Open knowledge. Challenges and facts

Francisco J. García-Peñalvo
Computer Science Department / Science Education Research Institute / GRIAL Research Group
University of Salamanca
fgarcia@usal.es

Carlos García de Figuerola
Computer Science Department / REINA Research Group
University of Salamanca
figue@usal.es

José A. Merlo
Library Science and Documentation Department / Library Service Director
University of Salamanca
merlo@usal.es

Abstract

Purpose – This article opens the special issue of the journal Online Information Review on Open Knowledge Management in Higher Education. Its aim is to review the concept and extension of the movement or philosophy of Open Knowledge in universities and Higher Education institutions.

Design/methodology/approach – The approach will follow the reference model used by the University of Salamanca (Spain) to promote open knowledge in the institution through its Open Knowledge Office. This model comprised four areas: free software, open educational contents and cultural dissemination, open science and open innovation.

Findings – For each of the four areas mentioned above, milestones and the most significant projects will be presented, showing how they are promoting publication and information transmission in an open environment, without restrictions and favouring knowledge dissemination in all fields.

Originality/value – Open Knowledge is an approach which, though having some controversy is growing relentlessly as cultural and scientific dissemination leave behind any other interests or economic models. International organizations and governments are gradually embracing Open Knowledge as the way to share scientific advances with society and as an international cooperation measure to favour development in third-world countries.

Keywords – Open Knowledge, Higher Education, Institutional Repositories, Open Access, Open Content, Open Software, Open Science, Open Innovation.

Paper type – State of art

1. Introduction

Information technologies, and especially the Internet, have changed the way to produce, publish and communicate information, heading towards models where information is primarily produced in digital formats and consumed through online media. There is, therefore, a predominance of bits instead of atoms (Negroponte, 1995), which has clear consequences.

First of all, the production costs of documents in electronic format have decreased considerably, and this is not just because of the decrease in technological equipment costs. The ease of use of this equipment makes it accessible to almost anybody.

On the other hand, the distribution of electronic documents is, thanks to the Internet, easy, simple and cheap. There are no physical entities to transport, just electric impulses that flow through networks. This implies that the most important part of the added value of an electronic document is now intellectual creation.

As a result, and especially in places where this intellectual creation is the core of their activity (such as educational and research institutions), the possibility of sharing this knowledge and reusing it to create new knowledge has been soon understood. These ideas were not new in these places, as was not the habit of exposing to public criticism the creations, but different barriers, both technical and economic, had imposed important restrictions to the free dissemination of knowledge (Suber, 2006).

These ideas are the bases of what came to be known as Open movement. The Open Contents initiative refers to the free distribution, use, copy and modification of results of any creative activity. This includes a wide range of resources, but has had a deeper impact in a series of areas, many of them related to activities of Higher Education Institutions (Tomlin, 2009), regarding both, educational and cultural resources and activities of scientific research.

In other words, "Open" refers to the fact of granting copyright permissions beyond those offered by standard copyright law. From a maybe simplistic, but intuitive, point of view, the less of restrictions is imposed on a certain content, the more "open" that content is. The permissions of basic use are expressed by means of what is known as the "4 Rs": Reuse, Revise, Remix and Redistribution (Wiley, 2006).

In this sense, Suber (2008) talks of "*gratis* Open Access" for the removal of price barriers alone and "*libre* Open Access" for the removal of price and at least some permission barriers. The new terms allow us to speak unambiguously about these two types of free online access.

1.1. History and evolution of the open knowledge concept

Different sources coincide in pointing out to the foundation of the Royal Society of London for the Improvement of Natural Knowledge (aka Royal Society) in 1667 as the precursor of the Open movement due to their foundational objective of promoting and disseminating scientific knowledge. Although it is true that the Royal Society is probably the oldest of a series of similar institutions founded in Europe during the 17th and 18th centuries, it could be a bit far-fetched to mention it to trace the historical evolution of the Open movement.

In more recent times, in 1998, David Wiley founds the Open Content Project, together with Eric Raymond, Tim O'Reilly and others, with inspiration from the concepts of Open Source Software and other elements such as the GNU licences. The Open Content Project was aimed at the academic world and it proposed a licence (the Open Publication Licence) which made the process of sharing intellectual creations easier. It is precisely David Wiley who coins the term "Open Contents", although it is clear that the idea is based on the Free Software movement that had emerged some years before.

In fact, different initiatives, all with notable similarities with free software, try to promote sharing of knowledge in different fields with as less restrictions as possible. Thus, in 1999, Rice University started the Connexions project (http://cnx.org), a project to share educational resources available free of charge to anyone under open-content and open-source licenses, Connexions offers custom-tailored, current course material, is adaptable to a wide range of learning styles, and encourages students to explore the links among courses and disciplines (Baraniuk et al., 2002). UNESCO (2002) coined the term Open Educational Resources (OER) to refer to the open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by the community of users for non-commercial purposes. In 1999, the Massachusetts Institute of Technology (MIT) initiated the MIT OpenCourseWare (OCW), a visionary commitment by the Institute to publish the materials from all MIT undergraduate and graduate subjects freely and openly on the web for permanent worldwide use. In September, 2002, the MIT launched a pilot project of its OpenCourseWare (http://ocw.mit.edu) with 50 courses. A year later, the official site would be presented with 500 courses and currently, they have more than

91 million visits by 65 million visitors from virtually every country and averages 1 million visits each month; translations receive 500,000 more (MIT OpenCourseWare, 2010), but most important of all is the fact that this initiative would soon extend to dozens (now hundreds) of universities (Wiley and Gurrell, 2009), leading to the creation of an international consortium.

