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Open knowledge: challenges and facts

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Abstract

Purpose – The purpose of this paper is to open the special issue of *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 follows the reference model used by the University of Salamanca (Spain) to promote open knowledge in the institution through its Open Knowledge Office. This model comprises four areas: free software, open educational content and cultural dissemination, open science, and open innovation.

Findings – For each of the four areas mentioned above, milestones and the most significant projects are 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, although somewhat controversial, is growing relentlessly as cultural and scientific dissemination leave behind other interests or economic models. International organisations and governments are gradually embracing open knowledge as the way to share scientific advances with society and as an international cooperative way to assist development in third-world countries.

Keywords Open systems, Knowledge management, Higher education, Innovation

Paper type Case study

Introduction

Information technologies and especially the internet have changed the way we produce, publish and communicate information towards models where information is primarily produced in digital formats and consumed through online media. There is

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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.

Moreover 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 understood at an early stage. These ideas were not new in these places, as it was not the risk of public criticism of the creations, but rather different barriers – both technical and economic – that had imposed important restrictions on the free dissemination of knowledge (Suber, 2006).

These ideas are the bases of what came to be known as the Open movement. The Open Content Initiative refers to the free distribution, use, copy and modification of the 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 the 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 perhaps simplistic, but intuitive, point of view, the fewer restrictions imposed on a certain content, the more "open" that content is. The permissions of basic use are expressed by what are 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.

The history and evolution of the open knowledge concept

Various sources cite 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 its objective of promoting and disseminating scientific knowledge. Although the Royal Society is probably the oldest of a series of similar institutions founded in Europe during the seventeenth and eighteenth centuries, it could be a bit far-fetched to consider it the first step in the historical evolution of the Open movement.

In 1998 David Wiley founded 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) that made the process of sharing intellectual creations easier. It was David Wiley who coined 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 to free software, tried to promote the sharing of knowledge in different fields with as few 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 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 contained 500 courses and now they have received more than 91 million visits by 65 million visitors from virtually every country (MIT OpenCourseWare, 2010). However most important of all is the fact that this initiative soon extended 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 was also the beginning of Wikipedia (www.wikipedia.org/), founded by Jimmy Wales and 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 at the end of 2001, of great importance to the Open movement, was the Budapest Declaration, which in a few months later in 2002 would give birth to the Budapest Open Access Initiative (BOAI) (2002). It can be considered 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 visible flagship of the Open movement. Also in 2002 e-prints emerged as a piece of software used by many of those repositories, and also other projects such as Rights MEtadata for Open archiving (RoMEO) (Oppenheim *et al.*, 2003) and Securing a Hybrid Environment for Research Preservation and Access (SHERPA) (Markland and Brophy, 2005). D-space, another very widely-used program in many repositories, also appeared in 2002. A year later, the institutional repository Fedora appeared.

In 2003 the "Bethesda Declaration" was signed (Brown *et al.*, 2003). The declaration is important for several reasons but especially because, despite the fact that it refers to scientific research in general, it emerged from the field of biomedical research, where important economic interests have always been present. When listing important declarations, the Berlin Declaration must 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 it should not be confused with other

Berlin declarations regarding different fields. The Berlin Declaration 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 in October 2003. The Berlin Declaration offers a definition of open access contributions: "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, 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, interoperability, 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 evaluation 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 discussed in this paper: Free Software and Open Science.

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

Aim of this paper

This paper aims to present 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 paper 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 causes an evolution that affects 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 assess the state-of-the-art of something this open and 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 paper (also the editors of the special issue) will draw on their experiences in the organisation 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 Figure 1): free software, educational resources or open contents, scientific content or open science and open innovation.

The paper is organised as follows. In the next section, the topic of free software is briefly 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 in software development to the field of digital information. The section after that deals with open contents, especially educational content, but including cultural content. The next two sections deal with open science followed by open innovation. The subsequent section talks about a series of general issues, such as legal topics or institutional management of open content by means of repositories. The final section gives some reflections as conclusions.

