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article

"Web Science" Dossier

E-learning from the Perspective of Web Science: Looking to the Future

Julià Minguillón

Abstract

This article shows the evolution that distance education has undergone recently from a new perspective, Web Science, which studies how the Web has evolved not only technologically but also socially and organisationally. A technological solution initially designed to share information, the Web is now present in all everyday activities and in every sphere – personal, academic and professional – and has changed the way we relate with one another, work and, obviously, access shared knowledge and learning. With the appearance of the Web, distance education has ceased to be a second option relegated to students not having the chance of accessing the university education system and is becoming common in the university education system, allowing students to take control of their lifelong learning process, both academic and professional, without the barriers of time or space. A number of factors have brought about this change – technological, methodological and organisational – but also social changes. Web Science studies how all of these changes are interrelated and their influence on such areas as the economy, leisure and education, the field of interest of this article. E-learning as the evolution of distance education is (or should be), therefore, a clear example of a Web Science case study, in which all of these aspects occur.

Keywords

e-learning, distance education, Web Science, virtual learning environments, Internet, Web

Resum

En aquest article es presenta l'evolució que ha sofert recentment l'educació a distància des d'una nova perspectiva, la ciència del web, que estudia com el web ha evolucionat tecnològicament, però també socialment i organitzativament. El web, una solució tecnològica inicialment pensada per a compartir informació, és avui dia present en totes les activitats quotidianes, en qualsevol àmbit –personal, acadèmic o professional–, i ha modificat la forma de relacionar-se, treballar i, evidentment, accedir al coneixement comú i aprendre. Amb l'aparició del web, l'educació a distància ha deixat de ser una segona opció relegada a estudiants sense la possibilitat d'accedir al sistema educatiu universitari i es va convertint en un fet comú en aquest sistema, on l'estudiant pren el control del procés d'aprenentatge al llarg de la vida, acadèmica i professional, sense barreres temporals o espacials. Diferents factors han afavorit aquest canvi: tecnològics, metodològics i organitzatius, però també socials. La ciència del web estudia com tots aquests canvis estan relacionats entre ells i la seva influència en àrees com l'economia, l'oci o l'educació, objecte d'interès d'aquest article. L'e-learning com a evolució de l'educació a distància és (o hauria de ser), doncs, un clar exemple de cas d'estudi de la ciència del web on es donen tots aquests aspectes.

Paraules clau

e-learning, educació a distància, Web Science, entorns virtuals d'aprenentatge, internet, web

Introduction

Distance education has undergone a great change since its beginnings, primarily because all of the elements involved have changed radically: the technology used, the educational and organisational models and, especially, the students themselves, who are more aware of the time and effort that studying (distance or face-to-face) represents and try to maximise their performance. Technology has enabled this change (Bates, 1995), yet as we will see below, there are many other factors that are influencing and determining the form that education at any level, but especially university education, will have in the not too distant future. As Bates (2008) stated, we are on the point of entering the fifth generation of distance education (Taylor,

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1999), where the student will be the key element of every e-learning-based education process.

The concept of e-learning, used to indicate a learning process supported by the intensive use of technology, has changed with time, and nowadays there are in fact different definitions or ideas of what we mean by e-learning, depending on the context (education, business, etc.). The basic idea behind the concept of e-learning is that the teaching and learning process occurs through the action of a certain technology, specifically Information and Communication Technologies (ICT). E-learning is an extension of the previously-used concept of Computer-Based Training, which dates back to the 1980s, coinciding with the appearance of personal computers and the first multimedia systems, called *second-generation systems*. In fact, the word e-learning has been used both to describe self-learning multimedia courses distributed on a CD-ROM and for integrated tools in learning environments with primitive computers (Graziadei, 1993), which has led to its being a confusing concept used for any educational experience no matter how small the presence of ICT. Today, the most widely accepted meaning of e-learning coincides with the fourth generation described by Taylor (1999), where there is an asynchronous process that allows students and teachers to interact in an educational process expressly designed in accordance with these principles.

Despite this, to avoid confusion, today we prefer to speak of Internet-Based Learning or, better still, Web-Based Learning, for example, to explain the fact that distance education is carried out using the Internet, with the appearance of the virtual learning environment concept, a web space where the teaching and learning process is generated and supported (Sangrà, 2002). This entails overcoming the barriers of space and time of brick and mortar education (face-to-face) or of distance education using broadcasting and adopting a completely asynchronous model that allows access to education by many more users, at any level (including secondary education, but primarily university education and lifelong learning).

