Defining and Classifying Learning Outcomes: A case study

Abstract

Bologne came globalize the education in higher education, creating a unified architecture that potentiated higher education and enhances the continued interconnection of the spaces of education policy in higher education in the world, in particular in Europe. The aim of this work consists in the presentation of an identification model and skills classification and learning outcomes, based on the official documents of the courses units (syllabus and assessment components) of a course of Higher Education. We are aware that the adoption of this model by the different institutions, will contribute to interoperability learning outcomes, thus enhancing the mobility of teachers and students in the EHEA (European Higher Education Area) and third countries.

Keywords: Learning Outcomes, Interoperability, Bologne, Syllabus, Topics.

Introduction

Since implementation of the Bologne process, the curriculum has become a focuses of attention of European Universities, inserted in the context of the European Higher Education Area (EHEA) and of the Bologne Process. The European Higher Education Institutions, inserted the context of the EHEA and the Bologna process, have organized their curricula so as to conform more with the guidelines patents in the Bologne Declaration. In Portugal, the Decrees-Law n.ºs 49/2005: Subsection IV 2005, 74/2006, 65/2006 and 107/2008 regulating these guidelines.

The mobility and employability of students in EHEA are goals advocated by Bologne since 1999. The mobility of high quality contributes to the expansion and academic exchange and transfer of knowledge and innovations. Mobility is essential to ensuring higher quality education and is also an important pillar for exchange and collaboration with other parts of the world (EHEA, 2012).

Thus, is necessary to create a coherent space, compatible, competitive and attractive to students and teachers, not only Europeans as of third countries, where teaching and research can be shared.

The development of tools for comparing curricula is of special interest in the context EHEA because have the potential to promote the improvement of syllabus of different educational institutions and allow these harmonize with the demands of the labour market and international trends in corresponding sectors of the economy, which, in turn, may increase the overall quality of education, and in particular, facilitate the mobility of students. On 23 April 2008, the Presidents of the European Parliament and of the Council of the European Union, have signed the Recommendation on the European Qualifications Framework for Lifelong Learning (EQF) being this shortly Formally (Attachment 1).

The purpose of this article is to develop, systematize and describe the study that aims to identify and classify the Learning Outcomes (LO) of the Units Courses (CU) of a scientific area of a course in

Business Sciences, based on competences and LO extracted from official documents, in the areas of Education/Information Management applied to Web and Educational Technology.

Structurally the article is divided into seven sections. After defining the concepts, the problem, the objectives and the investigation questions are defined. Then, is presented the research strategy and for achieving the objectives and the results obtained. Finally, are presented the conclusions and proposals for future work.

Definition of Concepts

Are many and diversified the definitions that exist in the literature for curriculum. In our opinion, perhaps the most consensual is, the definition presented by Ribeiro (1996) - the curriculum is a "structured plan and sequential of teaching and learning, which includes objectives, contents, strategies, activities and learning evaluation, covers different scopes (macro or micro), relates to contexts (formal or informal) and educational experiences (explicit or implicit) in school. "

To define the concept of LO we adopt the terminology used in the European Commission (2008), "increasingly used by Member States", in accordance with CEDEFO (2010). The European Commission (2008) defines LO “as what a learner knows, understands and is able to do” on completion with success of a learning process, described in terms of knowledge, skills and competences. Of Which:

- Knowledge, also designated as "Knowledge & Understanding" (UCE Birmingham, 2006), the result of assimilation of information through learning. The knowledge is the body of facts, principles, theories and practices related to an area of work or study.
- Skills, also designated as "Intellectual (thinking) Skills" and "Practical Skills (subject-specifics)" (UCE Birmingham, 2006), the ability to apply knowledge and use resources acquired to complete tasks and troubleshoot, describe themselves as cognitive skills (including the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).
- Competences, also designated as "Key/Transferable Skills (generic)" (UCE Birmingham, 2006) and Competences (CEDEFO, 2010), the proven ability to use knowledge, the skills and the personal capabilities, social and/or methodological in professional situations or study contexts and for the purposes of professional and personal development.

That is, the LO can be defined as to what the learner knows, understands and is able to do on completion of a learning process, described in terms of knowledge, skills and competence (Knowledge, skills and competence).