Open software

Free software is probably the oldest initiative within the open group and it has inspired most of the activities that we now know as open access. The idea of free software appears in the early 1980s, with the emergence of autonomous commercial software, independent from hardware (Benussi, 2005). Until then programs were considered closely linked to the computer where they ran. These machines were difficult to use and thus required a small 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

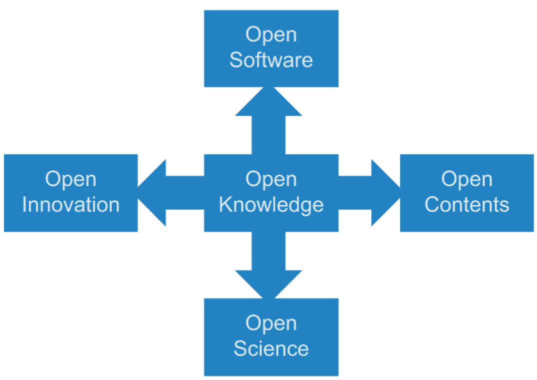

Figure 1.
Open Knowledge conceptual map

such applications and the operating system itself was diffuse. The exchange of applications between different DPCs was 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 project type. Selling programs became an important business and that meant programs were protected, both legally and technically. Restrictive licences that forbade 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 foremost characters was (and still is) Richard Stallman. He, among other things, gave conceptual consistency 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):

(1) *Freedom 0*: freedom to run the program for any purpose.

(2) *Freedom 1*: freedom to study how the program works, and change it to make it do what you wish.

(3) *Freedom 2*: freedom to redistribute copies.

(4) *Freedom 3*: freedom to distribute copies of your modified versions to others.

Freedoms 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 number 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 not only produces computer programs, but also licences for free software distribution. The most extended licence is the General Public Licence (GPL). Although 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, and the ability to improve and modify the program. An example of these can be found in the licences of some programs, some very well known, such as 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 copying 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 too permissive according to 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 the MySQL and Postgres databases. There is an ever-growing presence of free software on workstations too, such as OpenOffice, Mozilla Firefox, Mozilla Thunderbird, GIMP, etc.

Open contents in education

The field of education, in its broad sense, is where the Open movement has had a greater influence. Here open access might refer to learning content (complete courses, modules, different learning objects), to informative and cultural content, 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).

Some initiatives have a special relevance to learning resources. One of the most representative cases, as mentioned previously, is OCW. In 2002 the MIT presented a web-based editorial initiative which they called OpenCourseWare (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 becoming the Creative Commons, was minimally restrictive, which made it possible for other people to reuse them, 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 could those using these materials consider themselves MIT students: registration was required for that. By 2009 practically every subject taught by the MIT (around 1,900) 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, and translations receive 500,000 visits. The typical OCW user belongs to one of these three categories: self-learners, for obvious reasons (43 percent); students (42 percent) who want to enlarge their knowledge or who need to decide what subject to register in; and teachers (9 percent) looking for information and resources for their classes. Approximately half of the visitors come from outside the USA (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 comprises over 200 universities that publish courses in their own OpenCourseWare (www.ocwconsortium.org).

Another significant initiative related to open educational resources is OER Commons (Cleveland and Kubiszewski, 2007), a repository of learning materials of different levels, from primary to post-secondary education, which today holds over 40,000 items from all fields of knowledge.

The European SchoolNet is another network that should be mentioned here. This network consists of 31 European Ministries of Education. Its aim is to promote change in the methods of teaching and learning (Scimeca *et al.*, 2009) using the New Technologies and emphasising 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.

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 in which to carry out their activities and to communicate their results. Innovation applied to research also uses technology and open resources. It is the so-called e-Science or Science 2.0 (Shneiderman, 2008): 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 characterised by the use of 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 altruistic manner. Web 2.0 also applies to research, which benefits from these technologies in managing scientific activity, establishing links between communities of scientists and sharing hypotheses, procedures and results. In this section we reflect on the use of open technologies and participatory computing (social computing) in research.

