Concept Mapping For Developing Competencies in European Higher Education Area

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Abstract

The study describes an experience of university innovation on the educational implications of Information and Communication Technologies (ICT) in education with the use of conceptual digital interactive maps developed in different practice sessions of the training module called: "New Information Technologies and Communication" (Master of Teacher of Secondary Education), taught at the University Pablo de Olavide of Seville (Spain) during the academic year 2010–2012. Its objectives include: promoting active and independent role of students in the process of knowledge construction; designing and developing interactive concept maps about the main strengths and weaknesses of ICT in educational contexts with social software applications and promote multimodal learning among students. Through a qualitative and descriptive methodology, we infer several conclusions: concept mapping promotes the construction and management of knowledge by the student, allows estimation of the understanding of teaching graduate students in relation to the implications of ICT in Education, and facilitates multimodal learning.

Keywords: Teacher training, networking, teaching strategies, educational concept map, educational innovation.

1. Introduction

Teaching has been based on a methodological model focused on the teacher, with emphasis on content transmission via lectures and reproduction by the students and individual work. But teaching through Information and Communication Technologies (ICT), demands a series of changes that create a breach on this model, but at the same time, they may represent a step toward the quality of Higher Education (Aguaded; López- Meneses, & Alonso, 2010). New technological trends are bringing new ways of being connected, communicating, learning, or working (Cabero & Llorente, 2010) and training processes have created organizational changes, interaction between subjects and, especially, in the way learning and knowledge is constructed. Many researchers have asked questions about today's youth, who are growing up in a digital world and about the Web as a transformative medium (Wheeler, 2001; Williams, 2008; Reamsbottom & Toth, 2008; Weinberger, 2008; Prensky, 2010, & Sultan, 2010). In this sense, in the European context, it is clear that ICT and particularly networking university methodologies oriented under the socio-constructivist approach and research will play a significant role because of the possibilities they can offer: synchronous and asynchronous communications established among different members of the European community, strengthening the construction of international collective groupings of knowledge, providing contextualized and meaningful experiences for students, promoting decision making and social problem solving by students, enhancing common European research projects, and so on (Cabero, Valverde, & López-Meneses, 2009).

The Internet, social media, and Web 2.0 are becoming important components of students' education (Pulichino, 2006; Saeed, Yang, & Sinnappan, 2009). In fact, for teacher training, these web applications have become key factors in the college experiences of educational innovation in the context of the new challenges of European Higher Education Area (Aguaded & López Meneses, 2009). The importance of graphic organizers is significant as they help a human learner not only to understand information and see the relationships between ideas or concepts but also to organize and structure thoughts in a more readable and understandable manner (Birbili, 2007). There is still relatively little known about memory processes and how knowledge finally gets incorporated into our brain, but it seems evident from diverse sources of research that our brain works to organize knowledge in hierarchical frameworks and that learning approaches that facilitate this process significantly enhance the learning capability of all learners (Bransford; Brown & Cocking, 1999, & Tsien, 2007).

2. Concept maps: teaching methodologies of knowledge construction

Concept maps, as noted by several authors (Novak & Gowin, 1988; González & Novak; 1996, Novak 1998), among others, are some resources to organize, represent, and store knowledge. They are based on a framework of concepts and relationships linked by propositions or words, are organized hierarchically, and can play an important role in the teaching-learning process, representing and sharing knowledge from a constructivist perspective. In its simplest form, a concept map would consist of only two concepts linked by a linking word to form a sentence. Mind Maps are a new technique to develop the ability to "think" creatively and to increase competition to construct knowledge in an organized and inclusive way (Muñoz, 2010). In this sense, Novak (2000), indicates the main elements of a concept map:

- Concept. Concept is understood by the word or term that expresses a regularity in the facts, events, ideas, and/or qualities.
- Proposition. It is established from the merger of two or more concepts connected by linking words in a semantic unit. It corresponds to the main unit of meaning.
- Link words. They are words that connect concepts and identify the types of relationship between them.