Objectives and Investigation Questions

The present investigation has as objective the development of a model of extraction, classification and organization of the LO of a scientific area of a course in business sciences.

To pursue the goal mentioned, we define the following specific objectives:

1. Identify what one learns regarding IST (Information Systems and Technology), in CU of scientific area of Informatics, on the course of degree in Accounting and Administration of ISCAP/IPP, taking into consideration that the granularity of the contents can vary within the same curriculum. This variability is reinforced if we take account curriculum from various countries with different traditions (Laborde et al., 2008).

2. Understand the level of complexity of content taught, given specific powers in the field of knowledge (Bloom, 1989) and transferable skills, including skills for living and working in the information society and knowledge (Harel cited in Crespo, L, 2010).
3. Manage the LO, classified by categories, using a System Management Database (DBMS) relational.

To begin the study, we define the following research question:

What are the LO expected in the conclusion of CU of a scientific area, of a course of Higher Education?

According to the Recommendation of the European Parliament and of the Council for implementing of the EQF, in 2008, the LO to be undertaken in higher education should result in the acquisition by students of a set of specific and generic skills training. This notion of competence should normally be understood in a broad sense of acquisition of skills, knowledge and qualifications indispensable to the exercise of a given activity or to obtain a particular professional profile. The acquisition of competences takes place in the learning environment to which contributes the various curricular units that make up a course. The competences are divided into two large groups:

- Specific skills, specific from each scientific area, which translate by the acquisition, domain, application and communication of knowledge in a specific area of knowledge;
- Generic skills, also called transferable skills, common to many higher education courses and which could take instrumental character (cognitive skills, methodologies, techniques and linguistic), interpersonal (individual skills developed in cooperation environments, decision and social interaction) or systemic (adaptation capacities and leadership, initiative and creativity).

In order to operationalize the previously enunciated issue, necessarily open and embracing, we proposed to explore a set of sub questions which they are formulated in Table 1.

The issues are grouped into three categories according to their main focus be directed to the identification of knowledge (Category I), to educational objectives (Category II) or transferable skills, particularly in IT.

Table 1 - Investigation Questions

Category I – Focus on Identification of knowledge - Content (What?)
Q1: What knowledge (content) is taught in the CU of the scientific area of Informatics, in the bachelor course in Accounting and Administration of ISCAP / IPP? Q2: With which detail we intend to clarify this knowledge (granularity)?
Category II – Focus on the classification of educational goals (With that level of requirement?)
Q3: What goals of instruction in the cognitive domain (Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation) shall have acquired the students in the knowledge taught (content) in the scientific area of Informatics, at the conclusion of the respective CU?
Category III – Focus on the classification of generic skills

Q4: What transferable skills, particularly in IT, (IT skills - 3X: eXploration [eXploration], expression [eXpression] and exchange [Exchange]) shall have acquired the students in the scientific area of Informatics, at the conclusion of the respective CU?

State of the Art

The way we oriented and designed this study with a view to the treatment of the problem presented in the previous section, depending on the focus, was inspired in different taxonomies.

Category I – Focus on Identification of knowledge - Content (What?)

In this category we use standards in the areas of the business and in the areas of computer sciences, giving special importance to the NBES (National Business Education Standards) and ACM (Association for Computing Machinery), respectively.

Category II – Focus on the classification of educational goals (With that level of requirement?)

In bibliography there are many taxonomies for classification of educational goals, however we opted for Bloom's taxonomy and by the classification proposed by the EQE, making a parallelism between both. The Bloom's taxonomy for being a standard (Lima, 2003) and for being the classification referenced in the bibliography as the taxonomy to use for definition of LO (UCE Birmingham, 2006) and by the classification proposed by the European Commission (2008).

Category III – Focus on the classification of generic skills

For classification of generic skills, also known as transferable or attitudes, we chose to use the list of transferable skills proposed by Oxford University which, according to the bibliography is used as the basis of several studies. With regard to IT skills, the methodology used was strongly inspired by the MACC-3X, proposed by Crespo (2010).

Research Strategy

The strategy chosen to carry out the investigation followed the logic of a case study. One mode of research that Lessard -Hébert, Goyette & Boutin (1994) classify as little built, more open and less manipulate.