The Social Web or Web 2.0 has introduced significant changes to the scientific work environment. The main key to the Social Web is participation (Merlo, 2009). Technologies 2.0 allow people to socialise 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 mode of scientific communication, which coexists with traditional publication in academic journals and which often surpasses that 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, whether it is in an early stage or already advanced. To this end there are a number of open platforms for publishing content by means of blogs, academic portals, social networks or web sites specialising in sharing hypotheses and experiments. Second, 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 characterised 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 differs depending on the field of knowledge. However the scientific method always requires experiments to prove or disprove hypotheses. In the different kinds of scientific methodology teams of people develop experiment techniques from established procedures. The Social Web technologies facilitate the workflow of the scientific community and make the membership of research teams more flexible.

One contribution of Science 2.0 is the use of platforms to link people with the 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 so that the profile of a researcher and their work can be consulted. As the main characteristic of the Social Web is participation, we should include as resources those web sites created to share CVs, research, hypotheses, etc. in an effective manner.

Social networking has become the flagship 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, wiki, social network, virtual lab, e-learning system, or intranet or whatever technological application 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. These include networks such as 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 Web 2.0 to scientific databases helps people with similar profiles to get in touch with each other and allows researchers to easily follow the work of those in whom they are interested. A good example of this type of resource is Researcher 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. This group includes e-learning applications such as Moodle (moodle.org), video conference tools such as Skype or Messenger, and those specialised in workflow management. Open technologies for research also include those that are useful for carrying out experiments or research. Some examples of these tools are services that 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) and Mindomo (www.mindomo.com). Among all these applications, those that enable collaboration between researchers in the process of 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 and the creation of groups of scientists (De Roure *et al.*, 2008).

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

The management of bibliographic references has traditionally been done by means of closed programs that work as document databases. However some of these programs allow the sharing of references and working online. Two examples are Zotero (www.zotero.org) and Refworks (www.refworks.com). At the same time the social web allows people to share links through general systems of social bookmarking, such as Delicious (http://delicious.com) or Mister Wong (www.mister-wong.com), although from the Science 2.0 perspective, services that allow sharing of documents and bibliographic references are more relevant. Some sites specialising in open management of bibliographic references, with reviews and descriptions, are 2collab (www.2collab.com), CiteUlike (www.citeulike.org) and Connotea (www.connotea.org). Similarly the Labmeeting service (www.labmeeting.com) enables scientists to organise documents, manage references and exchange data with research groups.

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 the 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 source of 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, or with designing new business models to create markets that did not exist before or improving 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 and a culture of creativity (Alcántara and García-Peñalvo, 2009).

Innovation is an inherent element of human evolution. Innovation in itself must be considered a process with a series of very well defined functions and indicators. To innovate means to change, inside the organisation, in order to create value for its stakeholders, the organisation and society in general. Innovation is present in each little detail of everyday activity in higher education institutions and in the ways 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, according to the director of HP Labs Prith Banerjee (2010), is transferred 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 promote, such as anticipation, cooperation, leadership, audacity, creativity, dynamism and opportunity.

From a strictly university perspective, there are eight actions required to face the challenges inherent in 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. Second there should be continuous adaptation and evolution of the educational model in the country or region, using all possible opportunities. Third this has to be combined, in perfect symbiosis, with a life-long learning system. The fourth action is critical and free-thinking, a traditional pillar of the university. The fifth is that there has to be a permanent structure within organisations to promote innovation. Invention is the result of creativity, but it has no value until invention is used in a productive process to realise its value. This is innovation, that is, the fact of using innovation to generate value. This must be linked with the sixth item: actions aimed at favouring open innovation. The seventh action is the awareness of the urgent necessity of having innovation in all fields. Finally, there needs to be an increase in the level of international openness and the level of cooperation among citizens and organisations.