The representation of concept maps is given by a schema graph that displays the concepts placed within an ellipse and linking words are written on or near a line connecting the concepts. They help organize ideas, structure, and integrate constructive knowledge networks and visually represent meaningful connections between concepts. In scheme 1, the structure of a concept map is described (Novak & Cañas, 2006). Concept mapping is suggested "to take advantage of the remarkable capabilities of the human visual perception system and the benefits of visual information representation. These benefits include (a) ease of recognition, (b) the possibility to quickly scan a picture and find differences or keywords, (c) compactness of representation, and (d) the ease to keep an overview" (Kommers & Lanzing, 1997, 423).

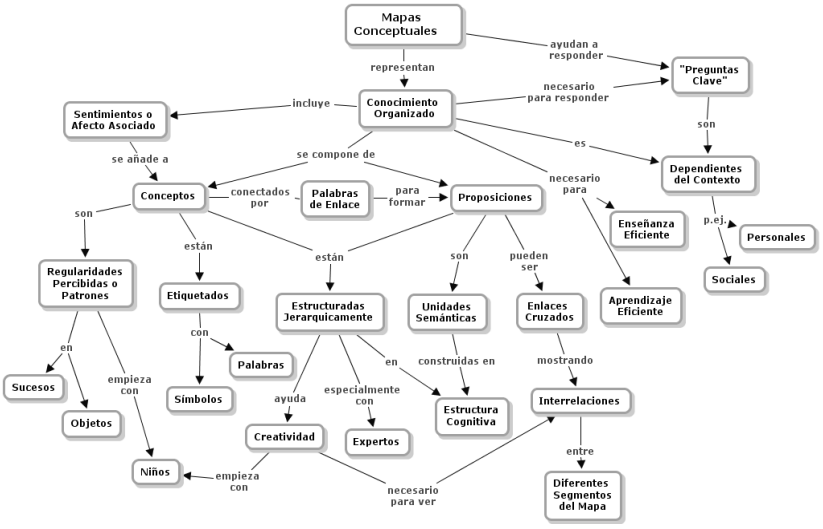


Figure 1. Structure of a concept map (Novak & Cañas, 2006).

As suggested by the authors, Cañas et al. (2000) and Novak and Cañas (2006), the concept map as a teaching resource has several possibilities: lessons, expert skeleton maps, pre- and post-assessment, investigation/research, oral presentations, multidisciplinary integration, incorporating drawings, photos and video, group collaboration, collection and interpretation of data, or related readings. Because of their visual way of presenting knowledge, concept maps appear to be more effective in contrast to forms of knowledge representation such as pure text (Kremer, 1998).

3. Description of the experience and objectives

The research describes a university experience with interactive concept maps belonging to the training module called: "New Information Technologies and Communication", developed in the Master of Teacher of Secondary Education, Vocational Training and Language Teaching, taught at the University Pablo de Olavide of Seville for the academic year 2010–2011. In this sense, in order that each student could actively participate in building their new knowledge, the research pretended that future education professionals analyze and reflect about the potential strengths and weaknesses of the ICT in education field, through the use of interactive concept maps as teaching resources for academic and professional development. Concerning the implementation of software for maps, diagrams, sketches, or conceptual networks can be found in many applications such as Cmap Tools (http://cmap.ihmc.us), Creatily (http://creately.com), Gliffy (http://www.gliffy.com), among others. To develop this study, Mindomo social software (http://www.mindomo.com/) was selected for being partly a free tool that allows network sharing for the work done by students, and offers a working environment (workspace) that is simple and intuitive; providing an intuitive platform, the hypermedia concept maps dynamically with the inclusion of text, images, graphics, videos, and comments (Fig. 2).

