problem based learning*

Problem based learning helps students to study and to apply different theories, methods and principles. In contrast to the cases which have multiple solutions and multiple alternative paths leading to them, problems usually have only one solution and one or probably more ways to get to it.



© University of Deusto - ISBN 978-84-15772-25-5

*Collaborative learning*

Small groups of students should discuss within the specified time a certain issue or problem given by the teacher, and then share the results of their discussion with other groups.

*Project based learning*

The project aims to develop a particular product or service within the specified time. Students should solve given problems and present the results of their work in the specified form. Students are aware of the assessment procedure and its criteria. The final result and the development process are both assessed.

While working on projects students gain experience of applying knowledge, in selecting and implementing methods for solving problems related to their future professional activities.

There may be projects focused on interdisciplinary relations.

Undergraduates' final projects address the issue of theory and practice interconnection, they give professional orientation to the educational process and improve its quality. Furthermore, project defence teaches students to express themselves in a correct and logical way, to convince listeners of the necessity and the correctness of the proposed solutions.

*Team projects*

Students are divided into groups, each group elaborates the given project. The aim of the project is to generate, analyse and validate the model for solving the given problem, for implementing it and for preparing the requested documents. An important aspect of this particular activity concerns organizing team work (distribution of roles and responsibilities, interaction of team participants, control of project progress) in conditions close to real ones.

*Seminars and discussions*

The teacher organizes within the group an exchange of views on different aspects of the subject. It can be either in-class or out-of-class activity using if needed distance learning technologies. Different methods can be used, for example «brainstorming» which is used to generate a variety of ideas, to select some of them and to evaluate them critically.

*Laboratory work*

Students work alone using the task description and tutorials provided by the teacher. At the end, they should present results of their work in the specified form.

*Business games*

The idea of the business game is to allow students to express their knowledge, to demonstrate their ability to use it individually or in a team, and to gain skills of understanding complex problems and to elaborate approaches to solve them. Business game has two tasks: the play one and the learning one. The play task is about realizing some professional activity by the player. And the learning task is to master the corresponding competences.

## 7.2. Learning activities

Learning activities of students are composed of class and out-of-class activities. Class activities consist in attending lectures, implementing laboratory and practical work, participating in seminars and discussions, business games, work on projects under the teacher's supervision.

The important role in the mastery of multiple subjects in the ICT area relates to organizing teamwork in order to provide students with an environment close to the real one.

Out-of-class activities can be realized in the following forms: learning different subject issues without assistance, carrying out homework, implementing laboratory work, compiling bibliography reviews on a given problem or issue, conducting research on a given direction.

Teachers elaborate tutorials and recommendations for guided self-learning in order to help students to summarize different concepts. One of the methods which can be applied is the method of the conceptual map. It is an active learning method consisting of knowledge visualizing.

The results of individual student's work in out-of-class activities can be also assessed, and it can be realized during additional consultations in class, or it can be done out of class using distance learning technologies.

## 7.3. Assessment tools

*Tests*

The test is the simplest kind of assessment, it makes it possible to check the mastery of terminology and some concrete knowledge in basic or applied subjects. Tests are composed of a small number of elementary tasks, they can provide the opportunity to choose the right answer from a list of answers.

Tests can also be composed of a small number of questions or problems where students should not only give the right answer, but also justify it, provide a complete solution.

*Interviews and colloquia*

Interview is a special conversation between a teacher and a student covering different issues of the subject. The aim is to assess the extent of a student's knowledge on a specific topic, problem, etc.

Colloquia constitute a kind of conference for collective discussion of different issues of the subject not included in seminars, and also reviews, projects and other students' work.

*Reports*

Reports represent a form of assessment of laboratory and practical work, all kinds of projects, all kinds of internships, and research work. Reports are a kind of written work allowing students to summarize their knowledge and skills on specific topics of educational programme.

*Presentation of work results*

This kind of assessment makes it possible to assess the ability of student for public communication, his or her skills for participating in discussions on professional topics, mastering professional terminology, ability to present and defend the result of his or her work.