We should highlight, among those eight actions, those that are essential 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), central to the reference framework for innovation management in organisations.

During most of the twentieth century, innovation took 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 that a non-collaborative perception of the creation of new knowledge and its application would be of value for society.

The idea, therefore, is to understand innovation as an open system in which both internal and external agents participate. In other words it is an idea of innovation which is based not only on its internal capabilities, but also on all possible sources (users, providers, networks, etc.) and which, going beyond the product and the technology, 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 support the level of competition, scientific and technological progress speeds up, the lifecycle of products gets shorter, globalisation intensifies, people's mobility grows, there is a greater level of education and access to information and all that by means of a democratisation 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 environment that will help to bring higher education institutions closer 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 organisations 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 Acha (2008) it was shown that design not only allows the division of tasks in the innovation process, but it also allows us 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 the transfer 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 "open" concept 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, one recommendation was to follow a parallel-path strategy in innovation, so that the organisation keeps an open strategy regarding the sources of information (breadth in sources) together with a widening of views regarding the ways to innovate (breadth of objectives). According to the UK Department of Trade and Industry (2005) open innovation is identified when there is 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 above, Laursen and Salter (2006) state that the practice of open innovation has an effect in terms of the results of innovation and on the economy.

In conclusion, open innovation is in line with the most current innovation processes that require institutions, including higher education institutions, to manage highly specialised knowledge in different kinds of people, technology and markets. The lack of openness towards external environments on the part of the institution reflects a shortsighted view and an excessive emphasis on resources and internal possibilities that will develop unaware of and disconnected from the advances and contributions of third parties, which will certainly be a disadvantage in competition.

Transversal issues

Open access is the term that is being used internationally to refer to the ability to consult a document for free. 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 altruistic authors and editors provide (Frandsen, 2009). Traditionally the term "open archive" has been used 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, the original aim was to archive documents to prevent their loss. Moreover, the concept of openness fits both the computer architecture, accessible from any machine, and 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 are hosted in servers accessible through the internet, whether repositories, publishers' web sites, electronic journals or authors' personal web sites.
- *Public use*: the ability 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).
- *Normalised 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 Object Identifier (Paskin, 2010) and Open Archives Initiative-Protocol for Metadata Harvesting (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 forms: open journals and repositories. For electronic journals with free or open access, the user goes to the web site and consults the abstracts and complete articles. The second option is the creation of repositories, whether individual, institutional or specialised, where documents are archived.

There are two ways to provide open scientific content (Jeffery, 2006): "Green Open Access" in which authors publish in non-open access journals and self-archive their final peer-reviewed drafts in their own open access institutional repositories, and "Gold Open Access" where researchers can provide their work through open access journals.

Open access became a reality when several institutions joined forces to promote free dissemination of scientific production and to push for the creation of digital repositories that could be consulted freely.

Among the international initiatives supporting free access, there are three important declarations. 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 publishing 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 (2003). In the library science area, the IFLA Declaration (IFLA, 2003) favours open access to academic and research publications. Furthermore another important initiative to establish open access for all publications derived from research funded by public bodies is currently being debated in the European Union.

Open documents' public accessibility is 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 protocol allows open documents to be traced by programs and specific search engines (harvesters), which integrate the information collected on the open documents available in the repository databases. Many of these repositories have been built by collecting public documents available on personal or institutional web sites, as well as in open access electronic journals. Examples of these harvesters are OAIster (www.oclc.org/oaister), Scientific Commons (www.scientificcommons.org) and BASE (http://base.ub.uni-bielefeld.de).

Normalisation 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 describes 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 descriptions of the data that must be included in OAI-PMH follow the Dublin Core metadata definitions (http://dublincore.org/) which have contributed to its quick diffusion.