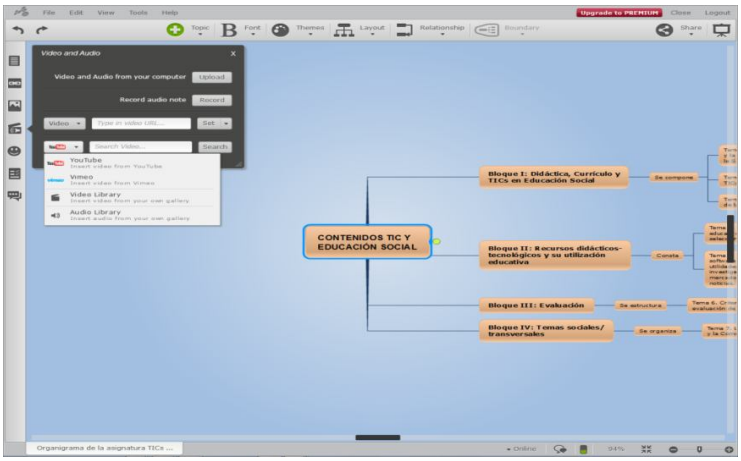


Figure 2. Work environment software on-line Mindomo: http://www.mindomo.com/

The training module related to ICT and teaching is organized in several thematic clusters: Society, Education, and ICT; students and teachers of the new millennium; social software and example of good practice with ICT; study of educational platforms and evaluation of multimedia network materials (design of rubrics), with the implementation of various educational projects related to them. The sessions are taught in computer classes and consisted of eight sessions of five hours each, developed during November and December 2010. The first part of each training session was devoted to explaining the basics of the relevant thematic cluster and then digital 2.0 resources that would be used in the educational practice. The general objectives of the ICT training module were the following:

1. Understand the use of new technologies as an educational resource.
2. Learn methodologies and technologies for the collection and processing of information in the teaching and learning process.
3. Encourage and facilitate the development of curriculum materials and teaching resources through the New Technologies.
4. Using a learning platform and its resources.
5. Analyze and evaluate projects, proposals, and innovative educational technology activities for teaching and learning, knowing how to evaluate their compatibility and viability with opinions and arguments.

The study focuses on the educational use of ICT —one of the targets set in the training module— in particular, the analysis of the potential advantages and disadvantages of ICT in learning contexts using digital educational concept maps. In order to reach the aim, the following objectives have been proposed:

1. Promote active and independent role of students in the process of knowledge construction.
2. Design and develop interactive concept mapping with software-related applications about the main social strengths and weaknesses of ICT in educational contexts.
3. Promote the socio-cognitive scaffolding.
4. Promote multimodal learning among students.
5. Promote digital creativity through media resources 2.0.

This educational research describes a university experience developed with 30 students, belonging to the Master of Teacher of Secondary Education, Vocational Training and Language Teaching, taught at the University Pablo de Olavide of Seville during the academic year 2010–2011. Its photography is housed in the Edublog Teacher training module: http://eloy3000.blogspot.com/. The innovative experiment involved the construction of an individual multimedia concept map on the most important advantages and disadvantages of the ICT in training spaces using social software with support from significant images and videos, in particular, with the application http://www.mindomo.com/. The specific objectives of the educational experience are the following:

- Designing and developing concept maps to communicate effectively and comprehensively.
- Promoting active and independent role of students in the process of knowledge construction.
- Designing and developing interactive concept mapping with software-related applications about the main social strengths and weaknesses of ICT in educational contexts.
- Promoting multimodal learning among students.
- Promoting digital creativity through media resources 2.0.

Subsequently, each student, through the virtual learning platform Blackboard (formerly called WebCT) offered by the University Pablo de Olavide, sent the work done under the following headings:

- Name of the student.
- Group.
- Short comment (max. 500 words) related to the multimedia concept map developed.
- Link of the operating concept map made with social software Mindomo.

Figure 3. Virtual classroom environment of graduate experiences.https://aulavirtual.upo.es/webct/entryPageIns.dowebct

It also provided an online 2.0 tutorial application for digital interactive mapping: http://es.scribd.com/doc/76334700/Tutorial-Mapas-Conceptuales-MAES (Fig. 4).

