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PROFESSIONAL ORIENTATION IN SOFTWARE ENGINEERING

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Abstract

The current situation, in which new study plans are being defined and Europe is heavily involved in an agreement on higher education, is fundamental to the future of certain degree courses such as that of computer engineering. The capacity to adapt these new study plans to the market's real necessities is, therefore, extremely important. In the case of computer engineering, both businesses and professionals are demanding increasingly more specialized profiles, principally in specialties such as software engineering, in which there are various specializations that are adapted to one or more international professional certificates. It is therefore extremely important that these new studies focus to a greater extent upon professional necessities, without losing sight of the scientific rigor demanded in engineering. If this objective is to be attained, it is fundamental that these new study plans have an orientation that will facilitate the obtaining of professional certificates. This paper provides an analysis of professional orientation when applied to the software engineering profile in the computer engineering degree at the University of Castilla-La Mancha, and can also be applied to many other degrees in computing within the Europe.

Keywords - Software Engineering, Professional Certifications

1 INTRODUCTION

The European Higher Education Space (EHES) came into being with the declaration at the Sorbonne in 1998, which highlighted the role of universities in the development of culture and knowledge within Europe. It was expanded with the Declarations of Bologna (June 1999), Prague (2001), Berlin (September 2003) and Bergen (May 2005), in which an agreement was reached by the participating countries to promote and develop a reformation of the structure and organisation of university teaching in order to stimulate the construction of the European Higher Education Space with the objective of favouring mobility and employment opportunities, along with ensuring that these new study plans would be adapted to business demands [1] in such a way that new professionals would raise productivity in the fabric of European business [2].

Spain's adoption of a system of flexible, comparable and compatible qualifications which will facilitate the mobility of students and degree holders is the principal objective of Royal Decree 1393/2007 of October 29th with which the regulation of official university teaching was established.

The University of Castilla-La Mancha has therefore created a study plan for the Computer Engineering Degree, which consists of four specialties (one of which is Software Engineering, which will be dealt with in this work), and which at the moment of writing this paper is being submitted to the ANECA¹ verification process.

In order to discover whether this degree is appropriate for real market needs [3, 4], it is necessary to analyse each subject, particularly those which are specialised, since the other subjects are optional or consist of basic or normal education within the branch of computer science. In this paper, therefore, we present an overview of each of the 8 subjects of which the intensification of the software engineering profile is made up, and we analyse them not only from the academic but also from the professional point of view. We shall also establish relationship mappings between the contents of these subjects and the contents of the principal professional certificates demanded by the market, with the objective of determining whether their orientation is correct, and to identify any contents which will complement these themes.

¹ Spanish agency for the quality and accreditation assessment.

The paper consists of four sections: In the first we shall present the current context of the creation of study plans, highlighting the necessity of software engineers being able to specialize in various areas and obtain professional certificates. In Section 2 we analyze the study plans of Software Engineering, commenting on the contents. In Section 3 we shall establish mappings between the contents of the principal professional certificates that each of the 8 subjects may lead to, and a comparison will be made between the contents of each certificate and those of the subjects. Finally, in the last section we shall describe the main conclusions obtained during this research, and we shall determine whether the new Software engineering profile is appropriate for professional requirements.

2 THE COMPUTER ENGINEERING DEGREE AT UCLM

The Computer Engineering degree at UCLM has been adapted to the EHES study plan by taking the three qualifications currently available (Advanced Computer Engineering, Technical Engineering in Computer Science Management and Technical Engineering in Computer Science Systems), and converting them into a single degree model consisting of four specialities or intensifications. These four intensifications correspond with four of the *Specific Technologies* from the General Secretary of Universities' General Resolution of June 8th 2009, which gave publicity to the University Council Agreement which recommended the proposals made by the Universities' official petition report on official qualifications in Computer Science Technical Engineering (BOE Num. 187 of 04/08/09) and the proposals made by the ACM [5-7], which are Software engineering, Computer Engineering, Computation and Information Technology

UCLM has two computer Science schools, on the Albacete and Ciudad Real campuses, which both offer the same degree courses (since this is the only one offered by the university), although differences in the choice of optional courses that each school offers its students do exist.

ACM and the norm elaborated by the Spanish government, defined 5 intensifications, the 4 shown here and that of information Systems, which was initially also considered as an intensification but which was, for various reasons, removed. However, the subjects that initially appeared in the intensification of Information Systems were moved to the optional course block, and it can therefore be considered that the UCLM degree includes all 5 technological blocks.