*Reviews*

This kind of activity consists in searching and analysing bibliographical information sources on a given problem, writing an essay, analysing research papers.

*Demonstration of work results*

This kind of assessment is related to the presentation of work results, but the specific point here is that the student should demonstrate the result of his or her work, i.e. a concrete product. And the presentation is mostly related to a description of the process and the result.

## 7.4. Assessment using competence-based approach

In order to put into practice the possibility of assessing the mastery of competences, the approach based on the Tuning methodology provides a model of competence description in terms of levels of mastery, indicators and descriptors.

Levels of mastery correspond to the *key milestones*. When designing concrete programmes, it is necessary to distribute levels of mastery of specific competences between bachelor and master cycles.

Indicators are *measurable*, they are used to determine whether a student has reached a certain level of competence mastery and to compare different students at the same level. Competences indicators correspond to concrete learning outcomes.

Descriptors make it possible to describe the state of knowledge and skills required of the student for each value of indicator. In the ICT subject area group we used five descriptors for each competence, and therefore for each indicator.

The 20 key competences defined in 5.2.4 have been described in this way, so 20 so-called passports of competences have been elaborated.

Some common guidelines for using various teaching methods, learning activities and assessment tools can be further elaborated for each competence concerned by a concrete programme. In the table below we



© University of Deusto - ISBN 978-84-15772-25-5

provide an example of a guideline for using different tools for assessing indicators of the first level of mastery of the competence [SSC-03] Ability to develop and implement ICT systems.

| [SSC-03] Ability to develop and implement ICT systems | [SSC-03.1] Software development for specific functional tasks | | |
|---|---|---|---|
| | Indicator [SSC-03.1.1] Development of detailed algorithms for solving functional tasks of information systems | Indicator [SSC-03.1.2] Development of software for information system components using modern tools | Indicator [SSC-03.1.3] Software testing |
| Tests | + | + | + |
| Interviews and colloquiums | | | |
| Reports | + | + | + |
| Presentation of work results | + | | |
| Reviews | | | |
| Demonstration of work results | | + | + |

Below we describe a tool for assessing whether a student has achieved learning outcomes planned in a given module. This tool makes use of the competences passports described above.

An assessment map is designed for each program module. This map includes all the competences concerned by the given module, and for each competence the corresponded level of mastery and its indicators are specified. Wordings of indicators are taken from the common passports of competences elaborated for the whole programme, the wordings can be made concrete all the better to describe the module.

For each module competence the corresponding assessment tools are indicated. For each pair <competence, assessment tool> the ratio of the partial mark for this pair to the final student mark is specified. Thus, the weight (importance) of the competence within the module can be calculated. It is indicated in the last column of the table.

In the table below, an example of assessment map for «Software engineering» module is given.

| Competence: level of mastery, indicators | Assessment tools | Percentage in final mark |
|---|---|---|
| [SSC-01] Ability to analyse subject area, identify, classify and describe problems; find the methods and approaches for solving them; define requirements.<br>[SSC-01.2] Ability to generate and to document alternative solutions; to investigate and to evaluate technical alternatives; to select and to justify methods and tools for problem analysis and solving; to participate in elaborating technical specification.<br><br>*Indicators / learning outcomes:*<br>1. The student distinguishes between different Software Engineering Process Models and the contexts in which they are appropriate.<br>2. The student defines and describes the basic strategies for the elicitation, analysis, negotiation and validation of requirements.<br>3. The student selects the appropriate strategies for the elicitation, analysis, negotiation and validation of the requirements of a specific problem.<br>4. The student elaborates a requirements specification document, without models, given a problem. | 10% = Test of knowledge<br>15% = Report | 25% |
| [SSC-02] Ability to design ICT systems, including modelling (formal description) of structure and processes<br>[SSC-02.2] Ability to design architecture and to elaborate technical specification for small systems and system components.<br><br>*Indicators / learning outcomes:*<br>1. The student develops accurate and complete Use Cases Models (essential, appropriate granularity, cohesive, correct from the notation perspective, expressive).<br>2. The student correctly uses the UML notation for producing Object Oriented Domain Models, which are consistent in relation to the use cases.<br>3. The student applies the steps to transition from requirements expressed by means of Use Case models and Domain Models, to design models, considering component-based logical architecture concepts. | 10% = Test of knowledge<br>20% = Report<br>10% = Presentation of work results | 40% |