Repositories using OAI-PMH allow their documents to be retrieved through harvesters, which act as meta-search engines. Thanks to OAI-PMH, searching repositories is easy and comprehensive, to the extent that most open archives on 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 on what repositories exist is the Directory of Open Access Repositories (www.opendoar.org), an international initiative that aims at collecting all the repositories available in the world. At the moment this is the best repository collection, and 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 (http://roar.eprints.org) created in 2004.

Conclusions

Knowledge turned into science increases its value as it is more widely spread. It is evident that open access to scientific production is multiplying the volume of available documentation and is reducing the temporal and economic obstacles to accessing 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. For example it is estimated that Europe will lose almost 50 percent 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 web wide (Harnad, 2006).

With roots in the free software movement, the open access philosophy has had a profound impact on digital information, with a special emphasis on education and culture. Thus it took a qualitative step into what has become known as open science, with major support from government institutions, such as the European Union, and is finally transferred to the production sector with open innovation.

The authors of this article understand that the sum of these four areas – software + content + science + innovation – is what we know as open knowledge. Thus the main milestones have been covered, as well as transversal topics, hoping that this can serve as a conceptual map for the development of this special issue dealing with open knowledge in higher education institutions.

These institutions should be where open knowledge flourishes and finally breaks the various barriers still found among lecturers/researchers against sharing their work, or among institution policy makers holding on to the excuse of better quality control (when there is no better quality control than exposing the content produced to the public), or among evaluation agents who still abide by privative publication models, which 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 attract more citations. They found 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 support 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 transfer that cannot be stopped once it has started.

From an ethical point of view higher education institutions have the moral duty to give back to society their research results and to advance the state of the art in scientific, technological, humanistic, social or artistic fields if they have been funded by public institutions. This also becomes one of the most effective methods of cooperation with developing countries.

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

References

Abelson, H. (2008), "The creation of OpenCourseWare at MIT", *Journal of Science Education and Technology*, Vol. 17 No. 2, pp. 164-74.

Acha, V. (2008), "Open by design: the role of design in open innovation", Department for Innovation, Universities and Skills, London, available at: www.dius.gov.uk/ (accessed 10 March 2010).

Alcántara, M. and García-Peñalvo, F.J. (2009), "Discurso de apertura", paper presented at the Taller de Innovación y Conocimiento de la Secretaría General Iberoamericana (SEGIB), Salamanca, 15-17 June.

Asay, M. (2004), "The GPL: understanding the license that governs Linux", available at: www.novell.com/coolsolutions/feature/1532.html (accessed 27 April 2010).

Bailey, C.W. (2005), "Open access bibliography: liberating scholarly literature with e-prints and open access journals", Association of Research Libraries, Washington, DC, available at: www.digital-scholarship.org/oab/oab.htm (accessed 26 April 2010).

Banerjee, P. (2010), "Wedding innovation with business value: an interview with the director of HP Labs", available at: www.mckinseyquarterly.com (accessed 10 March 2010).

Baraniuk, R.G., Burrus, C.S., Hendricks, B.M., Henry, G.L., Hero, A.O. III, Johnson, D.H., Jones, D.L., Nowak, R.D., Odegard, J.E., Potter, L.C., Reedstrom, R.J., Schniter, P., Selesnick, I.W., Williams, D.B. and Wilson, W.L. (2002), "Connexions: education for a networked world", *Proceedings of the 27th IEEE International Conference on Acoustics, Speech, and Signal Processing*, IEEE Press, Los Alamitos, CA, pp. IV4144-7.

Benussi, L. (2005), "Analysing the technological history of the open source phenomenon. Stories from the free software evolution, FLOSS history", working paper, Version 3.0, available at: http://freesoftware.mit.edu/papers/benussi.pdf (accessed 26 April 2010).

Berlin Declaration (2003), "Berlin Declaration on open access to knowledge in the sciences and humanities", available at: http://oa.mpg.de/openaccess-berlin/berlindeclaration.html (accessed 26 April 2010).