The newly proposed study plan is divided into a set of blocks oriented towards obtaining a degree which, on the one hand will centre on general aspects, signifying that the student will acquire at least transversal competencies and basic normal education in the branch of computer science, and on the other hand the competencies of at least one of the specialities recommended by the ACM.

ECTS	Structure of the title				Mod
12	Working order of degree				
24	Electivity				
48	Software Engineering	Information Technology	Computer Engineering	Computers	
36	Further training for the branch of Computer Engineering				3
60	Common training for the branch of Computer Engineering				2
60	Basic training for Engineering				1

Figure 1. Structure of the title "Computer Engineering of the UCLM"

Fig. 1 shows the general structure of the degree proposed by UCLM, which is made up of the following modules: i) Basic teaching module of 60 obligatory ECTS; ii) Teaching module common to the branch of computer science of 96 ECTS (60 ECTS of normal education and 36 ECTS of

complementary education); iii) Four technical modules specific to 48 ECTS, each of which includes an intensification of technology specific to each of the four that are offered; iv) there optional subjects, signifying that students can cover the 24 optional ECTS included in the Study Plan. They can also obtain 12 optional ECTS by participating in work experience in businesses, which is enormously important in assisting students to define their professional orientation; and v) there is an end of degree piece of work of 12 ECTS that must be carried out by all students.

From the methodological point of view, the design of the Study Plan has been based on a descending analysis, starting with the competencies moving to the subjects. The teaching-learning units are grouped thematically by materials and each piece of material is divided into one or various related subjects from the thematic point of view.

3 THE INTENSIFICATION OF SOFTWARE ENGINEERING

The intensification of software engineering proposed for the new degree in computer science engineering is made up of a total of 8 subjects of 6 ECTS each, supposing a total of 48 ECTS credits.

The realization of the specialisation module will allow students to tackle Software Engineering, Security and Auditing projects, covering all the aspects of their related life cycles, direct projects with guarantees of quality and to acquire the capacity to evaluate clients' needs and specify software requirements to satisfy these needs, reconciling conflictive objectives through the search for acceptable compromises within limitations of cost, time, the existence of already developed systems and of the organisations themselves, communicating in a clear and efficient manner, working in and with multidisciplinary teams, and adapting to changes. It will also allow them to practise this profession, being fully conscious of the human, economic, social, legal and ethical dimensions.

Below we show 8 subjects from the Software Engineering module whose content can be seen in detail in the following sub-section: i) Requirements Engineering; ii) Software Design; iii) Data Base Development; iv) Business Information Systems; v) Software Engineering Processes; vi) Software Systems Security; vii) Software Systems Quality; viii) Software Project Management.

4 PROFESSIONAL CERTIFICATES FOR SOFTWARE ENGINEERS

The present moment, during which the new study plans are being defined and Europe is immersed in the higher education convergence process, is fundamental for the future of certain studies which are so new, so changeable and which depend to such a great extent upon society's progress, as is the case of Computer Science Engineering [8]. The capacity to adapt the new study plans to real market needs is, therefore, extremely important. In the case of Computer Science Engineering, businesses and professionals are demanding increasingly more specialized profiles (here we analyse those related to software development), signifying that it is desirable for future graduates to obtain one or various international professional certificates [9, 10], or at least have the way prepared to obtain them. It is therefore very important that the new studies be highly focused on professional needs [11], without losing the scientific rigour demanded by engineering, and to achieve this objective it is fundamental that these new study plans be oriented towards obtaining professional certificates

It is of great importance to show businesses that the subjects of which the new specialisation areas are made up really offer what the market demands, establishing relational maps between the contents of the subjects and the contents of the principal professional certificates demanded by the market. Managing to link this with real educational needs in practice is a challenge that offers many advantages, both for professionals who will obtain a more direct insertion into employment, and for the businesses themselves who will see their needs satisfied much more quickly and, moreover, in an international context.

Below we shall analyse the existing relationship between each of the subjects of which the Software Engineering profile is made up, along with the principal professional certificates associated with them, which will allow us to discover the proximity of said subjects to the most frequently demanded professional profiles (based on a set of abstract descriptions). We shall name the most relevant professional certificates, associated with each subject, together with their contents, and we shall contrast them with the descriptors defined for that subject. We shall also show those subjects which may help to cover the contents of the certificates, and those aspects of the certificates which are not within the official agenda.

Evidently this is not a question of obtaining professional certificates with the subjects, but of offering the students the bases through which to achieve them, and of bringing the contents of the subjects closer to the contents of the certificates, which are directly connected to the most frequently demanded professional needs.