| Competence: level of mastery, indicators | Assessment tools | Percentage in final mark |
|---|---|---|
| [GC-02] Ability to work in a team<br>[GC-02.1] Ability to participate and to collaborate actively in team tasks, and to focus on common work.<br><br>*Indicators / learning outcomes:*<br>1. The student collaborates with others in defining, organising and distributing group tasks.<br>2. The students focuses on and is committed to agreement and shared objectives. | 10% = Report<br>10% = Presentation of work results | 20% |
| [GC-22] Ability to search for, process and analyse information from a variety of sources<br>[GC-22.3] Ability to produce new information as a result of the search, analysis and compilation of information from different sources.<br><br>*Indicators / learning outcomes:*<br>1. The student retrieves the appropriate information, summarizes and produces new information; draws adequate conclusions. | 10% = Review<br>5% = Interview or colloquium | 15% |

| | Tests | Reports | Presentation of work results | Reviews | Interviews and colloquiums | Total |
|---|---|---|---|---|---|---|
| Subject-specific competences | 20% | 35% | 10% | 0% | 0% | 65% |
| Generic competences | 0% | 10% | 10% | 10% | 5% | 35% |
| Total | 20% | 45% | 20% | 10% | 5% | 100% |

# 8

# Subject area group

## Coordinators

Petrova Irina, Astrakhan State University, petrova@aspu.ru

Malikov Andrei, North-Caucasus Fedearl University, malikov@ncstu.ru

## Members

Zaripova Viktoriya, Astrakhan State University, vtempus2@gmail.com

Ishkina Evgeniya, Astrakhan State University, ishkina@aspu.ru

Militskaya Svetlana, Astrakhan State University, svetlana.militskaya@gmail.com

Kurmishev Nikolai, Yaroslav-the-Wise Novgorod State University, nikolai.kurmishev@novsu.ru

Kuzenkov Oleg, N.I.Lobachevsky State University of Nizhni Novgorod, kuoa7@uic.nnov.ru

Varfolomeev Viktor, Moscow State University of Railway Engineering, vvictor@mail.ru

Zakharova Irina, Tver State University, zakhar_iv@mail.ru

## Expert

Rayón Alex, University of Deusto, alex.rayon@deusto.es

© University of Deusto - ISBN 978-84-15772-25-5

# 9

# References


1. Denning, P.J. *et. al.* (1999). *Computing as a discipline*. [ONLINE] Available at: http://cs.gmu.edu/cne/pjd/GP/CompDisc.pdf. [Last Accessed 10 February 2013].

2. Sukhomlin, V.A. (2012). Analysis of international educational standards in the field of information technology. *Computer systems and tools*. 22 (2), pp. 278-307 (in Russian).

3. Wolfengagen, V.E. (2009). «Quarks, atoms, moleculs of computing». *Proceedings of the Russian-German Workshop «Innovation Information Technologies: Theory and Practice», Ufa, Russia*, pp. 5-6.

4. Wolfengagen, V.E. (2009). *Computing: scope and characteristics*. [ONLINE] Available at: http://jurinfor.ru/elibcs/articles/vew09s02/vew09s02.pdf. [Last Accessed 10 February 2013] (in Russian).

5. ACM and IEEE Computer Society (2005). *Computing Curricula 2005. The Overview Report*. [ONLINE] Available at: http://www.acm.org/education/curric_vols/CC2005-March06Final.pdf. [Last Accessed 1 March 2012].

6. The International Foundation for Information Technology (IF4IT). *Information Technology (IT)*. [ONLINE] Available at: http://if4it.com/SYNTHESIZED/GLOSSARY/I/Information_Technology_IT.html. [Last Accessed 5 February 2013].

7. ACM and IEEE Computer Society (2001). *Computing Curricula 2001. Computer Science*. *Funal Report*. [ONLINE] Available at: http://www.acm.org/education/curric_vols/cc2001.pdf. [Last Accessed 5 February 2013].