Boyd, D.M. and Ellison, N.B. (2007), "Social network sites: definition, history, and scholarship", *Journal of Computer-mediated Communication*, Vol. 13 No. 1.

Brown, P.O., Cabell, D., Chakravarti, A., Cohen, B., Delamothe, T., Eisen, M., Grivell, L., Guédon, J.-C., Hawley, R.S., Johnson, R.K., Kirschner, M.W., Lipman, D., Lutzker, A.P., Marincola, E., Roberts, R.J., Rubin, G.M., Schloegl, R., Siegel, V., So, A.D., Suber, P., Varmus, H.E., Velterop, J., Walport, M.J. and Watson, L. (2003), "Bethesda statement on open access publishing", *Scholarly Communications Report*, Vol. 7 No. 6, pp. 9-10.

Brown, T. (2008), "Lessons from innovation's front lines: an interview with IDEO's CEO", available at: www.mckinseyquarterly.com (accessed 10 March 2010).

Budapest Open Access Initiative (BOAI) (2002), available at: www.soros.org/openaccess/index.shtml (accessed 26 April 2010).

Cabezas, Á., Torres, D. and Delgado, E. (2009), "Ciencia 2.0: catálogo de herramientas e implicaciones para la actividad investigadora", *El profesional de la información*, Vol. 18 No. 1, pp. 72-9.

Caswell, T., Henson, S., Jensen, M. and Wiley, D. (2008), "Open Educational Resources: enabling universal education", *The International Review of Research in Open and Distance Learning*, Vol. 9 No. 1, available at: www.irrodl.org/index.php/irrodl/article/view/469/1001 (accessed 27 April 2010).

Chesbrough, H.W. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA.

Chopra, S. and Dexter, S. (2009), "The freedoms of software and its ethical uses", *Ethics and Information Technology*, Vol. 11 No. 4, pp. 287-97.

Cleveland, C.J. and Kubiszewski, I. (2007), "Open Education Resource (OER) commons", in Cleveland, C.J. (Ed.), *Encyclopedia of Earth*, Environmental Information Coalition, National Council for Science and the Environment, Washington, DC, available at: www.eoearth.org (accessed 27 April 2010).

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective of learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-52.

CTOED (2007), "Cape Town Open Education Declaration: unlocking the promise of open educational resources", available at: www.capetowndeclaration.org/ (accessed 29 April 2010).

Davis, P.M., Lewenstein, B.V., Simon, D.H., Booth, J.G. and Connolly, M.J.L. (2008), "Open access publishing, article downloads, and citations: randomised controlled trial", *British Medical Journal*, No. 337, p. a568, available at: www.bmj.com/cgi/content/full/337/jul31_1/a568

De Roure, D., Goble, C., Bhagat, J., Cruickshank, D., Goderis, A., Michaelides, D. and Newman, D. (2008), "myExperiment: defining the social virtual research environment", *Proceedings of the 4th IEEE International Conference on E-science*, IEEE Press, Los Alamitos, CA, pp. 182-9.

Department for Innovation, Universities and Skills (DIUS) (2008), "Annual innovation report 2008", DIUS, London, available at: www.dius.gov.uk/ (accessed 10 March 2010).

Department of Trade and Industry (2005), *UK Innovation Survey*, Department of Trade and Industry, London.

Frandsen, T.F. (2009), "Scholarly communication changing: the implications of open access", Royal School of Library and Information Science, Copenhagen, available at: www.nordbib.net (accessed 15 April 2010).

Fukuhara, Y. (2005), "Lecture exchanging among universities and course sharing on the internet (Opencourseware: OCW)", *Proceedings of the Annual Conference on Informatization of Universities*, pp. 28-36.

Harnad, S. (2005), "The implementation of the Berlin Declaration on Open Access", *D-Lib Magazine*, Vol. 11 No. 3, available at: www.dlib.org/dlib/march05/harnad/03harnad.html (accessed 26 April 2010).