Figure 4. Tutorial on social software Mindomo.http://es.scribd.com/doc/76334700/Tutorial-Mapas-Conceptuales-MAES

After the theoretical explanation and practical utility of the concept; socio-educational and interactive concept maps were designed from a constructivist perspective. The task was assessed on 10% of the final training module. To evaluate the educational experience, the following rubric or evaluation matrix was developed (Table 1).

Table 1. E-rubric from the experience of university innovation

Concepts and terminology	**2 Points**
1. Identify the most important advantages and disadvantages of ICT in educational contexts.	**1**
2. Displays an appropriate educational terminology.	**1**
Relations between the concepts	**2 Points**
1. The sentences are clear and logical connectors with educational themes.	**1**
2. The overall conceptual organization of the conceptual framework is legible.	**1**
Multimedia presentation	**6 Points**
1. The use of video and images help the interpretation of the theme of the study.	**3**
2. The graphic design of the concept map facilitates understanding of the subject matter being taught.	**2**
3. Writing clearly and concisely with a wide appropriate and relevant vocabulary and correct use of spelling rules and accent.	**1**

Each student had free choice for performing the interactive conceptual map in the most creative way, so that, all students included images and videos to reflect and explain the strengths and weaknesses of ICT in training areas. An example is the work done by a student (Fig. 5).

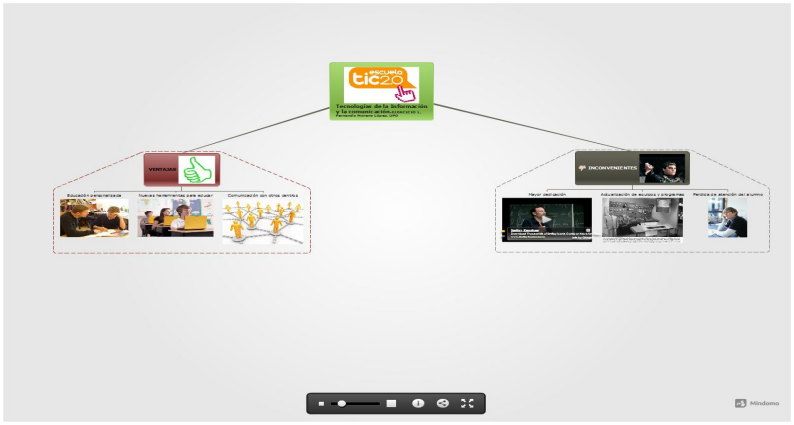


Figure 5. Interactive concept map done by a student.
http://www.mindomo.com/es/view.htm?m=fdd136b7c9094bda990c183feebb4109

Some students even used other educational resources such as the comic (Fig. 6) to specify the different advantages and disadvantages they wanted to highlight.

Figure 6. Use of comic to emphasize the disadvantages of ICT in learning contexts. http://www.mindomo.com/es/view.htm?m=795bd61db623437e80aee4aa4e9ee747

4. Methodology

The methodology was qualitative and descriptive, with the evaluator-in-charge to extract, process, and interpret the results through a cyclical process, simultaneous and interactive. Initially, the sample consisted of 33 graduate students enrolled in the training module; however, 30 interactive concept maps that were operational were analyzed, the remaining ones could not be assessed for absence or for professional reasons.