The first stage consisted of the content analysis of official documents used in the CU of Informatics scientific area: CU syllabus and evaluation components (tests, examinations, individual and group work), of the course of Accounting and Administration of Porto. This analysis allowed us respond to 1, 3 and 4 investigation questions formulated in advance.

To decide the detail with which we wanted to clarify the LO, Question 2, we base ourselves on a previous study that aimed to identify what type of Learning Objects (re) use of Higher Education teachers in their teaching practices (Angélico, M.J; Cota, M; Pimenta, P., 2011). To proceed to the management of information extracted have implemented a database using a DBMS (Database Management System).

Methodology of analysis and classification of competences and LO.

The technique chosen to proceed to the analysis and interpretation of documents was content analysis.

According to Krippendorff (1988), the content analysis is a research technique used for making valid inferences and replicable from data within their contexts. The analyzed data can be viewed based on various perspectives. The organization of the content analysis part of three chronological segments: the pre-analysis; the material exploration; and the interpretation of results.

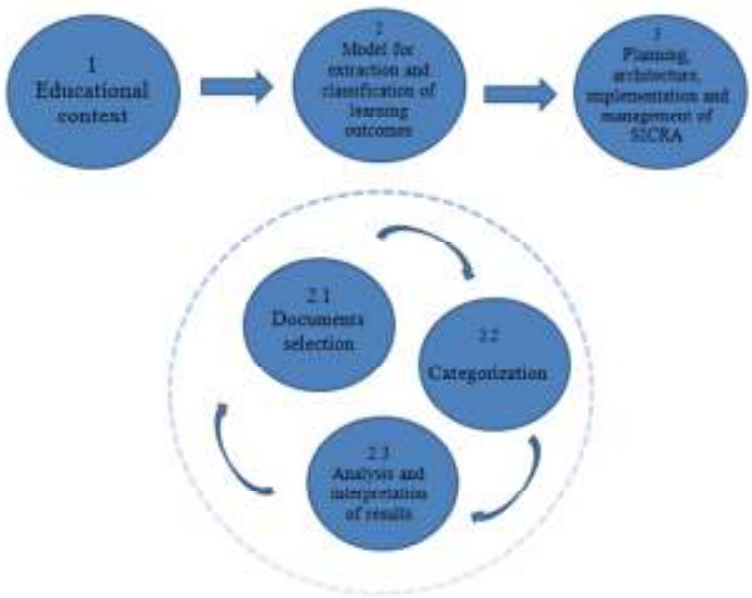

Figure 1 - Analysis and classification model of LO

To proceed to the content analysis, described below, we use the tool WebQDA, proprietary software of analysis of texts, videos, audios and images that runs on distributed and collaborative environment based on the Internet.

a. The pre-analysis

The pre-analysis is the organization of work itself. It is in this stage that makes the choice of the object under study, as well as the formulation of the objectives of the work.

We began our work, observing syllabus of CU. After a brief analysis, we found that; by itself, do not contain the information needed to be able to answer the research questions Q2, Q3 and Q4. In a general way, in the syllabus do not appear transferable skills or specific skills that address the entire syllabus. In the syllabus, the topics are not preceded of verbs and therefore not possible to identify what kind of competence in the cognitive domain that is necessary to demonstrate (Definitions, Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation).

We decided, so, to extend the analysis to all elements of evaluation of the CU. The corpus of this work has consisted of CU official documents of the scientific area of Informatics of the course of Accounting and Administration (Technologies and Information Systems and Management Information Systems), including syllabus, tests CA (Continuous Assessment) and examinations, individual and group work and DB (Database) of questions from tests performed on computer. The table 2 presents the Documental corpus.