4.1 Requirements Engineering

In the case of Requirements Engineering there exists a small but select group of international certificates which have attempted to tackle the material in this subject. Amongst the most prominent are:

- Value Requirements Certification (GILB-VRC), GILB the consultancy, which consists of the following modules: i) Paradigm shift in thinking about requirements; ii) How to specify Product Quality Requirements; iii) How to specify Stakeholder Value Requirements; iv) How to specify Function Requirements; v) How to specify Design Constraints; vi) The various requirements concepts defined and exemplified; vii) Practical examples; viii) Standards for requirements (templates, rules, processes, glossary); ix) How to quantify any qualitative requirement; x) Advanced quantification-scale specification methods; xi) How to measure a requirement level numerically; xii) Principles for requirements; xiii) Changing requirements culture; xiv) Expected results from requirements culture improvement; xv) A policy for improved requirements.

And the certifications ISEB and IREB of International Software Quality Institute (ISQI):

- Certificate in Requirements Engineering (ISEB): i) The role of the analyst; ii) The requirements engineering process; iii) Actors and viewpoints; iv) Project initiation; v) Facilitated workshops; vi) Other requirements elicitation techniques; vii) Fact-finding Interviewing; viii) Documenting requirements; ix) Analysing requirements; x) Scenarios and prototyping; xi) Requirements management; xii) Options; xiii) Validating requirements.
- iSQI: Certified Professional for Requirements Engineering (IREB): i) Requirement types and description; ii) Requirements elicitation; iii) Requirements Specification; iv) Domain model; v) Validation of requirements; vi) Requirements Management; vii) Best practices and tools.

Table 1 shows how the descriptors of the subject include the knowledge required by the principal professional certificates, providing the student with extra contents which are not demanded by the certificates. We should also highlight that the GILB-VRC certificate presents a structure of modules whose organization varies to a great extent from the subject of "Requirements Engineering" and from the other certificates.

Requirements Engineering	GILB-VRC	iSQI-ISEB	iSQI-IREB
Fundamentals of software analysis.	i ii; iii; iv; v vi, viii; ix; xi; xii	I	i, ii, iii, iv
Software requirements.		li	
Types of requirements.		ii, iii	
Elicitation.		iv, vi	
Analysis, specification and validation of software requirements.		v, vii; viii; ix	
Object Oriented Analysis			
Advanced notations.	x		
Requirements management tools.	vii	X	vii
Requirements management methods.	xiii; xiv; xv	xi; xii; xiii	v, vi
Aspects not covered by the subject:			
Percent Compliance:	100%	100%	100%

Table 1. Relationship between the "Requirements Engineering" and their certifications

4.2 Software Design

As with the previous sub-section, a small group of international certificates centred on tackling the material in the "Software Design" subject exists. Among the highlights are the iSAQB and ICQA of International Software Quality Institute (ISQI), the SAPC and ATAM of Software Engineering Institute (SEI) and CSPM of European Certification & Qualification Association (ECQA).

- iSQI: Certified Professional for Software Architecture (iSAQB): i) Software Architecture; ii) The Software Architect; iii) Software development Process; iv) Notation and Modelling; v) Architecture concepts; vi) Processes; vii) Technologies and Tools.
- iSQI: Certified SW Architect (iCSA): i) Results of the analysis phase would not lead to conscious decisions in later phases and would be lost; ii) The structure and behaviour of the software would result at best from individual technological decisions and at worst accidentally;

iii) Knowledge gained in previous projects would stay with the individual developer and could easily be lost or not re-used; iv) Flexibility and extensibility would be limited or would affect the consistency of the software design; v) Documentation becomes a chore when it has no direct relationship to the software system; vi) Comprehensibility and the complete overview suffer, especially for external project members such as management, operator and customers.

- SEI Software Architecture Professional Certificate (SAPC): i) Software Architecture: Principles and Practices; ii) Documenting Software Architectures; iii) Software Architecture Design and Analysis; iv) Software Product Lines.
- SEI Architecture Tradeoff Analysis Method (ATAM) Evaluator Certificate: i) Documenting Software Architectures; ii) Software Architecture Design and Analysis; iii) ATAM Leader Training.
- ECQA Certified SW Project Manager (CSPM): i) Software Architecture; ii) The Professional for Software Architecture; iii) Procedure; iv) Notation and Modelling; v) Architectural Concepts; vi) Processes; vii) Technologies and Tools.