First, it is worth mentioning that when analyzing the work done by students, a system of categories was not established previously, but an inductive categorization process was followed. For this, the analysis focused on those words or sets of meanings that postgraduate students add to their digital interactive conceptual map and considered as units of record. In turn, each selected unit has been encoded with its frequency count. Given the use of this coding system, there is a wide variety of similar meaning units, but appointed differently by the students; therefore, we have recoded these units as being grouped under a common meaning. Subsequently, the visual-conceptual frame was transcribed and categorized taking as reference the guidelines established by different authors (Bogdan & Biklen, 1992; Miles & Huberman, 1994):

• **Phase One:** Data Reduction. It is the realization of rational procedures that involve the categorization and coding of data, identifying and differentiating units of meaning. The procedures are:

- Categorization of data. The simplification involves categorization and selection of information to make it more manageable. This process involves several subphases:

- Separation of units. It consists of separate pieces of information in some sort of criteria such as spatial, temporal, thematic, and/or grammatical.
- Identification and classification of units. It is to classify conceptually the units that are covered by a single meaning. The procedure can be inductive as data is being examined, or deductive, having previously established the system of categories on which to categorize, after a review of specific literature on the subject under study. Usually this classification is often mixed.
- Synthesis and grouping. This phase is actually attached to the former because the categorization itself involves the synthesis. It is also present once it has completed the process of categorization and some categories are grouped into meta-categories.
- Encryption. It is a really concrete and manipulative operation for which each category is assigned to each textual unit. In this sense, each selected unit has been coded for frequency counting.

• **Phase Two:** Interpretation and inference. Finally, the data analysis process was completed with a stage where we proceeded to the interpretation of the different pieces of information. The information obtained was categorized and ordered systematically in tables and graphs to facilitate interpretation and explanation phase of the results.

The following section shows the results, conclusions, and limitations of the research.

5. Results

First, all graduate students conducted a thematic representation of education in a coherent and clear manner showing the basic organizing structure as being interrelated and, in most cases, with absence of words links. In addition, most participants used a conceptual design of radial networks with the key concept (ICT) at the center and from it the advantages and disadvantages derived and, in turn, forming new branches. In addition, all students had inserted media (text, image, video) most of them of great educational significance and visual impact to improve understanding of the subject (Fig. 7). Unfortunately, the students primarily used "Google" as a unique source of audiovisual information.

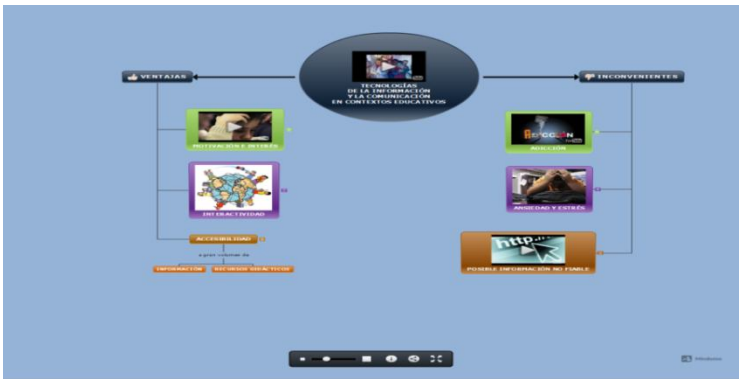
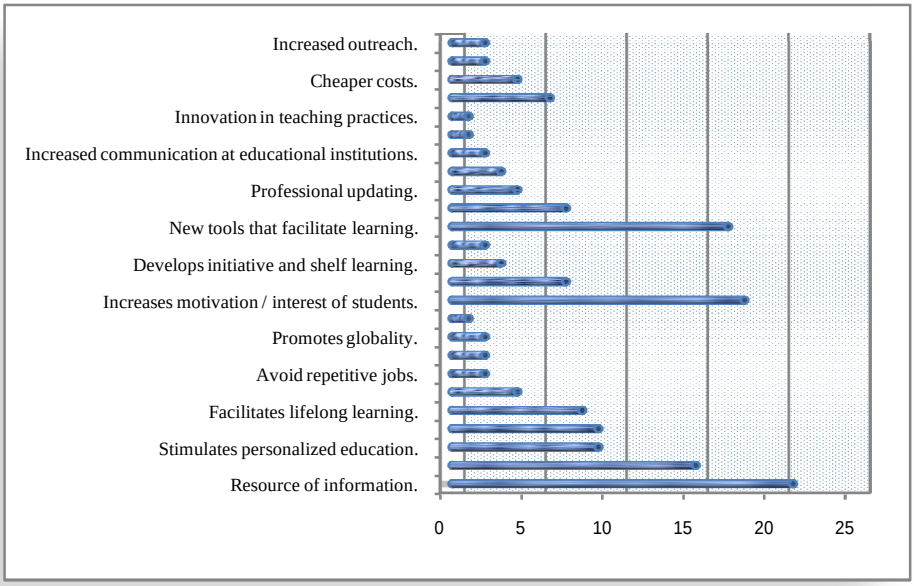