Table 2 - Documental corpus

Document type	Documents	Identification code

Syllabus	ECTS Syllabus IST (Technologies and Information Systems)	P1
	ECTS Syllabus ISM (Management Information Systems)	P2
Tests*	Theoretical test - TSI (BD Moodle)	BD1
	Practice Test I - IST	T1
	Practice Test II - IST	T2
	Exam - IST	E1
	Theoretical test - ISM (BD Moodle)	BD2
	Theoretical test - ISM (Parte 2)	T3
	Practice Test I - ISM	T4
	Practice Test II - ISM	T5
	Exam - ISM	E2
Individual works	Activity 1- TSI	A1
	Activity 2 – TSI	A2
	Activity 3 – TSI	A3
	Activity from 4 to 9 TSI	A4
Groups work	Groups work - TSI	TG1
	Group Work – ISM	TG2

This analysis fell on "official documents" (Bodgan & Bliken 1994) of whom withdrew the information to be analysed. In the study, the documental research "presents itself as a method of collecting and verifying data" (Saint-Georges, 1997). The selection of the documents was conducted in accordance with the objectives defined once in the data collection is searched, "as much as possible, gather or make emerge materials" That revealed "more directly systems of sense effectively operating in the subjected" (Hiernaux, 1997).

b. The material exploration

After selecting the documental corpus of research and having done the "floating reading" (Bardin, 2007; Esteves, 2007) proceeded to the exploration of the material, by running two fundamental actions (Bardin, 2007), namely:

- The choice of units of register (Context Unit);
- A choice of categories (Classification and aggregation).

In the study, the units of register were made at the semantic level, originating thematic categories (Bardin, 2007; Vala, 2007) - Topics of knowledge – and - Knowledge in the Cognitive Domain.

Then we proceed at the choice of the categories that is a "sort operation of constituent elements of a set, by differentiation, and then by regrouping according to genus (analogy) with previously defined criteria "(Bardin, 2007).

In this study we used the deductive method of analysis, i.e., we had defined a priori that we would use the following categories: “Knowledge Topic”, “Skills in the cognitive domain” and “IT Com-

petencies". According to Esteves (2007), "the validity of categorization [...] passes by the fact it consistent with the objectives defined, just be relevant and, to the extent possible, productive." Therefore, we proceed to construction of "grid" (Esteves, 2007) of the respective of categories and subcategories, presented in Table 3. We try to harmonize them with the goals of research, taking, also, into consideration the documentary corpus.

Table 3 - Investigation Questions

Categories	Subcategories
C1. Knowledge Topic	Sub 1. General Concepts of IT Sub 2. System and Project Management Sub 3. Troubleshooting of Accounting Sub 4. Information Topics
C2. Skills in the cognitive domain	Sub1. Knowledge Sub 2. Comprehension Sub 3. Application Sub 4. Analysis Sub 5. Synthesis Sub 6. Evaluation
C3. Transferable Skills	Sub1. Others Sub2. IT Skills Sub 2.1 eXploration Sub 2.2 eXpression Sub 2.3 eXchange

Table 4 - Investigation Questions

In this part of the study we proceed to the detailed explanation of each category and the respective subcategories in order to clarify the why of the choices made.

C1 Category – "Knowledge Topic"

We intend with this category identify the specific knowledge (knowledge as content assimilated), expected at the conclusion of the CU of the area of technologies and information systems, generically in business courses and in particular on the course of Accounting and Administration, in the CU of Informatics area in ISCAP. According to the EQF, in 2008, "knowledge must be deepened" the "implies a critical understanding of theories and principles".

To achieve this goal, we identified, firstly skills in Information Technologies that students of the courses in Business Sciences (Business) must acquire to live and work in today's society, using the standards proposed by the Business Education Standards Association (NBEA), widely used in Secondary and higher education schools, namely Commonwealth of Pennsylvania, Massachusetts and Wisconsin.

Then, we analysed of the course curricula in Information Technologies, Information Systems and Computer Sciences. In this area, over time, International Associations ACM, AIS, and IEEE IS have been proposing curricula of courses in technologies and information systems and to advise

contents for courses which whilst not being require skills of the same. In this analysis we verify that, depending on the context, the concepts/topics cross several knowledge areas.

Pursuing the goal of classifying the topics and subtopics in groups of knowledge, using controlled vocabulary, we adopt the ontology proposed by ACM Computing Classification System, 1998, with the proposed classification updates in 2012, and the classification proposed by the group ITiCSE, in 2008, Computing Ontology of the project.

Then, we proceeded to the intersection of the standards proposed by NBEA with the groups of knowledge obtained as a result of the ratings of the ACM and the ITiCSE group. From this intersection, we conclude that there are groups that are not cited in the NBEA standards, designated in the classification of the ACM, 2012, the "Theory of computation", "Computing methodologies". If we consider the document Computing Curricula, of AIS, IEEE-CS, in 2005, we found that the knowledge units belonging to these groups in the courses at Information Technologies and Information Systems has a weighting average of importance that tends for 0, being 0 the minimum value and the maximum value 5.