Harnad, S. (2006), "Publish or perish – self-archive to flourish: the green route to open access", *ERCIM News*, No. 64, pp. 18-19, available at: www.ercim.eu/publication/Ercim_News/enw64/harnad.html (accessed 29 April 2010).

IFLA (2003), "IFLA statement on open access to scholarly literature and research documentation", International Federation of Library Associations and Institutions, The Hague, available at: http://archive.ifla.org/V/cdoc/open-access04.html (accessed 28 April 2010).

Innobasque (2007), "Manifiesto por la innovación en Euskadi", Basque Innovation Agency, Zamudio, Bizkaia, available at: www.innobasque.com/home.aspx?tabid=136 (accessed 10 March 2010).

Jeffery, K.G. (2006), "Open access: an introduction", *ERCIM News*, No. 64, pp. 16-17, available at: www.ercim.eu/publication/Ercim_News/enw64/jeffery.html (accessed 29 April 2010).

Kumar, S. (2006), "Enforcing the GNU GPL", *University of Illinois Journal of Law, Technology & Policy*, Vol. 1, available at: www.jltp.uiuc.edu/archives/kumar.pdf (accessed 27 April 2010).

Kumar, V. (2006), "Upfront: OpenCourseWare (OCW)", *Digital Learning*, Vol. 2 No. 3, pp. 36-8.

Lagoze, C., Van de Sompel, H., Nelson, M. and Warner, S. (2002), "The Open Archives Initiative Protocol for Metadata Harvesting, Version 2.0", available at: www.openarchives.org/OAI/openarchivesprotocol.html (accessed 28 April 2010).

Laursen, K. and Salter, A. (2006), "Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms", *Strategic Management Journal*, Vol. 27 No. 2, pp. 131-50.

Leiponen, A. and Helfat, C.E. (2005), *Innovation Objectives, Knowledge Sources and the Benefits of Breadth*, Cornell University, Ithaca, NY.

Lin, Y.H., Ko, T.M., Chuang, T.R. and Lin, K.J. (2006), "Open source licenses and the creative commons framework: license selection and comparison", *Journal of Information Science and Engineering*, Vol. 22 No. 1, pp. 1-17.

Markland, M. and Brophy, P. (2005), "SHERPA project evaluation final report", Centre for Research in Library and Information Management, Manchester Metropolitan University, Manchester, available at: www.sherpa.ac.uk/projects/sherpa.html (accessed 26 April 2010).

Merlo, J.A. (2009), "Las diez claves de la web social", *Anuario Thikepi*, pp. 34-6, available at: www.thinkepi.net/las-diez-claves-de-la-web-social/ (accessed 13 May 2010).

Michalec, G. (2002), "Free software: history, perspectives and implications", senior project for the degree of Bachelor of Philosophy Interdisciplinary Studies, Miami University, Oxford, OH, available at: http://greg.primate.net/sp/ (accessed 26 April 2010).

MIT OpenCourseWare (2005), *2005 Program Evaluation Findings Report*, Massachusetts Institute of Technology, Cambridge, MA.

MIT OpenCourseWare (2010), "Site statistics", Massachusetts Institute of Technology, Cambridge, MA, available at: http://ocw.mit.edu/OcwWeb/web/about/stats/index.htm (accessed 23 April 2010).

Negroponte, N. (1995), *Being Digital*, Vintage Publishing, New York, NY.

Nikam, K. and Babu, R. (2009), "Moving from script to science 2.0 for scholarly communication", *Webology*, Vol. 6 No. 1.

Oppenheim, C., Probets, S. and Gadd, E. (2003), "Project RoMEO final report", available at: www.lboro.ac.uk/departments/ls/disresearch/romeo/ (accessed 26 April 2010).

O'Reilly, T. (2007), "What is Web 2.0: design patterns and business models for the next generation of software", *International Journal of Digital Economics*, Vol. 65, March, pp. 17-37.