Figure 7. Multimedia concept map of a graduate student.
http://www.mindomo.com/es/view.htm?m=a42b1749824c4a4da2eeeae467369e6a

Then, we present the results obtained from the analysis of the coding work done by postgraduate students in relation to the benefits of ICT in educational settings (Table 2 and Graph 1).

Table 2. Coding of textual units related to the benefits of ICT.

Recoding	*Units of words with meaning*	*Frequencies*
Teaching-learning process	– Source of resources and information.	21
	– Facilitates interaction and collaborative work.	15
	– Stimulates personalized education.	9
	– Promotes more flexible and open educational processes.	9
	– Facilitates lifelong learning.	8
	– Helps interdisciplinarity.	4
	– Avoids repetitive jobs.	2
	– Saves time.	2
	– Promotes globality.	2
	– Helps to visualize simulations.	1
Students	– Increases motivation / interest of students.	18
	– Enhances expression and creativity.	7
	– Develops initiative and independent learning.	3
	– Promotes self-evaluation.	2
Teachers	– New tools that facilitate learning and development of digital skills.	17
	– Increases teacher and student communication.	7
	– Professional updating.	4
	– Increases teacher and school communication.	3
	– Increases communication between different educational institutions.	2
	– Research in the classroom.	1
	– Innovation in teaching practices.	1
Schools	– Facilitates management.	6
	– Cheaper costs.	4
	– Improves communication with families.	2
	– Increases outreach.	2



Graph 1. Frequencies of textual units with the advantages of using ICT according to the theme.

As shown in Fig. 1, the two main advantages that the student believes that ICT can offer in training processes are: to provide a source of information (f=21) and to facilitate communication, interaction, and collaborative work in the teaching and learning process (f=15). In this sense, the results corroborate others studies (Harasim, 2000; Marques, 2000; Cabero, 2005; Cenih & Santos, 2005; Area, 2009). To a lesser extent, they favor a personalized and individualized education (f=9), help to develop more flexible and open training processes as often as the previous update allows, and facilitate ongoing learning (f=8). To a lesser extent, they help develop interdisciplinarity (f=4), avoids repetitive tasks, saves time, and promotes globality (f=2). Finally, only one student stated that ICT can help to visualize simulations to guide the learning processes.

Regarding the category of students, it should be noted that more than half of students believe that ICT increases motivation and interest in learning (f=18), enhances expression and creativity (f=7). In this sense, the work of a graduate student described in Fig. 8 may be illustrative.