In 2001, a year especially productive for the open movement, Larry Lessig and others founded Creative Commons, a foundation that, a year later, launched the first version of its well-known licences. These licences were the successors of the Open Publication Licence proposed by Wiley three years before (Lin et al., 2006). The year 2001 is also the beginning of the Wikipedia (http://www.wikipedia.org/), founded by Jimmy Wales y Larry Sanger, who a year before had tried a precursor idea: Nupedia (Sanger, 2005). Also in 2001, The Internet Archive Project became what we can access today (Thelwall and Vaughan, 2004).

An event that has had a great importance in the Open movement was, at the end of 2001, the Budapest Declaration, which in a few months later, in 2002, would give birth to the Budapest Open Access Initiative, BOAI (2002), which can be considered as a milestone in the application of the "Open" philosophy to scientific communication, especially regarding dissemination of research results. The BOAI played a major role in the emergence of Digital Repositories, which are nowadays the most outstanding flag of the Open movement. Not in vain, that same year of 2002, E-prints was born as a piece of software used by many of those repositories, and also other projects such as RoMEO (Rights MEtadata for Open archiving) (Oppenheim et al., 2003) and SHERPA (Securing a Hybrid Environment for Research Preservation and Access) (Markland and Brophy, 2005). D-space, another very widely-used program in many repositories, appeared in 2002. A year later, Fedora would be born too.

In 2003, the "Bethesda Declaration" is signed (Brown et al., 2003). The declaration is important, among other things, because, despite the fact that it refers to scientific research in general, it emerges from the field of biomedical research, where there has always been a presence of important economic interests. In this same chapter of important declarations, the Berlin Declaration has to be mentioned (Harnad, 2005). The exact title of the declaration is "Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities" (Berlin Declaration, 2003) and which should not be confused with other Berlin declarations regarding other different fields. The Berlin Declaration being referred to here took place as a consequence of the Conference on Open Access to Knowledge in Sciences and Humanities hosted by the Max Planck Institute on the 22nd and the 23rd of October, 2003. The Berlin Declaration offers the definition of an open access contribution: "Establishing open access as a worthwhile procedure ideally requires the active commitment of each and every individual producer of scientific knowledge and holder of cultural heritage. Open access contributions include original scientific research results, raw data and metadata, source materials, digital representations of pictorial and graphical materials and scholarly multimedia material". According to this, an open access contribution must satisfy two conditions:

1. The author(s) and right holder(s) of such contributions grant(s) to all users a free, irrevocable, worldwide, right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of, as well as the right to make small numbers of printed copies for their personal use.
2. A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in an appropriate standard electronic format is deposited in at least one online repository using suitable technical standards that is supported and maintained by an institution that seeks to enable open access, unrestricted distribution, inter operability, and long-term archiving.

Thus, the Berlin Declaration links the Open philosophy with the mission of Higher Education and Research Institutions to disseminate and spread knowledge. It proposes concrete actions, not just dissemination, but also topics such as the inclusion of open publications in the evaluations of scientific activity and the recognition of those publications in the researchers' professional careers.

In 2007, the Cape Town Open Education Declaration took place: Unlocking the promise of open educational resources, with the aim of accelerating efforts to promote open resources, technology and teaching practices in education (CTOED, 2007). It is interesting to note that this declaration promotes not only the creation of open educational resources in different formats, but also the use of technologies to facilitate collaborative and flexible learning and sharing resources between lecturers and researchers, including two elements present in this article: Free Software and Open Science.

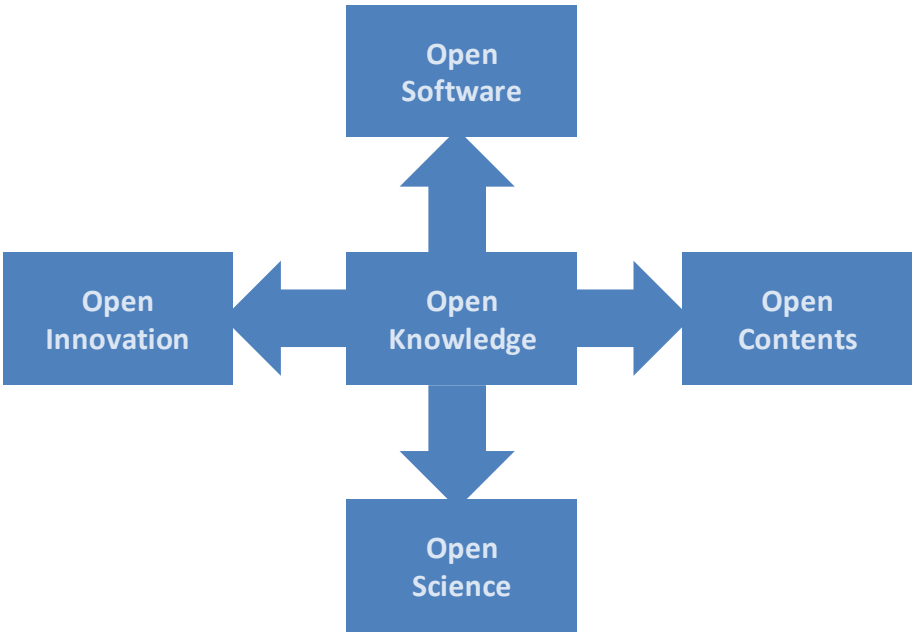
In 2004, The Directory of Open Access Journals (DOAJ – www.doaj.org/) is established. This directory offers nowadays a database of about 5000 scientific journals of all fields. All these journals are Open Access and apply proven methodologies of scientific quality control. The most important editors soon realised the impact of the Open movement (Bailey, 2005): Springer in 2005; Elsevier, Wiley & Sons and Cambridge University Press in 2006; Emerald, Sage or Bentham in 2007, just to quote some significant examples where journals have been opened to the public in different degrees.