Finally, we cross the syllabus topics of the CU with the results obtained previously. From this crossover resulted the table 7, existing in Attachment 2. In observation of this table we verify that the curricular units teaching contents classified into several groups, in the area of Computer Sciences, and that the same covers large part of the contents advised by NBES (11 topics in 18). To be noted, further that, in ISCAP, some of topics not referenced in the syllabus of scientific area of Informatics (7 in 18 topics) form part of the syllabus of other scientific areas, notably in the scientific area of Management and Accounting. This fact is not shown here because it outside of the scope of our study.

Taking into consideration the analysis effected previously and the aim of the study and the absence of uniformity in the designation and classification of topics by groups of knowledge, we decided to group the contents into the following subcategories, in the category Knowledge Topic: “Sub1.General Concepts of IT”, “Sub 2.Systems and Project Management”, “Sub 3. Troubleshooting of Accounting” and “Sub 4. Topics Information”. The Sub 1. category groups several topics of the classifications proposed by NBES, ACM e ITiCSE, the Sub 2. filters out the topic "Project Management" of the classification of the group ITiCSE, the Sub 3. is new and the Sub 4. filters out the topic "Data Management System" of ACM classification.

C2 Category -Skills in the Cognitive Domain Area

To identify the type of skills in the domain of knowledge expected upon conclusion of the CU in the subtopics topics of the CU, as previously mentioned, we use the Bloom's taxonomy. This taxonomy is structured into six levels of increasing complexity: knowledge, comprehension, application, analysis, synthesis and evaluation.

C3 Category - Transferable Skills

With the category C3 we intend to identify the transferable skills, which may take instrumental character (cognitive capacities, methodological, technical and linguistic), interpersonal (individual skills developed in environments of cooperation, decision making and social interaction) or systemic (adaptation capacities and leadership, initiative and creativity), expected at the conclusion of the CU of scientific area of Informatics, notably in IT.

In this context, specifically at competences of Information Technologies, we used the classification proposed by Harel Idit (cited in Crespo, L., 2010) defines eXploration, eXpression and eXchange as essential skills for living and working in the knowledge society.

c. The interpretation of results

The next moment, is the stage of the processing of the results, of inference, of interpretation of the search for answers to the questions following guiding of the investigation (Esteves, 2007). It is presented in the following section.

Presentation of Results

The data description

C1 Category – "Knowledge Topic"

To proceed to the listing of the contents taught in the CU, we start by analyze the documents [P1] and [P2], sections objectives/ syllabus and competence. Then, classify them according to the sub-categories [Sub1], [Sub2], [Sub3], [Sub4] belonging to the category C1 ("Knowledge Topic"), described in the preceding section. In this analysis, we verified that the information made available in the documents previously mentioned did not us permit understand with clarity the specific knowledge required for students (contents) because they had low granularity (too generics topics). We decided therefore also analyze the evaluation components of CU, including databases [BD1] and [BD2], which contains the questions whence result the theoretical tests, performed in LMS Moodle, one exemplary of the CA tests [T1], [T2], [T3] [T4] and [T5], one exemplary of final exams [E1] and [E2], the individual works [A1] [A2], [A3] and [A4] and the Group work [TG1] and [TG2]. According to the QAA (Quality Assurance Agency for Higher Education) in order to make an assessment of the courses is necessary that the specific outcomes of learning included of the syllabus of the CU, courses or modules. Otherwise, the LO will be obtained through the collection of evidences in the entire range of assessment activities (QAA, 2007).

C2 Category -Skills in the Cognitive Domain Area

To identify the specific skills in the cognitive domain expected upon completion of the CU we use the documents [P1] and [P2], sections: objectives/skills and syllabus. In this analysis we found that the information made available in the documents [P1] and [P2], in syllabus section, not allow us to understand the maturity level of knowledge required to pupils in content taught (Bloom, 1971), since the topics are not preceded by any verb. We decided therefore also analyze the documents that constitute the components of evaluation of the CU ([T1], [T2], [T3], [T4], [T5], [E1], [E2], [A1], [A2], [A3], [A4], [TG1] and [TG2]. The 6 subcategories of category C2 correspond at six levels of Bloom. The content classification, on a certain level, depends on the verb used that precedes, normally, the noun (topic/content).