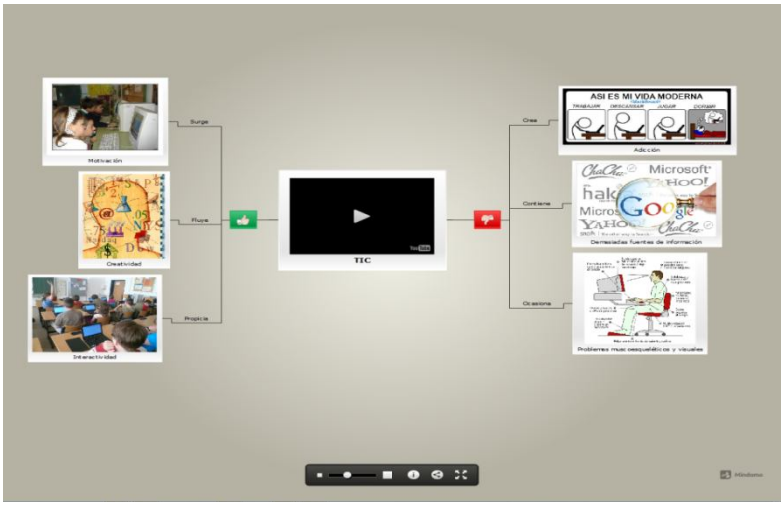


Figure 8. Work of a graduate student. Academic year 2010–2011.
http://www.mindomo.com/es/view.htm?m=8742326aee6849578b20011c94e542ec

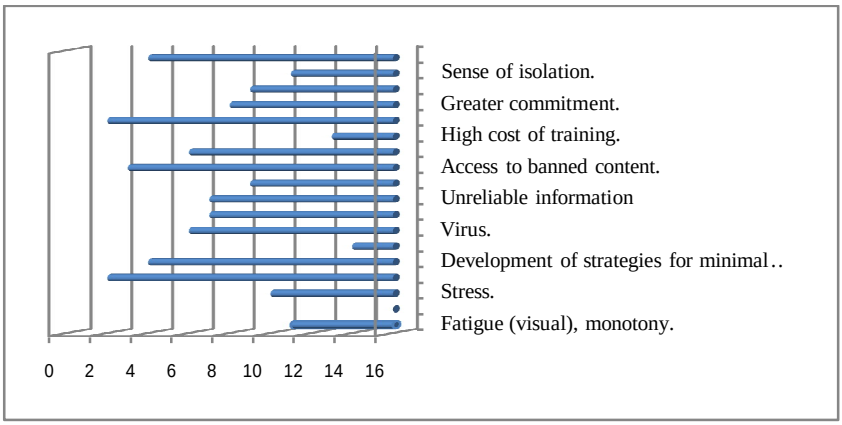
And only three students indicate that ICT develops initiative and promotes independent learning and self-assessment (f=2).

Concerning the teachers, results show that the technologies are new resources that facilitate the learning process and development of digital skills (f=17), allowing better communication with students (f=7), facilitate professional development (f=4), and only three students believe that ICT enable better communication between the teacher and educational institutions. In addition, Fig. 1 shows that ICT facilitates better communication between different schools (f=2) and it is striking that only one student estimates that ICT can serve as an educational tool for research in the classroom and teaching innovation. Finally, ICT facilitate the administrative management of schools (f=6), it can influence with cheaper costs (f=4); a greater communication with families and a better social projection (f=1). In summary the main benefits of ICT in education focus on being a resource for information, facilitate communicative interaction in educational processes, improve student motivation and facilitate learning processes. In regard to the drawbacks of the use of ICT in educational settings are grouped into four categories: effects on people or damaging problems such as tiredness, fatigue (visual), monotony (f=11), anxiety, dependency and addiction (f=16) and stress (f=10). And two students find that can be generated objectionable behavior (f=2). Regarding to technical problems, almost half of students believe that ICT require technical maintenance and upgrade of computer equipment (f=14), dependence on them (f=7) and have a serious problem with the virus (f=6). As for the category related to the teaching and learning with (f=13) that requires a high cost in training for their use; dominated by a saturation of information (f=9), some of them unreliable (f=7) and which may result in the spread of information (f=9), also require more time to use (f=8), can lead to superficial learning (f=6) with the development of strategies of minimum resistance (f=4). Moreover, another drawback of ICT in education sector is its possible misuse, providing access to inappropriate content (f=3). Finally, two students expressed the need for the creation of a Department of Educational Technology.
Ultimately, in relation to human relationships, the analysis shows that ICT can induce a feeling of isolation (f=11) and security and identity problems (f=4).