1.2. Article organization

This article aims at presenting the state of the art of Open Knowledge as a basis for this special issue on Open Knowledge in Higher Education Institutions. The focus of the article is on online information and the way in which this is transforming the dissemination, transmission and, especially, creation of knowledge. This has repercussions in any field of economic, industrial or technological development, but it is clearly the field of education and scientific production where it provokes an evolution that affects to several collateral business models. There is a radical change in dissemination of scientific results and transference to the production sector towards a context of open innovation.

To face the state of the art of something as open an innovative and, at the same time, that causes so much controversy, is not a simple task. There are hundreds of different ways of doing it, but the authors of this article and the editors of the special issue will put into practice their experience in the organization and promotion of Open Knowledge at the University of Salamanca (Spain) between 2007 and 2009. To this end, the Open Knowledge Office (http://oca.usal.es) was created. This Office worked on four large areas (See Fig. 1): Free Software, educational resources or Open Contents, scientific contents or Open Science and Open Innovation.

Figure 1: Open Knowledge conceptual map



The article is organised as follows: in Section 2, very briefly, the topic of free software will be dealt with, not as the core of open knowledge, but as the movement that was the origin of the Open philosophy in a more generalised way when taking their contributions on software development to the field of digital information. Section 3 deals with open contents, especially educational contents, but including cultural contents. Section 4 deals with Open Science and Section 5 with Open Innovation. Section 6 talks about a series of general issues, such as legal topics or institutional management of open content by means of repositories. Finally, Section 7 closes the article with some reflections as conclusions.

2. Open software

Free Software is probably the oldest initiative within the Open group and it is, somehow, what has inspired most of the activities that we know now as Open Access. The idea of Free Software appears in the early 80s, with the emergence of autonomous commercial software, independent from hardware (Benussi, 2005). Until then, programs were considered as something closely linked to the computer where they ran. These were machines hard to use which required a little army of highly qualified people. Their environments were Calculus Centres or Data Processing Centres (DPC), where people would write specific applications for each task that had to be done. In many cases, the difference between such applications and the operating system itself was diffuse. Exchange of applications between different DPCs was something common and frequent (Michalec, 2002).

When personal workstations appeared, programs and autonomous applications also emerged. These applications were acquired separately from the machine and belonged to the turnkey projects type. Selling programs became an important business area and that meant programs were protected, both legally and technically. Restrictive licences that forbid copies, reinstallation in a different machine, etc. became common.

This situation caused, as a reaction, the emergence of a movement in favour of what we could generically call free software. One of the most outstanding characters was (and still is) Richard Stallman. He, among other things, gave a conceptual consistence to the ideas behind the term “free software”. Thus, he formulated what is known as the four freedoms of software, which sum up with precision what “free software” is (Chopra and Dexter, 2009):

- Freedom 0: freedom to run the program for any purpose.
- Freedom 1: freedom to study how the program works, and change it to make it do what you wish.
- Freedom 2: freedom to redistribute copies.
- Freedom 3: freedom to distribute copies of your modified versions to others.

Freedom 1 and 3 require access to the source code, one of the essential characteristics of free software. Stallman also created the Free Software Foundation (www.fsf.org) and the GNU Project (www.gnu.org). GNU is a recursive acronym of “GNU is Not Unix” (programmers will probably see the humour in it) and its main aim is to create a totally free and portable operating system for any architecture (Stallman, 1999).

To build that operating system, Unix was taken as a model. Although Unix was not free software, its source was known. The operating system sought should have a kernel and a large amount of small programs for different tasks. Many of those programs already existed. Others had to be rewritten to make them free software. Others were built from scratch.

The kernel, however, was still not there, until in 1992, the Linux kernel joined the project and made possible what we know today as the GNU/Linux operating system (Robles and González-Barahona, 2003).

The GNU project does not only produce computer programs, but also licences for free software distribution. The most extended licence is the General Public Licence (GPL). Though originally designed for licensing the components of GNU/Linux, it has been adopted by many other software producers. The GPL licence guarantees Stallman's four freedoms and extends them to any derivative from the original program (Kumar, S., 2006).