8. Association for Information Systems (2002). *IS 2002. Model Curriculum and Guidelines for Undergraduate Degree Programs in*

*Information Systems.* [ONLINE] Available at: http://www.aisnet.org/intranet/aiscouncilnet/aiscouncil/ccl2002/Curriculum IS 2002 9-25-2002 for ACM, AIS, and AITP.pdf. [Last Accessed 5 February 2013].

9. IEEE Computer Society (2004). *Computer Engineering 2004. Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering*. [ONLINE] Available at: http://www.acm.org/education/education/curric_vols/CE-Final-Report.pdf. [Last Accessed 5 February 2013].

10. IEEE Computer Society (2004). *Software Engineering 2004. Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering*. [ONLINE] Available at: http://sites.computer.org/ccse/SE2004Volume.pdf. [Last Accessed 5 February 2013].

11. ACM and IEEE Computer Society (2008) *Information Technology 2008. Curriculum Guidelines for Undergraduate Degree Programs in Information Technology*. [ONLINE] Available at: http://www.acm.org/education/curricula/IT2008%20Curriculum.pdf. [Last Accessed 5 February 2013].

12. All-Union State Standard 52653-2006 (2008). *Information and communication technologies in education. Terms and definitions.*

13. Murray, J. (2011). *Cloud network architecture and ICT*. [ONLINE] Available at: http://itknowledgeexchange.techtarget.com/modern-network-architecture/cloud-network-architecture-and-ict/. [Last Accessed 5 February 2013].

14. AP KIT (2009). *Analytical study «IT-staff 2010».* [ONLINE] Available at: http://www.apkit.ru/files/personal2009_final.pdf. [Last Accessed 1 March 2012].

15. Korshunov, S.V.; Guzenkov, V.N. (2005). *Training and retraining IT-staff. Issues and perspectives*. Moscow, Russia: Goryachaya liniya-Telecom (in Russian).

16. McLaughlin, S.; Sherry, M.; Carcary, M.; O'Brien, C. (2012). *e-Skills and ICT Professionalism. Fostering the ICT Profession in Europe. Final Report.* [ONLINE] Available at: http://ec.europa.eu/enterprise/sectors/ict/files/eskills/ict_professionalism_report_en.pdf. [Last Accessed 5 February 2013].

17. Sovetov, B.Ya. (2011). *On the problems of transition to two-level system in Russian higher education*. VII St. Petersburg Scientific and Practical Conference «Problems of training in the field of information and communication technologies», March 16, 2011.

# Contacts

The Tuning Project is coordinated by the University of Deusto (Spain) and the University of Groningen (The Netherlands).

**Tuning General Co-Coordinators:**


**Julia González**

juliamaria.gonzalez@deusto.es

**Robert Wagenaar**

r.wagenaar@rug.nl


The University of Deusto (Spain) is Coordinator of the Tuning Russia project:


**Pablo Beneitone**
**(Director)**

International Tuning Academy
Universidad of Deusto
Avda. de las Universidades, 24
48007 Bilbao
Spain
Tel. +34 94 413 9467
Fax. +34 94 413 9433
pablo.beneitone@deusto.es

**Ivan Dyukarev**
**(Tuning Russia Project Manager)**

International Tuning Academy
University of Deusto
Avenida de las Universidades 24
48007 Bilbao
Spain
Tel. +34 94 413 9466
Fax. +34 94 413 9433
ivan.dyukarev@deusto.es

The Association of the Classical Universities of Russia is Co-Coordinator of the project in Russia:

**Evgeniya Karavayeva**
**(Executive Director)**

The Association of the Classical Universities of Russia
Moscow State University,
Leninskiye Gory, GSP-1
Moscow, 119991, Russia
Tel. +7 495 939 25 05
Fax +7 495 939 16 24
karavaeva@rector.msu.ru

For more information visit our websites:

http://tuningrussia.org/
http://www.unideusto.org/tuningeu/

Tempus

Deusto
University of Deusto

university of groningen