C3 Category - Transferable Skills

To identify the transferable skills expected upon the completion of the CU, namely in IT, we use the documents [P1] and [P2], sections teaching methodologies/ learning and assessment methodologies, and the documents [A1] [A2] [A3], [A4], [TG1] and [TG2] that correspond to individual activities and group to be performed by students. The selection of these documents, specifically the section teaching methodologies/ learning was due to the fact that we want to know if the teachers and students adopt pedagogical strategies that use the IT. According Laurillard (1993) the use of these strategies can promote active learning more student-centred, valuing their personal experiences and their participation.

Interpretation of results

To give answer to the question Q1 we classify the units of registration in the Knowledge Topic category

Relatively the question Q2 we opted to introduce 2 or 3 levels of detail in the topics taught (one or two layers below the "Knowledge Topic"), by the fact the syllabus with the detailed topics be more explicit.

Then we used the classifications proposed by the ACM, in 2012 and by the ITiCSE, in order to identify the topics and subtopics. We opted, whenever possible, the classification of ACM owing to the same, it find implemented in OWL language. When a topic or subtopic is not included in the classification of the ACM, we used the term proposed by group ITiCSE, 2008. If not listed in any of the classifications we defined it.

Of this analysis we obtained the list of topics (Q1) and subtopics (Q2) taught in the CU, in the scientific area of Informatics in ISCAP, by Knowledge Topic. The table 4 shows General Concepts of IT Topic.

Table 4 - General Concept of IT Topics

I General Concepts of IT
1 Computer Systems Organization
1 Machine organization (ITiCSE)
2 Architectures
Distributed architectures
2 Software and its engineering (ACM, 2012)
1 Software organization and properties
Contextual software domains
2 Software notations and tools
General programming languages
Compilers
Context specific languages
3 Computer Networks (ACM, 2012)
1 Architectures
2 Protocols
3 Components
4 Network properties
5 Types
4 Security and privacy (ACM, 2012)
1 Security policies (ITiCSE, 2008)
2 Assurance Model (ITiCSE, 2008)
3 Cryptography
4 Security services
Authentication
Access control
Digital rights management
Authorization
5 Intrusion/anomaly detection and malware mitigation
6 Systems security
Operating systems security
Browser security
Denial-of-service attacks
Firewalls
Vulnerability management
File system security
7 Network security
Web protocol security

	Mobile and wireless security
	Denial-of-service attacks
	Firewalls
5	Applied computing (ACM, 2012)
	1 Electronic commerce
	2 Enterprise computing
	3 Education
	4 Computers in other domains

Relatively the question Q3, we intersected of the Knowledge Topic categories ("C1. Knowledge Topic") and C2 (Skills in the Cognitive Domain). The following figure shows an extract of the analysis performed.

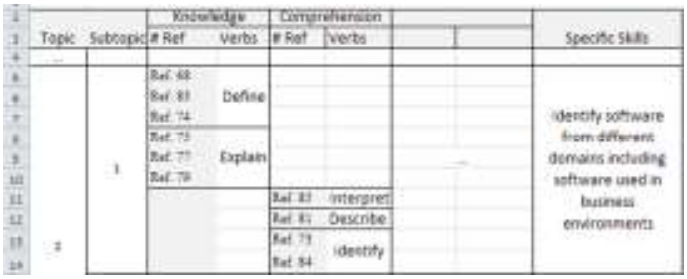

Figure 2 - Specific skills extract

According to the analysis carried out, and taking into consideration that students at the end of the study cycle, shall have acquired specific skills (attitudes) of level 6 (EQF), the same, after completing the teaching of the topic General Concept of IT in the domain of cognitive knowledge, should have acquired specific skills listed in Table 5.

Table 5 - Specific skills of General Concepts of IT extract
1. Define computer system organization 2. Identify software from different domains including software used in business environment. 3. … 4. Conceive one proposed acquisition of a computers system with detail of the physical characteristics and logical, substantiating the choice.