This last aspect has been seen by many as excessively restrictive. Its application implies that you cannot use a GPL program (for example, a programming language compiler, such as GNU C) to produce other programs if they are not licensed as well with the GPL licence (Asay, 2004). As a result, other less orthodox licences have appeared, keeping the basics of free software: access to source code, free copy and distribution, possibility to improve and modify the program. An example of these is the licences of some programs, some very well know, like Python (www.python.org/psf/license/). Python is an interpreted high-level language, similar to free software, but its licence allows programs to be written and then distributed as proprietary programs, the copy of which is not permitted.

In any case, free software is a fact today and has an ever-growing presence in all computer areas. In the area of operating systems, GNU/Linux is becoming more and more common, not only in servers, but also in workstations. But this is not the only free software operating system; there are others, such as BSD or OpenSolaris systems, although their licences are considered as too permissive by free software orthodoxies.

Free software has a strong presence in many other computer areas. Almost all important Internet services run through free software. Some significant examples, just to name a few, are Apache, the most widely-used server; PHP, one of the most widely-spread web programming languages; or MySQL and Postgres as databases. Regarding workstations, there is an ever-growing presence of free software too, such as OpenOffice, Mozilla Firefox, Mozilla Thunderbird, GIMP, etc.

3. Open contents in education

The field of education, in its broad sense, is where the Open movement has had a greater influence. In this field, Open Access might refer to learning contents (complete courses, modules, different learning objects), to informative and cultural contents, to free software tools to build these learning resources or to platforms to organise and distribute these materials (virtual campuses, Learning Management Systems, Content Learning Management Systems, etc.) (Caswell et al., 2008).

Focussing on learning resources, some initiatives have a special relevance. One of the most representative cases is the OpenCourseWare (OCW). In 2002, the MIT presented a web-based editorial initiative which they called OpenCourseWare (OCW) (Abelson, 2008). The idea was simple: to offer to the world, for free, the teaching materials of some of the courses that were being taught online. These materials would be available and could be used by anybody, without having to register. The licence to use these materials, which would end up being Creative Commons, was very little restrictive, which made it possible to reuse them by other people, for example, to prepare new teaching materials (Kumar, V., 2006). The use of these materials was free, but it did not entail any type of certification, nor contact with the MIT lecturers nor those using these materials could consider themselves MIT students: registration was required for that. The experience started with 50 subjects in 2002 that turned into 500 the next year; in 2009, practically every subject of the MIT (around 1900) was on the OCW. While this happened, many of the subjects were translated to other languages. Currently, the MIT OCW receives one million visits per month. The typical OCW user belongs to one of these three categories: self-learners, for obvious reasons (43%); students (42%), who want to enlarge their knowledge or who need to decide what subject to register in; and teachers (9%) looking for information and resources for their classes. Approximately half of visitors come from outside the United States (MIT OpenCourseWare, 2005).

From the beginning, there were mirrors of the MIT OCW. Further, the initiative was soon followed by other universities and higher education institutions, which organised their own OCW portals with their own subjects (Fukuhara, 2005). Out of this trend, the OCW Consortium was born, which nowadays gathers over 200 universities that publish subjects in their own OpenCourseWare (www.ocwconsortium.org).

Another significant initiative related to open educational resources (OER) is OER Commons (Cleveland and Kubiszewski, 2007), a repository of learning materials of different levels, from primary to post-secondary education, which holds today over 40000 items of all fields of knowledge.

The European SchoolNet is another network that should be mentioned here. This network is composed of 31 European Ministries of Education. Its aim is to promote the change in the ways of teaching and learning (Scimeca, 2009) using the New Technologies and emphasizing the interoperability and reuse of resources (www.eun.org). Based on these ideas, the Learning Resource Exchange for Schools has been formed (http://lreforschools.eun.org). This is a repository of several tens of thousands of educational resources. Most of them, since the aim of the network is to share, are under a Creative Commons licence.

4. Open Science

Technological development offers new tools to the researcher, which can be employed from a methodological point of view or for dissemination of results. Technological resources to support research offer scientists new channels to carry out their activity and to communicate their production. Innovation applied to research also uses technology and open resources. It is the so-called e-Science or Science 2.0 (Shneiderman, 2008). Science 2.0 is the application of the technologies of the Social Web to the scientific process. The Social Web, Web 2.0 or Participatory Web (O'Reilly, 2007) is characterized by the use of the open technologies, both from the point of view of information architecture and of the interconnection of services, and, especially, the collective work carried out in an online, collaborative and altruist manner. The Web 2.0 also applies to research, which benefits from these technologies to manage scientific activity, to establish links between communities of scientists and to share hypotheses, procedures and results. In this section, a reflection will be made about the use of the open technologies and participatory computing (social computing) in research.