Thus, it is displayed the results of the frequency of occurrence of textual units related to the main drawbacks of ICT (Table 3 and Figure 3).

Table 3. Coding textual units related to disadvantages of using ICT.

Coding	Units of words with meaning	Frequencies
Effects on people	– Fatigue (visual), monotony.	11
	– Anxiety, dependence and addiction.	16
	– Stress.	10
	– Reprehensible behavior.	2
Technical Problems	– Updating and technical maintenance.	14
	– Virus. Problems of computers maintenance.	6
	– Dependence on computer systems.	7
Teaching-learning process	– Unreliable information (superficial, incomplete, erroneous).	7
	– Saturation of information.	9
	– Access to banned content.	3
	– Superficial learning.	6
	– High cost of training.	13
	– Need to create a Department of Educational Technology.	2
	– Greater commitment.	8
	– Development of strategies for minimal effort.	4
	– Distraction and dispersion of information.	9
Human Relationships	– Sense of isolation.	11
	– Security issues and identity theft.	4



Graph 2. Frequencies of textual units related to weaknesses in the use of ICT in educational settings.

Because of the results obtained we may indicate that the use of multimedia concept maps is a proper and useful activity for the development of an active role of the student, learning skills and higher-order capacity-building and conceptual frame network. In short, we can confirm that concept maps are interactive active metacognitive methodological strategies that guide recreation and construction of knowledge and allow the categorization of concepts relevant to an educational theme.

6. Conclusions

It is difficult today to think of a quality university that operates without the support of ICT as a large part of teaching; thus research and transfer are performed on technology. In this sense, social software has become a key factor for the implementation of university experiences of educational innovation in the context of new challenges of European Higher Education Area (Aguaded & López Meneses, 2009). Among the conclusions, we highlight, in the first instance, that the use of digital educational applications 2.0 (cloud computing) in learning contexts can help to spread the knowledge in a globalized way, the collective thinking, the creation of repositories of learning experiences and teaching resources for educational research, all of them, key considerations when developing skills among university students. On the other hand, it may be indicated that the new emerging technology trends are valuable resources for the construction of knowledge in the learning process away from those transmission model teaching methodology strategies and encouraging reformulation of socio-constructivist methodologies and research. They facilitate information management, social development and university teaching innovation (Cabero, López-Meneses, & Llorente, 2009). The true potential of Web 2.0 philosophy is not only the technical aspect, but its cultural and educational function. It has also been fully achieved that students are active agents in their own learning process, to design and develop autonomously interactive concept maps, selecting and structuring the main areas of intervention of social educator in a professional context. Regarding the limitations of the research, we have to indicate that in most of the work done by students, there are not semantic connections, linking words or linking phrases between concepts and therefore propositions resulting in a higher level of abstraction and complexity between the key concepts obstructing the didactic learning of digital interactive maps. Also, as a negative aspect we indicate that “Google” is the only internet search engine.

Also it has to be emphasized the need for establishing self and hetero evaluation processes among students to promote more thoughtful and enriching evaluation processes. In the case of our study, the lack of time made impossible to implement it. The methodology based on digital interactive concept maps helps the students to be more effective in the European Higher Education Area, mainly because it enhances the following:

- Change the paradigm centered on rote learning and goes into the teaching of learning to learn.
- Promote collaborative learning and student self-tutored by the teacher.
- Develop a new way of learning organization: modularity and multi-disciplinary curricular areas.
- Enhance an educational model based on ICT methodologies which favor a way of learning to learn.

In the final liability, work with concept maps makes the students more active, independent, thoughtful, strategic, cooperative and responsible in the European Higher Education Area.

We would close our discussion by highlighting that the range of applications related to Web 2.0 is very broad and can offer in education new spaces for communication, collaboration, imagination and creating communities of shared knowledge. In fact, they can be the new walking trails through the forest of educational innovation and teacher professional development [33-34]. In this sense, some of them can be found at the following personal repository http://alacenadigital.blogspot.com

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