To give answer to question Q4 we analyzed of the registration units classified according to the category C3 “Transferable Skills”.

According to the analysis, and taking into consideration that students at the end of the study cycle, shall have acquired generic skills (attitudes) of level 6, to the same, after conclude the Curricular Unit of IST, should have acquired the transversal skills listed in Table 6.

Table 6 - Transferable skills of CU TIS
1. Self-management 2. Group work 3. Study skills 4. Communication skills 5. IT skills: eXploration, eXpression and eXchange.

Answered the questions Q1, Q2, Q3 and Q4 are gathered the conditions warranting to proceed to the presentation of the LO of the CU of scientific areas of the course.

The figure 3 shows the parallelism between the Bloom's taxonomy and the EQF.

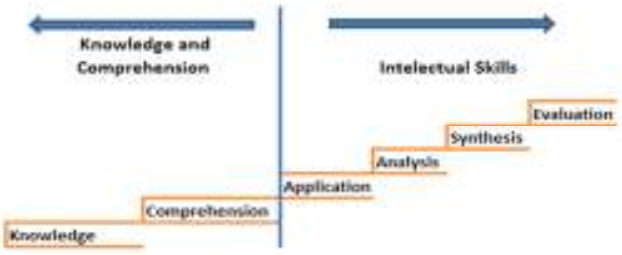

Figure 3- Bloom vs EQF

The junction of the information obtained in responses Q1, Q2 and Q4, using the classification presented in the previous figure enables us to obtain the LO of the CU of scientific areas of the course, according to the EQF.

C Data base implementation

Presents the conceptual model of Database "SICRA" developed with the goal to store, manipulate and search for information from our study case

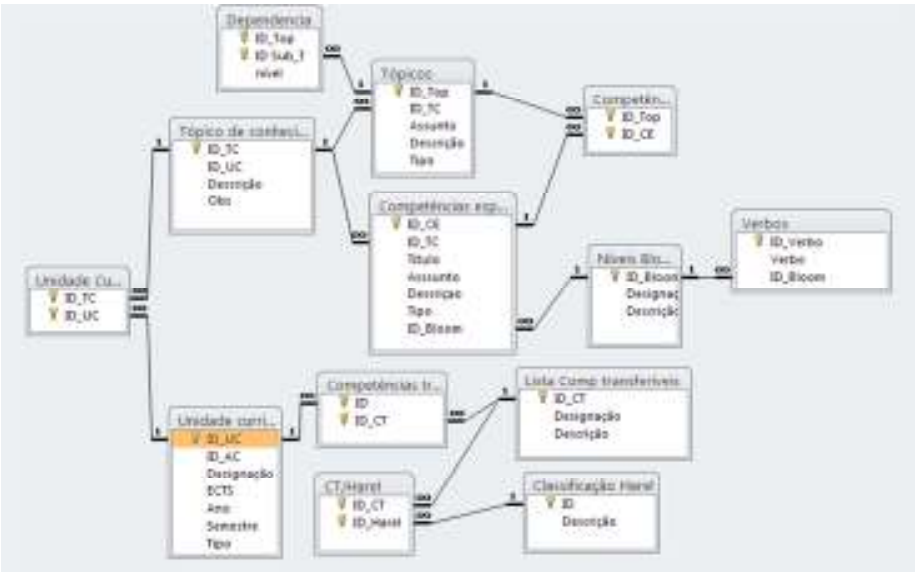

Figure 4 . DB Conceptual model

Then, inferences are presented to database.