The Social Web or Web 2.0 has introduced significant changes in the scientific work environment. The main key to the Social Web is participation (Merlo, 2009). Technologies 2.0 allow people to socialize without obstacles and to share data in an open way. There are various ways in which the Social Web applies to research (Cabezas et al., 2009), especially in bibliography management and relationships between researchers. Likewise, scientific communication is much more fluid thanks to open publishing and repositories (Nikam and Babu, 2009). Open Access is the new way of scientific communication, which coexists with traditional publication in academic journals and which often surpass this in terms of dissemination and impact.

It is possible to determine three large areas where open science is present. First of all, the Social Web offers the necessary resources for researchers to carry out their work, be this in a first stage or already advanced. To this end, there are a number of open platforms for publishing contents by means or blogs, academic portals, social networks or websites specialised in sharing hypotheses and experiments. Secondly, as a distinctive feature, Open Science offers the possibility of sharing useful resources for research, such as bibliographic references, learning objects, links, information or documents. Finally, Science 2.0 is characterized by its open attitude towards the dissemination of research results, mainly through open access journals and repositories. To sum up, Open Science shares processes, resources and results. In the next few paragraphs these aspects will be extended and significant examples will be given.

Research methodology presents differences depending on the field of knowledge. However, the scientific method always needs experimentation to prove the hypothesis, which then becomes a thesis. In the different options of scientific methodology teams of people are involved developing experimentation techniques from established procedures. The Social Web technologies facilitate the work flow of the scientific community and make the constitution of research teams more flexible.

A first contribution of Science 2.0 is the use of platforms to link people with same research interests, so that they can exchange information, resources and documents. This is what is called “Social Computing” (Wang et al., 2007). It is not simply sharing resources where the profile of a researcher and their works can be consulted. As the main characteristic of the Social Web is participation, we should include as resources those websites created to share in an effective manner CVs, research, hypotheses, etc.

Social networks have become the flag of the new generation Web. Relationships between

people in the same network are collaborative, immediate and ubiquitous. The concept of a social network, within the open science context, should be understood as a scientific community that employs collaborative technologies to exchange information. This technology could be a blog, a wiki, a social network, a virtual lab, a e-learning system, an intranet or whatever technological application that might be considered useful, such as content management systems (Ramachandran et al., 2009).

Relationships between professionals find an ideal space in social networks, especially in those created specifically as academic and professional networks. In this sense, we could mention networks like Academia (www.academia.edu), Academici (www.academici.com), Sciencestage (http://sciencestage.com), Scispace (www.scispace.com) or Epernicus (www.epernicus.com). Big social networks, such as Facebook (www.facebook.com) are also excellent platforms for establishing links between researchers (Boyd and Ellison, 2007). Together with social networks, the application of the Web 2.0 to scientific databases also facilitates that similar profiles get in touch and that researchers can follow the work of those in whom they are interested. A good example of this type of resources is Research ID (www.researcherid.com).

At the same time, there are collaborative tools for distributed work online that can be included in open science, as they are computer applications with interoperable technology and groups of people exchanging experiences. In this group, we could mention eLearning applications, such as Moodle (moodle.org), video conference tools such as Skype or Messenger, or those specialised in workflow management. We could also include within the group of open technologies for research those that are useful to carry out experiments or research. Some examples of these tools are services which allow the user to create and share surveys for social research, such as SurveyMonkey (www.surveymonkey.com) and conceptual maps, such as Compendium (http://compendium.open.ac.uk), FreeMind (http://freemind.sourceforge.net) or Mindomo (www.mindomo.com). Among all these applications, those that conceive collaboration between researchers in the process of some research with a global view are the ones that stand out. An excellent example is MyExperiment (www.myexperiment.org), a platform that allows communication, task and file sharing or the creation of groups between scientists (De Roure et al., 2008).

Scientists use for their work information resources which can be useful for people in their teams or for researchers working in the same field. Open Science facilitates sharing bibliographic references or links to online documents by means of social bookmarks. Also, digital repositories specialised in learning objects are being created, which allow sharing information resources, especially tutorials and how-to guides for certain tools. An example of this type of repositories is Merlot (www.merlot.org). Other platform for dissemination of scientific results is SciTopics (www.scitopics.com), where scientists share their results with other researchers and exchange opinions.

Management of bibliographic references has traditionally been done by means of closed programs that work as document databases. However, some of these programs allow sharing references and work online. Examples would be Zotero (www.zotero.org) and Refworks (www.refworks.com). At the same time, the social web allows sharing links through general systems of social bookmarking, such as Delicious (http://delicious.com) o Mister Wong (www.mister-wong.com), although from the Science 2.0 perspective, services that allow sharing of documents and bibliographic references are more interesting. Some specialised sites in open management of bibliographic references, with reviews and descriptions, are 2collab (www.2collab.com), CiteUlike (www.citeulike.org) and Connotea (www.connotea.org). In the same line, we can find the Labmeeting service (www.labmeeting.com), where we can organize documents, manage references and exchange data with research groups.