Table 2 shows how the descriptors of the subject include the knowledge required by the principal professional certificates, which provide the student with extra contents that the certificates do not include, with the exception of some cases in which the certificates are oriented towards very specific themes (eg. The third chapter of the SEI-ATAM).

Software Design	iSQI-ISAQB	iSQI-ICSA	SEI-SAPC	SEI-ATAM	ECQA-CSPM
Fundamentals of software design.	v	i; ii; iii; iv; v; vi	i	i	i, v
Object-oriented design.			ii; iii	ii	
Software Architecture.	i; ii				ii
Software design patterns.	iii; vi		iv		iii, vi
Analysis and design evaluation.					
Advanced notations.	iv				iv
Other design strategies.					
Analysis and design tools.	vii		iv		vii
Aspects not covered by the subject:				iii	
Percent Compliance:	100%	100%	100%	66%	100%

Table 2. Relationship between the "Software Design" and their certifications

4.3 Software Process Engineering

In the case of "Software Process Engineer", there are two organizations that have gained recognition with its certifications, the European Certification & Qualification Association (ECQA) with CCCM certification, and CQSPE and CSPE of QAI Global Institute.

- ECQA Certified Configuration and Change Manager (CCCM): i) Fundamentals of Configuration Management; ii) CM Activities; iii) CM Organisation; iv) CM Planning; v) Automation of CM; vi) Improving CM. This certificate is focused on a specific aspect of the "Software Design" as change management.
- QAI: Certified Software Process Engineer (CSPE): i) SE 100 Series - Software Engineering Process Approach; ii) SE 201: Basic Concepts of Software Project Management; iii) SE 202: Software Project Measurement and Metrics; iv) SE 301: Basic Concepts of Software Quality; v) SE 303: Formal Technical Reviews; vi) SE 501: An Introduction to Software Testing.
- QAI: Certified Quantitative Software Process Engineer (CQSPE): i) The significance of managing a process quantitatively; ii) Formulation of a measurement action plan for the quantitative management of critical organizational processes; iii) Collection, verification, and organization of the process data corresponding to critical organizational processes; iv) Selection and use of an appropriate statistical tool to organize, analyze, and interpret process data; v) Methods to analyze and control of the performance of a process and sustain the controlled state of the process; vi) Initiation and maintenance activities for improving critical organizational processes.

Table 3 shows that the descriptors of the subject contain the thematic groups identified in the principal professional certifications, which even provide additional contents that are not reflected in the certifications. In the case of QAI-CSPE some contents exist that are related to the quality that is dealt with in the subject "Software Quality", which complement the knowledge required for the certification.

Software Process Engineering	ECQA-CCCM	QAI-CSPE	QAI-CQSPE
Construction of software.		i; ii; iii	i-vi
Management implementation.			
Fundamentals of software testing techniques tested.	i-v	v; vi	
Configuration management software.			
Process configuration management.			
Fundamentals of software maintenance.			
Maintenance techniques.			
Modeling and specification of software processes.			
Other subjects in the module:			
Software Quality Systems		iv	
Aspects not covered by the subject:		i	
Percent Compliance:	100%	100%	100%

Table 3. Relationship between the "Software Process Engineer" and their certifications

4.4 Software Quality Systems

In contrast to the few existing certifications for other subjects, in the case of "Software Quality Systems" a considerable amount of certifications are centred on this theme. These certifications tackle problematic aspects from two perspectives: quality and tests. Of the principal certifications available we can highlight

- 4 Del QAI Global Institute: Certified Associate in Software Testing (CAST); Certified Software Quality Analyst (CSQA); Certified Software Tester (CSTE); y Certified Software Tester (CSTE).
- 7 de la de la American Society for Quality (ASQ): Certified Software Quality Engineer (CSQE); CQA (Certified Quality Auditor); ASQ: CQE (Certified Quality Engineer); CQT (Certified Quality Technician); ASQ: CQI (Certified Quality Inspector); ASQ: CMQ/OE (Certified Manager of Quality/Organizational Excellence); ASQ: CQIA (Certified Quality Improvement Associate); ASQ: CQPA (Certified Quality Process Analyst).
- 1 del International Software Quality Institute (ISQI): Certified Tester (ISTQB).
- 1 created by Sogeti Netherlands which is a part of the French Capgemini: TMap NEXT
- 1 of European Telecommunications Standards Institute (ETSI): The Testing and Test Control Notation Version 3 (TTCN-3) Certificate.