Paskin, N. (2010), "Digital Object Identifier (DOI®) system", in Bates, M.J. and Maack, M.N. (Eds), *Encyclopedia of Library and Information Sciences*, 3rd ed., CRC Press, Boca Raton, FL, pp. 1586-92.

Ramachandran, R., Movva, S., Conover, H. and Lynnes, C. (2009), "Talkoot software appliance for collaborative science", *Proceedings of the 2009 IEEE International Geoscience and Remote Sensing Symposium*, IEEE Press, Los Alamitos, CA, pp. 378-81.

Robles, G. and González-Barahona, J.M. (2003), "From toy story to toy history: a deep analysis of Debian GNU/Linux", available at: http://es.tldp.org/Presentaciones/200309hispalinux/20/20-en.pdf (accessed 27 April 2010).

Sanger, L. (2005), "The early history of Nupedia and Wikipedia: a memoir", in DiBona, C., Stone, M. and Cooper, D. (Eds), *Open Sources 2.0*, O'Reilly, Sebastopol, CA, pp. 307-38.

Scimeca, S., Dumitru, P., Durando, M., Gilleran, A., Joyce, A. and Vuorikari, R. (2009), "European Schoolnet: enabling school networking", *European Journal of Education*, Vol. 44 No. 4, pp. 475-92.

Shneiderman, B. (2008), "Science 2.0", *Science*, Vol. 319 No. 5868, pp. 1349-50.

Stallman, R. (1999), "The GNU operating system and the free software movement", in DiBona, C. and Ockman, S. (Eds), *Open Sources: Voices from the Open Source Revolution*, O'Reilly, Sebastopol, CA, pp. 53-70.

Suber, P. (2004), "Guide to the open access movement", Earlham College, Richmond, available at: www.earlham.edu/~peters/fos/guide.htm (accessed 15 April 2010).

Suber, P. (2006), "Open access overview", in Sahu, D.K. (Ed.), *Open Access: Unrestricted Access to Published Research*, pp. 7-12, available at: http://openmed.nic.in/1359/ (accessed 22 April 2010).

Suber, P. (2008), "*Gratis* and *libre* open access", *SPARC Open Access Newsletter*, August, available at: www.arl.org/sparc/publications/articles/gratisandlibre.shtml (accessed 29 April 2010).

Swan, A. (2010), "The open access citation advantage: studies and results to date", Technical Report, School of Electronics and Computer Science, University of Southampton, Southampton, available at: http://eprints.ecs.soton.ac.uk/18516/2/Citation_advantage_paper.pdf (accessed 29 April 2010).

Thelwall, M. and Vaughan, L. (2004), "A fair history of the web? Examining country balance in the internet archive", *Library & Information Science Research*, Vol. 26 No. 2, pp. 162-76.

Tomlin, P. (2009), "A matter of discipline: open access, the humanities, and art history", *Canadian Journal of Higher Education*, Vol. 39 No. 3, pp. 49-69, available at: http://ojs.library.ubc.ca/index.php/cjhe/ (accessed 22 April 2010).

UNESCO (2002), *Forum on the Impact of Open Courseware for Higher Education in Developing Countries. Final Report*, UNESCO, Paris.

Wang, F.-Y., Zeng, D., Carley, K.M. and Mao, W. (2007), "Social computing: from social informatics to social intelligence", *IEEE Intelligent Systems*, Vol. 22 No. 2, pp. 79-83.

Wiley, D. (2006), "Open sources, openness, and higher education", *Innovate*, Vol. 3 No. 1, available at: http://innovateonline.info/pdf/vol3_issue1/Open_Source,_Openness,_and_Higher_Education.pdf (accessed 9 March 2010).

Wiley, D. and Gurrell, S. (2009), "A decade of development … open learning", *The Journal of Open and Distance Learning*, Vol. 24 No. 1, pp. 11-21.

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