5. Open Innovation

Innovation, according to Webster's Dictionary, is defined as 1. the introduction of something new; and 2. a new idea, method, or device. In words of Albert Einstein "*We can't solve problems by using*

the same kind of thinking we used when we created them". Therefore, innovation has to go beyond launching new products or using the latest technological advances. This must be kept in mind especially when we are talking about a higher education institution that tries to be a reference regarding creation and transmission of knowledge. The historical legacy of some universities, many of them hundreds of years old, cannot be incompatible with inventing new processes or work methodologies, with designing new business models to create markets that did not exist before or to improve the existing ones. The university is, in essence, a space to select and put into practice the best ideas within a very brief period of time in order to serve the community. The university is a fundamental agent that, like no other, bridges the gap between a culture of efficiency to a culture of creativity (Alcántara and García-Peñalvo, 2009).

Innovation is an inherent element of human evolution. Innovation in itself must be considered as a process with a series of functions and indicators very well defined. To innovate means to change, inside the organization, in order to create value for its stakeholders, the organization and society in general. Innovation is present in each little detail of everyday activity in higher education institutions and in the ways how they operate. Innovation entails rethinking strategies and increasing the speed of processes. Open innovation aims at building an idea-generating machine that can compete in imagination, wit, inspiration and initiatives and that, finally, as the director of HP Labs Prith Banerjee (2010) says: "I have transferred it to a business".

Innovation and development, inseparable elements of the university's essence, imply elements of applicability closely linked to innovation, but innovation also implies factors that the university must boost, such as anticipation, cooperation, leadership, audacity, creativity, dynamism and opportunity.

From a strictly university perspective, we could point out eight actions to face the challenges inherent to innovation. These actions have been adapted from the Manifesto for innovation in the Basque Country (Innobasque, 2007).

First, it is necessary to promote an attitude of entrepreneurship. Secondly, a continuous adaptation and evolution of the educational model in the country, area or region has to be sought, using to that end all possible opportunities. Thirdly, this has to be combined, in perfect symbiosis, with a life-long learning system. The fourth action is that critical and free thinking, a traditional pillar of the university, has to be recovered. The fifth is that there has to be a permanent structure in organizations to promote innovation. Invention is the result of creativity, but it has no value until invention is used in a productive process to realize its value. This is innovation, that is, the fact of using innovation to generate value. This has to be linked, in sixth place, with actions aiming at favouring open innovation. The seventh action is the awareness of the urging necessity of having innovation in all fields. Finally, there needs to be an increase in the level of international opening and the level of cooperation among citizens and organizations.

We should highlight, among those eight actions, those which are central to support the others within a fundamental framework for the development of the Knowledge Society: open innovation. This has become, since its formulation by Henry Chesbrough (2003), in the reference framework for innovation management in organizations.

During most of the 20th century, innovation has taken place within the limits of closed entities. However, monopolies of knowledge from the industrial society are falling apart and, to achieve a real Knowledge Society, it is unthinkable a non-collaborative perception in the creation of new knowledge and its application to become value for society.

The idea, therefore, is to understand innovation as an open system in which both internal and external agents participate in it. In other words, an idea of innovation which is based not only in the internal capabilities, but also in all possible sources (users, providers, networks, etc.) and which, going beyond the product and the technology, it also takes into account intangibles and, in general, the multiple dimensions that lead to the creation of value.

This is justified in the very structure of the digital and technological society in which we currently live, where users and/or clients are more and more demanding and favour the level of competition, scientific and technological progress speeds up, the lifecycle of products gets shorter,

globalization intensifies, people's mobility grows, there is a greater level of education and access to information and all that by means of a democratization of technologies.

The philosophy behind open innovation must be part of the university and be present in its strategic mission as the only way of being part of the academic culture (Wiley, 2006), which will inevitably contribute to a more open participation context that will help to bring closer higher education institutions to the production sector. This will create true Open Knowledge, with a great ecosystem for innovation (Brown, 2008) in which every university department should be challenged to transform public services and create new markets through the production of their own innovation plan (DIUS, 2008).

The decision to be open is a choice for the organizations to make in line with their business models, and this choice is revealed in their external search patterns (Laursen and Salter, 2006) and judged in terms of their innovative and economic outcomes.

Nevertheless, the term "open innovation" reflects a range of organisational behaviours, which finds meaning under different contexts of market and innovation dynamics. In a study carried out by Virginia Acha (2008), it is explained that design not only allows the division of tasks in the innovation process, but it also allows to cross the range of innovative activities with external sources suggested by the open model of the innovation. Whereas the capacity of absorption is important for transference of traditional technology, the capacity of design stands out among the open strategies of innovation due to the importance of the contributions and ideas coming from that field. This report shows that the concept "open" is an umbrella term for the various means, depths and motives for reaching across organisational boundaries to achieve an innovation task. Thus, according to Cohen and Levinthal (1990), the ability to explore external knowledge is a critical factor for the development of innovation. In the Finnish Community Innovation Survey, in 1997, it is suggested to follow a parallel-path strategy in innovation, so that the organization keeps an open strategy regarding the sources of information (breath in sources) together with a widening of views regarding the ways of innovate (breath of objectives). According to the Department of Trade and Industry (2005) open innovation is identified when there is a more exhaustive use of external sources related to technology and knowledge. Leiponen and Helfat (2005) point out the benefits of keeping some options open to fight the uncertainty that always surrounds innovation processes. As we mentioned before, Laursen and Salter (2006) state that the practice of open innovation has an effect in terms of results of innovation and economy.