Given the large number of certifications available in this section we will concentrate on analyzing the 4 most important:

- QAI: Certified Software Quality Analyst (CSQA): i) Quality Principles and Concepts; ii) Quality Leadership; iii) Quality Baselines (Assessments and Models); iv) Quality Assurance; v) Quality Planning; vi) Define, Build, Implement, and Improve Work Processes; vii) Quality Control Practices; viii) Metrics and Measurement; ix) Internal Control and Security; x) Outsourcing, COTS and Contracting Quality.
- QAI: Certified Manager of Software Quality (CMSQ): i) Quality Planning; ii) Define, deploy and improve work processes; iii) Measurement; iv) Organizational Development; v) Communication; vi) Risk Management.
- ASQ: CQE (Certified Quality Engineer): i) Management and Leadership; ii) The Quality System; iii) Product and Process Design; iv) Product and Process Control; v) Continuous Improvement; vi) Quantitative Methods and Tools.
- ASQ: CQT (Certified Quality Technician): i) Quality concepts and tools; ii) Statistical techniques; iii) Metrology and calibration; iv) Inspection and test; v) Quality audits; vi) Preventive and corrective action.

In Table 4 it is possible to analyse how the descriptors of the subject include the knowledge required for the principal professional certifications, although there are fewer than for other subjects. Some of the knowledge needed for these certifications can be complemented with material from other subjects, such as security concepts which can be complemented with the subject “Software Systems Security”, or project risk management that is tackled in “Software Project Management”. But other knowledge also exists which is not currently tackled, such as the concepts of cost-associated Outsourcing, or the quality auditing that is required by specific operative subjects.

Software Quality Systems	QAI-CSQA	QAI-CMSQ	ASQ-CQE	ASQ-CQT
Fundamentals of software quality.	i; ii		i , ii	i, ii
Process quality.	iii; iv; v; vi	ii	iii, iv	
Quality of product.				
Verification and validation of software.				iv
Measurement software.	viii	iii		lii
Evaluation and improvement of software processes.	vii			vi
Quality management software.		i	v	
Standards and quality standards.			vi	
Tools of quality management.				i
Other subjects in the module:				
Software Project Management		vi		
Software Systems Security	ix			
Aspects not covered by the subject:	x	iv; v		v
Percent Compliance:	90%	70%	100%	80%

Table 4. Relationship between the "Software Quality Systems" and their certifications

4.5 Software Project Management

Few certifications related to “Software Project Management” exist, but some of these are of great significance to the software industry. Of the principal certifications available we can highlight:

- 2 Del QAI Global Institute: Certified Software Project Manager (CSPM), Certified Software Business Analyst (CSBA).
- 3 Del Project Management Institute (PMI): Certified Associate in Project Management (CAPM), Project Management Professional (PMP), y Risk Management Professional (PMI-RMP).
- 1 Del International Software Quality Institute (ISQI): Certified Professional for Project Management (CPPM).
- 1 Del European Certification & Qualification Association (ECQA): ECQA Certified EU Project Manager.

Among these certifications, we focus on the 4 most relevant in the market have taken:

- QAI: Certified Software Project Manager (CSPM): i) Principles of Software Project Management; ii) Risk Management; iii) Managing the Project Staff; iv) Schedule and Budget Management; v) Software Project Control; vi) Defining Software Requirements; vii) Measurement and Status Reporting; viii) Software Development and Deployment Processes; ix) Software Testing; x) Configuration Management.
- PMI: Project Management Professional (PMP): i) Initiation, ii) Planning, iii) Executing, iv) Monitoring and Controlling, v) Closing, vi) Professional and Social Responsibility,
- iSQI: Certified Professional for Project Management (CPPM): i) Overview, bases, terms; ii) Project organizational types; iii) Process and procedural models; iv) Project initiation and aims of the project; v) Project planning; vi) Project steering and control; vii) Requirements management; viii) Human resource management; ix) Project acceptance and conclusion; x) Risk management, project management from another perspective; xi) Overview of software quality management; xii) Software development with CMMI and SPICE.

Table 5 shows that the subject in itself does not cover any of the certifications, since the knowledge provided by other subjects in the module is necessary (Requirements Engineering,

Software Process Engineer, and Software Quality Systems). On the other hand, some aspects such as “social and professional responsibility”, human resources management”, and certain aspects centred on specific methodologies such as CMMI and SPICE (which are tackled at Master’s rather than degree level at this university) are also pending.