Figure 5- Knowledge Topics by CU

Figure 6 - Topics by knowledge topic

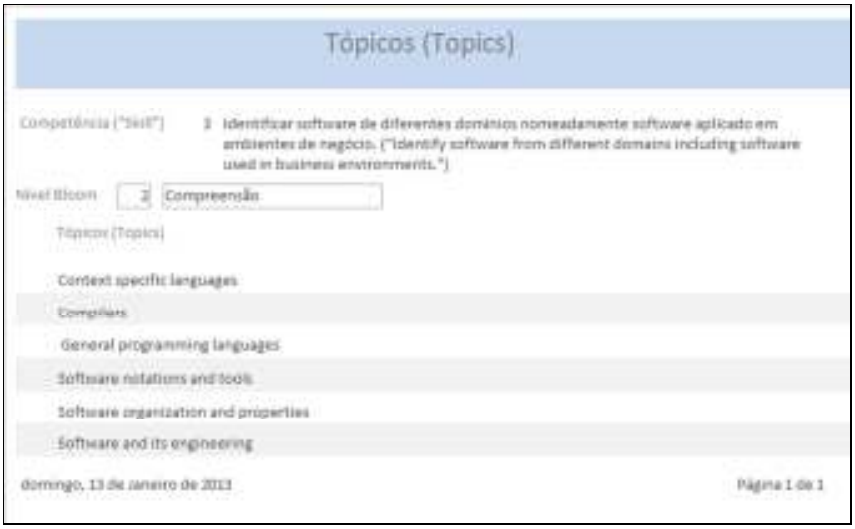

Figure 7 - Topics by specific competences

Conclusions and Future Work

In the last two decades, we have witnessed a set of transformations in higher education, in order to construct a European Area of Higher Education, focalized on harmonization and comparability of knowledge and procedures and in the excellence of results, able to attract new students and teachers.

One of the objectives of this process, since its inception, is encourage mobility of the students and teachers between the higher education establishments, ensured through the European Credits Transfer System (ECTS), based on the principle of mutual recognition of the value of the formation and of skills acquired (Decree-Law n. º 74/2006). The mobility of students within Europe highlights the need to information exchange between institutions of higher education.

In this article, we have proposed a methodology of classification and extraction of the LO, by using a case study with a view to promotion of mobility in the EHEA.

With the information resulting from the application of the methodology at the end of the chapter, we implemented a BD, by using a relational DBMS..

The scientific advances achieved in areas such as the Semantic Web ends contributions potentials to the automatization of the interoperability between institutions in higher education, namely in LO interoperability. We intend to then develop ontology that make available on Semantic Web the information made available in the Database.

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Anexo 1 – The European Qualifications Framework (EQF)

Level	Knowledge	Skills	Competence
Level 1	Basic general knowledge	basic skills required to carry out simple tasks	work or study under direct supervision in a structured context
Level 2	Basic factual knowledge of a field of work or study	basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	work or study under supervision with some autonomy
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
Level 5[1]	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others
Level 6[2]	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
Level 7[3]	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
Level 8[4]	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

1. The descriptor for the higher education short cycle (within or linked to the first cycle), developed by the Joint Quality Initiative as part of the Bologna process, corresponds to the learning outcomes for EQF level 5.
2. The descriptor for the first cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 6.
3. The descriptor for the second cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 7.
4. The descriptor for the third cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 8.

Anexo 2. curriculum matrix (cross-reference)

Table 5 - Curriculum Matrix (Cross Reference)

Accounting and Administration of ISCAP/IPP		NBES	Computing Classification System (ACM, 2012)	Computing Ontology (Work in progress)
Unit courses	**Area: Computer Science**	**Topics**	**Top Level Concepts**	**Top Level Concepts**
Technologies and Information Systems (TSI) 48 core hours	**General concepts of IT (12 hours):** Components of a computer system Communication and computer networks	**Information Technology:** II. Hardware IV. Input Technologies III. Operating Systems and Utilities XI. Programming and Application Development XII. Telecommunications and Networking Infrastructures	Hardware Networks Computer systems organization Software and its engineering	Computer Hardware Organization Computer and Network Systems Programming Fundamentals
	Security of the IS/ IT	**Information Technology:** XIV. Security, Privacy, and Risk Management	Security and privacy	Security
	Areas of application of ICT	I. Impact on Society	Applied computing	
	Introduction to project management tools (12 hours): Areas of application of project management Introduction to MS_Project		Social and professional topics	System and Project Management
	Troubleshooting Accounting (24 hours) Data analysis through management simulation Data analysis through statistical , mathematical and financial functions	**Information Technology:** V. Productivity Software		
Management Information Systems (MIS) 48 core hours	**Database Systems (48 hours):**	**Information Technology:**	Information systems	Information Topics
	Database Systems Data Modelling Study of a Database Management System	VIII. Information Retrieval and Synthesis IX. Database Management Systems X. Systems Analysis and Design		