As a conclusion, open innovation is in line with the most current innovation processes that require institutions, including higher education institutions, to manage highly specialised knowledge on different alternatives of people, technology and markets. The lack of opening towards external environments on the part of the institution reflects a short-sighted view and an excessive emphasis on resources and internal possibilities that will develop unaware and unconnected with the advances and contributions of third parties, which will certainly provoke a loss in competition.

6. Transversal issues

Open Access is the term which is being used internationally to refer to the possibility of consulting a document freely. Open Access can be understood in a broad sense as a document published for public consultation or, in a more strict sense, as the document published digitally, for public use and following certain technical standards and specific international recommendations.

In the last few years, there has been a considerable increase in the number of open access initiatives, created with the aim of making available to the scientific community the publications that altruist authors and editors provide (Frandsen, 2009). Traditionally, it has been used the term "open archive" to refer to a document hosted in a server to which there is free access (*gratis* and *libre*). The reason this term is used is because, in its origin, the aim was to archive documents to prevent their loss. Also, the concept of openness fits both with the computer architecture, accessible from any machine, and with the public nature of these initiatives.

It is necessary to restrict the concept of open access, as has been done in different institutions

which work on this topic (Suber, 2004). Initiatives and projects that qualify as "open access" must comply with these conditions:

- Digital documentation: all documents available for free access are in electronic formats.
- Online access: documents hosted in servers accessible through the Internet, be them repositories, editors' websites, electronic journals or authors' personal websites.
- Public use: possibility to read, download, copy, print and distribute a document, with the only exception that there must be respect for the intellectual property that the author has kept for the attribution and citation of their work. Authors use licences that reserve some rights (copyleft).
- Normalized archives: standards must be complied with regarding identification of digital documents, data mining and exchange of information about them. Use of international protocols, such as Digital Objetc Identifier (DOI) (Paskin, 2010) and Open Archives Initiative-Protocol for Metadata Harvesting (OAI-PMH) (Lagoze et al., 2002).
- Cooperative initiatives: participation in collective projects, with institutions or in online networks, such as joining initiatives that promote free communication among the scientific community.

Nowadays, the movement for open access to publications can be seen in practice in two ways: open journals and repositories. Regarding the edition of electronic journals of free or open access, the user goes to the website and there, the abstracts and complete articles can be consulted. The second option is the creation of repositories, be them individual, institutional or specialised, where documents are archived.

There are two ways for open scientific contents providing (Jeffery, 2006), the so-called "Green Open Access" that means authors publish in non-Open Access journals and self-archiving their final peer-reviewed drafts in their own Open Access Institutional Repositories, and the so-called "Gold Open Access" that means researches can provide their works in Open Access journals.

Open Access became a reality when several institutions joined forces to promote free dissemination of scientific production and to push public administrations to create digital repositories that could be consulted freely.

Among the international initiatives supporting free access, there are three which gave place to three important declarations, which stand out. The first of these actions is the Budapest Open Access Initiative BOAI (2002), which supports the creation of open repositories of scientific documents and the edition of electronic journals also with free and open access. This initiative has been followed by others, such as the Bethesda Declaration (Brown et al., 2003) and the Berlin Declaration (Berlin Declaration, 2003). In the library science area, the IFLA Declaration (2003) favours open access for academic and research publications. Furthermore, it is currently being debated in the European Union another important initiative to establish open access for all publications derived from research funded by public bodies.

Open documents have their public access document condition explicit in their metadata. By means of protocols such as OAI/PMH the document is labelled, indicating both, its intellectual property and its free use and distribution. This type of protocols allows open documents to be traced by programs and specific search engines (harvesters), which integrate in the repositories databases the information collected on the open documents available. Many of these repositories have been built collecting public documents available in personal or institutional websites, as well as in open access electronic journals. Examples of these harvesters are OAIster (www.oclc.org/oaister), Scientific Commons (www.scientificcommons.org) or BASE (http://base.ub.uni-bielefeld.de).

Normalization has played a crucial role in the creation of open access repositories. A standard was necessary in order to exchange the digital information contained in the different open documents. The aim was to have a common outline describing the information to allow data exchange. This was achieved with the OAI-PMH protocol, developed by the Open Archives Initiative, which is met by the computer applications designed to start repositories and digital collections.

The Open Archives Initiative (www.openarchives.org) develops interoperability standards for

content dissemination. They also register the information services and providers that use their standards. Their most widely used standard is OAI-PMH. The main purpose of this standard is to provide the document with metadata that informs about its content, its location and its public nature. Documents following this standard must be hosted in a repository available for full-text consultation. OAI-PMH is technically simple and follows the HTTP and XML standards, which makes it easy to integrate in any web context. The description of the data that must be included in OAI-PMH follow the Dublin Core metadata definitions (http://dublincore.org/), which has contributed to its quick generalization.

Repositories using OAI-PMH allow their documents to be retrieved through harvesters, which act somehow as meta-search engines. Thanks to OAI-PMH, search in repositories is more simple and complete, to the extent that most open archives of a certain topic share their resources with other same-topic or multidisciplinary repositories to achieve the much-sought global dissemination of information. Nowadays, a scientific article hosted in an institutional repository can be located from any other source, as it is possible to exchange data between systems that meet the same protocol. Computer programs currently used to manage open archives include the OAI-PMH standard. There is a wide variety of software, mainly distributed as free software, designed for creating institutional repositories, such as Dspace (www.dspace.org), Eprints (www.eprints.org) and Fedora (www.fedora-commons.org).