Software Project Management	QAI-CSPM	PMI-PMP	iSQI-CPPM
Strategic planning.	i, iii, iv	i, ii	v
Project planning software.			
Estimate.			
Monitoring and control software projects.	V	iii, iv, v	Vi, ix
Risk management.	li		x
Project management tools.			
Other subjects in the module:			
Requirements Engineering			vii
Software Process Engineer	i, iii, vi, vii, viii, x		I, ii, iii, iv
Software Quality Systems	lx		Xi
Aspects not covered by the subject:		vi	viii, xii
Percent Compliance:	100%	85%	90%

Table 5. Relationship between the "Software Project Management" and their certifications

4.6 Database Development

In the case of "Database Development", very few generic certificates and among these, only worth mentioning those of the Insurance Data Management Association (IDMA):

- IDMA: Certified Computing Professional (CCP): i) Data Management; ii) Data & Metadata Infrastructure Creation/Maintenance; iii) Data Analysis and Design; iv) Data/Metadata Infrastructure Management; v) Information Quality Management.
- IDMA: Certified Data Management Professional (CDMP): i) IT Core; ii) Data Management; iii) Data Warehousing; iv) Database Administration; v) Integrated Project Management; vi) IT Management; vii) Systems Development; viii) Business Intelligence; ix) Data and Information Quality.

However, a wide set of certificates offered by private companies and centred on their own Data Base Management Systems (DBMS) does exist. Of these, those which are most successful on the current market are those offered by Microsoft, Oracle and IBM.

- Microsoft offers certifications related to Database:
 - Database Developer (MCITP-DD): i) Microsoft SQL Server 2005 - Implementation and Maintenance; ii) Designing Database Solutions by Using Microsoft SQL Server 2005; iii) Designing and Optimizing Data Access by Using Microsoft SQL Server 2005.
 - Database Administrator (MCITP-DA): i) Microsoft SQL Server 2005 - Implementation and Maintenance; ii) Designing a Server infrastructure database using Microsoft SQL Server 2005, iii) Optimizing and maintaining a management solution database using Microsoft SQL Server 2005.
 - Business Intelligence (MCITP-BI): i) Microsoft SQL Server 2005 Business Intelligence - Implementation and Maintenance; ii) Designing a Business Intelligence Solution by Using Microsoft SQL Server 2005.
- Oracle offers a number of certificates, but for the present paper we will focus only on the Oracle Certified Database Administrator (OCDA), whose main contents are: i) 1Z0-051 - SQL Fundamentals I (Explore the Lifecycle Development Phases, Write and Execute a Basic SQL Statement, Examine Single Row Functions, Create Tables and Views, Control User Access); ii) 1Z0-052 - Oracle Database: Fundamentals I (); iii) 1Z0-053 - Oracle Database: Fundamentals II; iv) 1Z0-054 - Oracle Database: Performance Tuning. The contents of "Business intelligence" are complemented by an extension of Oracle, Oracle Business Intelligence Applications Release (OBIAR).
- IBM has a set of certifications us oriented DBMS called DB2. These certifications, the most important are: i) IBM Certified Database Administrator (CDA); ii) IBM Certified Database

Administrator - DB2 Universal Database; iii) IBM Certified Advanced Database Administrator (CADA) – DB2 Universal Database; iv) IBM Certified Solutions Expert - DB2 Universal Database. Main contents of which can be grouped as follows: DB2 9 Family Fundamentals (000-730): i) Planning, Security; ii) Working with Databases and Database Objects; iii) Working with DB2 Data using SQL; iv) Working with DB2 Tables; v) Views and Indexes; vi) Data Concurrency. DB2 9 DBA for Linux UNIX and Windows (000-731): i) DB2 Server Management; ii) Data Placement; iii) Database Access; iv) Analyzing DB2 Activity; v) Utilities; vi) High Availability. The contents of “Business Intelligence” are supplemented by the Cognos tool.

Table 6 shows the descriptors of the subject, including the majority of the knowledge required by the principal professional certifications, which provide the student with extra contents which are not contained in the certifications, such as aspects of DB security. On the other hand, the subject syllabus is complemented with other subjects from the module such as “Software Systems Quality” and degree options such as “Data Base Administration” and “Advanced Data Bases”. However, the certifications with specific technological contents are not completely covered, since they require a specific number of hours for each of these technologies (e.g. SQL Server, Oracle, DB2).

Database Development	IDMA-CCP	IDMA-CDMP	Microsoft	Oracle	IBM
Data Requirements.	i, ii, iii, iv	I, ii, iv, v, vi, vii	MCITP-DD MCITP-DA	OCDA	CDA CADA
Conceptual design.					
Logical Design.					
Physical Design.					
DB Security.					
Advanced design data.		iii, viii	MCITP-BI	OBIAR	Cognos
Other subjects in the module:					
Software Quality Systems	v	ix			
Other subjects:					
Database Administration			MCITP-DD MCITP-DA	OCDA	CDA CADA
Advanced Databases		iii, viii	MCITP-BI	OBIAR	Cognos
Aspects not covered by the subject:			SQL Server	Oracle	DB2
Percent Compliance:	100%	100%	50%	50%	50%

Table 6. Relationship between the "Database Development" and their certifications

4.7 Business Information Systems

Very few generic certifications exist for “Business Information Systems”, between the existing one is worth mentioning the two offered by the European Certification & Qualification Association (ECQA), Certified Computing Professional (CCP) and Certified Data Management Professional (CDMP):

- ECQA Certified e-Business Manager (CeBM): i) Managing E-Business; ii) Managing Support; iii) Understanding E-Business.
- ECQA Certified e-Commerce Engineer (CeCE): i) Advanced Applications; ii) Basic Applications; iii) Database; iv) Security.

However, a wide set of certifications offered by private companies and centred on their own Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) does exist. Of these, those that are most successful in the current market are those offered by SAP and Microsoft

- SAP offers more than 100 certifications, divided into three groups according to the orientation of the same: i) Application certification: SAP-oriented operation; Technology certification: aimed at the implementation and application maintenance, certification and Development: aimed at development and parameterization of new modules using ABAP programming language.

- For its solution Microsoft ERP / CRM goes through an application called Navision is an integrated solution for complete management and cost updating and adapting to the needs of small and medium enterprises. Includes functionality that helps organizations to reduce the burden of daily administrative tasks and optimize the communication and interaction internally and externally. The key features are: i) Analysis ii) E-Business; iii) Financial management; iv) Management of the supply chain v) customer relationship management (CRM), vi) Project Management vii) Retail Management viii) Human Resources Management. And the main certification is la Business Management Solutions Specialist for Microsoft Dynamics NAV (BMSS-NAV): i) Costing; ii) C/SIDE Introduction in Microsoft Dynamics NAV 5.0; iii) C/SIDE Solution Development in Microsoft Dynamics NAV 5.0; iv) Financials in Microsoft Dynamics NAV 5.0; v) Installation and Configuration in Microsoft Dynamics NAV 5.0; vi) Manufacturing in Microsoft Dynamics NAV 5.0; vii) Relationship Management; viii) Service Management; ix) Trade and Inventory in Microsoft Dynamics NAV 5.0; x) Warehouse Management.

Table 7 shows that the subject syllabus includes a wider-ranging list of themes than that required by the principal professional certifications, thus providing students with contents of great professional worth (e.g. the aspect of process integration), which are not contained in the certifications. However, the syllabus does not include knowledge concerning the handling of specific applications of those companies in charge of producing the certification (e.g. SAP, Navision, etc.).

Business Information Systems	ECQA-CeBM	ECQA-CeCE	SAP	Microsoft
Fundamentals of business information systems.				
Integration of business processes.				
Implementation, selection and acquisition.				
Business and electronic commerce.	i, ii, iii	i, ii		
Business solutions in information systems: CRM, ERP, SCM.			SAP	BMSS-NAV
Other subjects:				
Software Systems Security		iv		
Database Development		iii		
Aspects not covered by the subject:			SAP	Navision
Percent Compliance:	100%	100%	50%	50%

Table 7. Relationship between the "Business Information Systems" and their certifications

4.8 Software Systems Security

In contrast to the few certifications that exist for other subjects, software systems security is by far the theme that has become most relevant in the private sector, which has given rise to a large number of different certifications [9]. Of the principal certifications specifically oriented towards security, we can highlight:

- 1 ISQI: Certified Professional for Secure Software Engineering (ISSECO), TeleTrust Information Security Professional (TISP).
- 2 ECQA: ECQA Certified e-Security Manager, ISECMA© ECQA Certified Professional for IT-Security Management.
- 7 ISC: Certified Information Systems Security Professional (CISSP), Information Systems Security Architecture Professional (ISSAP), Information Systems Security Management Professional (ISSMP), Information Systems Security Engineering Professional (ISSEP), Certification and Accreditation Professional (CAP), Systems Security Certified Practitioner (SSCP), Certified Secure Software Lifecycle Professional (CSSLP).
- 1 ISACA: Certified Information Security Manager (CISM)
- 1 DRI (Disaster Recovery Institute): Certified Business Continuity Professional (CBCP):
- 1 SANS Global Information Assurance Certification (GIAC):
- 2 ISECOM (Institute for Security and Open Methodologies): Security Tester (OPST), Security Analyst (OPSA).
- 1 CompTIA Security+ - Computing Technology Industry Association
- 3 EC-Council: Certified Ethical Hacker (CEH), Computer Hacking Forensic Investigator (CHFI), Licensed Penetration Tester (LPT).