Big academic institutions have their own open archives and many scientific disciplines have their own specialised repositories where they share articles and scientific documents. There are currently about 1600 repositories. The most complete source of information to find out what repositories exist is the Directory of Open Access Repositories (OpenDOAR) (www.opendoar.org), an international initiative which aims at collecting all the repositories available in the world. At this moment, this is the best repository collection, which can be consulted by country, document type or subject matter. The other large directory with access to repositories all over the world is the Registry of Open Access Repositories (ROAR) (http://roar.eprints.org), created in 2004.

7. Conclusions

Knowledge turned into science increases its value as it is more widely spread. It is possible to state that open access to scientific production is multiplying the volume of available documentation and is reducing the temporal and economic obstacles to access scientific articles and other research results. When research is publicly funded, its results should also be public, which is why initiatives leading to open the access to scientific production are becoming very important. As an example, there is an estimation that Europe is losing almost 50% of the potential return on its research investment until research funders and institutions mandate that all research findings must be made freely accessible to all would-be users, webwide (Harnad, 2006).

With roots in the Free Software movement, Open Access philosophy has had a profound impact in the area of digital information, with a special emphasis in the area of education and culture. This has made it take a qualitative step into what has become to be known as Open Science, with major support from government institutions, such as the case of the European Union, and which finally reaches the area of transference towards the production sector with Open Innovation.

The authors of this article understand that the sum of these four areas: software + contents + science + innovation is what we know as Open Knowledge. Thus, the main milestones have been covered, as well as transversal topics, hoping that this could serve as conceptual map for the development of this special issue dealing with Open Knowledge in Higher Education Institutions.

This type of institutions should be the place where Open Knowledge should flourish and finally break the different barriers still found among lecturers/researchers to share their work, or among institution policy makers holding on to the excuse of better quality control (when there is no better quality control that expose the contents produced to the public), or among evaluation agents who still abide by privative publication models, which, on the other hand, must look for new business models to sustain the publication costs of scientific documents.

Another important aspect is the number of citations an openly accessible work receives. A study

made by Davis et al. (2008) disputes the claim that open access articles equals more citations, they found, in an interim analysis, that in the first year after the articles were published, open-access articles were downloaded more but were no more likely to be cited than subscription-based articles. Different studies can be found which either share or refute this hypothesis. However, Swan (2010) reviewed these studies and concludes that most of the studies analysed (27 out of 31) show a positive correlation between the accessibility of an article and the number of citations it receives.

Despite all the obstacles, Open Knowledge is expanding. Its aim (unlike Free Software) is not to become the only alternative, but to become the main channel for dissemination of knowledge and, therefore, to contribute to the creation of more and better knowledge in the world. Digital information published with free access on the Internet is a powerful channel of transference that cannot be stopped once it has started.

From an ethical point of view, Higher Education Institutions have the moral duty of giving back to Society research results and the advance of the state of the art in the scientific, technological, humanistic, social or artistic fields if they have been funded by public institutions. This also becomes one of the most effective ways of cooperation with developing countries.

By means of open innovation, the production sector joins this movement, looking for their own interests, obviously, but also balancing the benefits that collaboration with other agents can bring forward.

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About the authors

Francisco J. García-Peñalvo holds a PhD in Computer Science (2000, University of Salamanca, Spain). He works as a teacher of the Computer Science Department of the University of Salamanca. Dr. García is the GRIAL (research GRoup in InterAction and eLearning) director. His main research interests are eLearning, Computer & Education, Adaptive Systems, Web Engineering, Semantic Web, and Software Reuse. He was member of the Member from Technologic and Academic Committee of the White Book for Digital University 2010. He was Technology Innovation Vice-Rector of the University of Salamanca from March 2007 to December 2009 and the President of the Technical Committee of the SCOPEO observatory, an observatory for the eLearning activity, innovation and trends, from its beginning until December 2009. He has more than 100 published papers in international journals and conferences. Francisco J. García-Peñalvo is the corresponding author and can be contacted at: fgarcia@usal.es

Carlos García de Figuerola is a professor at the Department of Informatics and Automatics of the University of Salamanca. He teaches in the BA in Information and Documentation and also in postgraduate degrees in Intelligent Systems and in Social Studies of Science and Technology. His research interests are information recovery, electronic documentation, cybermetrics and knowledge organization and dissemination, about which he has published numerous articles and books. He has also supervised several PhD thesis in those areas. He has been Dean of the Faculty of Translation and Documentation, as well as Head of the Open Knowledge Office of the University of Salamanca.

José Antonio Merlo holds a PhD in Documentation. He is a lecturer at the Department of Documentation and Library Science of the University of Salamanca. He is a specialist in technologies applied to library services and has written a hundred articles on research on libraries and information technologies. He is a board member of FESABID (Spanish Federation of Associations of Information Professionals).