And some that have focused on developing the field of auditing, including:

- 2 ISACA: Certified Information System Auditor (CISA), Certified in the Governance of Enterprise IT (CGEIT).
- 1 Lead Auditor ISO27001.

Given the big number of certifications available in this section we will concentrate on analyzing the 6 most important:

- ISC: Certified Information Systems Security Professional - Certified Information System Security Professional - (CISSP): i) Information Security and Risk Management; ii) Access Control Systems and Methodology; iii) Cryptography; iv) Physical Security; v) Security Architecture and Design; vi) Legal, Regulations, Compliance, and Investigation; vii) Telecommunications and Network Security; viii) Business Continuity and Disaster Recovery Planning; ix) Applications Security; x) Operations Security.
- ISECMA© ECQA Certified Professional for IT-Security Management: i) IT-SM-B-NS Network Security; ii) IT-SM-B-SA System Administration; iii) IT-SM-B-SP Security Policy.
- SANS Global Information Assurance Certification (GIAC): It is a set of security-related certification and audit and that focus on the following domains: i) Security Administration, ii) Security Management, iii) IT Audit, iv) Software Security.
- ISACA: Certified Information Security Manager (CISM): i) Information Security Governance; ii) Information Risk Management; iii) Information Security Program Development; iv) Information Security Program Management; v) Incident Management & Response.
- ISACA: Certified Information System Auditor (CISA): i) IS Audit Process; ii) IT Governance; iii) Systems and Infrastructure Lifecycle Management; iv) IT Service Delivery and Support; v) Protection of Information Assets; vi) Business Continuity and Disaster Recovery.
- ISACA: Certified in the Governance of Enterprise IT (CGEIT): i) IT Governance Framework; ii) Strategic Alignment; iii) Value Delivery; iv) Risk Management; v) Resource Management; vi) Performance Measurement.

Table 8 shows that the subject syllabus includes the majority of the knowledge required, although this must be complemented with other optional subjects, and only a few specific methodologies, such as is the case of the COBIT methodology offered by ISACA are not within the scope of this subject.

Software Systems Security	ISC-CISSP	ISECMA-ECQA	SANS-GIAC	ISACA-CISM	ISACA-CISA	ISACA-CGEIT
Security basics.	i	i	i	i	i, ii, iii	i, ii, iii
Organizational Security.						
Safety requirements.						
Security in software development.	v		iv	iii		
Security of information systems.	i				i, ii, iii	i, ii, iii
Security risks.	i			ii	v	iv
Security services.	ii, iv, vii, viii, x	iii		v	iv, vi	
Security management.	i	i	ii	iv	i, ii, iii	v, vi
Certification, standards and safety standards.	vi					
Other subjects:						
Information Systems Audit	ix		iii	i	i, ii, iii	i, ii, iii
Cryptography	iii	ii				
Network Security		ii				
Aspects not covered by the subject:						COBIT
Percent Compliance:	100%	100%	100%	100%	100%	80%

Table 8. Relationship between the "Software Systems Security" and their certifications

5 CONCLUSION

In this paper we have demonstrated the importance of the current restructuring of study plans in order to adapt them to the EHES, both for the students' professional future and for the stable long and medium term growth of the fabric of European business.

To do this it is fundamental to carry out study plans in accordance with real market needs, so that these plans will serve as a catalyst in the increase of productivity and of the market fabric. These study plans must therefore agree with the market demand.

Some of the best indicators of market needs are professional certifications, which tend to appear in order to provide solutions to companies' concrete demands. We can therefore conclude that that a study plan which is capable of suitably preparing its students and providing them with the aptitudes that will guarantee that they can obtain the majority of professional certifications required by businesses will be of enormous worth, both to the students and to the companies.

Therefore, and with the objective of evaluating the profile of Software Engineering in the Computer Science Engineering degree, we have analysed the professional certifications most frequently demanded by those businesses related to this profile, and although we have detected certain aspects which could be improved, they are isolated and could be mitigated by optional and post-graduate subjects.

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