Under this paradigm, besides the purely virtual educational institutions, still few in number, increasingly more universities and secondary schools are adopting and incorporating virtual learning environments to complement the education of their students, albeit with diverse results (Curran, 2001). Adopting a purely virtual or blended model is not simply incorporating the necessary technology but also implementing methodological and organisational changes (Thomas *et al.*, 1998). Posting documents on a website does not automatically lead to a learning process, but the organisational and methodological challenges associated with technological change must be posed

(Bates, 1995). In fact, some authors are critical of this process of adoption of virtual technology by the traditional universities, highlighting the failures of such initiatives as NYU Online and Cornell University, to name just two (Bang, 2006). Apart from this, there are also initiatives that have been successful and become benchmarks in university virtual teaching, such as the University of Phoenix and the UOC. The popularisation of proprietary and especially open tools for course and educational content management has been a key factor in the adoption of this technology (Boneu, 2007).

As regards non-regulated, or informal, learning, Internet users organise themselves around communities of interest in any subject, no matter how minor it may seem. Technology has simplified the creation of these communities, no matter how small and specialised they are. The fact of having search engines like Google allows any resource to be found; in fact, the problem is not finding resources on a subject but evaluating which resource is the most suitable for a specific use. This is just one more effect of the so-called *long tail*, described by Chris Anderson (2004) to refer to the business models based on Internet use for the dissemination of their products, such as Amazon, for example, which can have catalogues with millions of entries even though the majority of them only potentially interest one single user. In the same way, the Internet has allowed geographically disperse users to group themselves around common interests, no matter how minority they may be. Some of these communities of interest become genuine learning communities, where the users construct knowledge collectively, following informal learning models, sharing experiences and interacting using the tools provided by the community. Technology provides the necessary elements to motivate the students and make the most of their experience (Huitt, 2001). A good example of this fact is the DLESE[1] repository devoted to earth sciences, on the basis of a digital library with resources on the subject, focusing on a clear educational objective (Sumner *et al.*, 2001). It has been the Internet network that has enabled this radical change in access to information and the creation of communities around it, offering users a range of tools and services for communication, both synchronous and asynchronous.

The Internet Network

The Internet, the network of networks, is the medium that we all know as the World Wide Web, becoming popularised since the appearance of the first protocols (HTTP), which allowed the

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1. Visit: <http://dlese.org>.

linking of documents located on other machines that were part of the network. These documents, written in HTML, permit the incorporation of text, images and links to other documents and are increasingly becoming true hypermedia documents, creating an enormous range of information locatable simply by the use of search engines such as Google. This is what is known as Web 1.0, a read-only web offering access to the available information. A recent estimate[2] points to more than 1.4 billion Internet users worldwide accessing over 170 million websites[3], which gives an idea of the huge size of it all. Having the suitable informational competences to find, filter and select the appropriate information is, therefore, a vital necessity for Internet users, and in this sense there are increasingly more tools that provide support to these needs. The Internet is evolving beyond this simple model of inter-linked hypertext documents towards a heterogeneous knowledge database in multiple formats, giving ever more importance to the concept of resource or content. Today, the Internet is a reflection of the real world in all its dimensions and is present in every aspect of the everyday life of its users, be it professionally, academically or personally.

Following its natural evolution, the Web is currently immersed in what is known as Web 2.0, a social movement that gives more power to the end users, as it is these who create, publish and manage their own content (Geser, 2007) through the use of very simple tools, such as blogs, wikis, flickr and YouTube, to name just a few. The Web 1.0 was reserved for experts and worked, more or less, in one direction, with a small number of people generating content for the great majority of users. Web 2.0 is a real social movement supported by the technology, which has democratised user participation on the net, going from being simple consumers of information to its producers, without having to be expert in any technology. The best example of this movement is Wikipedia,[4] a free and multilingual encyclopaedia constructed and maintained collaboratively by thousands of users worldwide and which, since its creation in 2001, has become one of the most visited websites in the world, with more than 10 million articles in 253 languages, and over two million in English.

The field of education does not escape this movement either. On the one hand, students are increasingly using Web 2.0 tools to work collaboratively as a common part of their learning process, which is more participative and student-centred, following the guidelines of the new European Higher Education Area. On the other, educational institutions and their users (teachers and students) are beginning to publish educational contents created by them in open form so that everyone can access them freely and at no cost. This movement, Open Educational Resources,

has become a true show of strength by users, similar to the one represented by the free and open source software movement in its day (Geser, 2007).

In fact, both movements have implications in the educational sector, as for the first time it is possible to have a suitable technological platform to support a virtual learning environment and also the necessary contents that comprise the courses, ie, the educational offer. Despite this, there are other factors that are necessary to provide a more detailed analysis of the evolution of distance education using the Internet, following the analytical model proposed by what is known as Web Science.

The Web as Science

What we understand as the Web has also evolved over time since its invention (as we understand it today) in 1989, with Tim Berners-Lee being regarded as its creator. It began to become popular after 1993 with the appearance of the first search engines, such as Mosaic 1.0, while 1994 saw its mass adoption by users. Today, the Web is an everyday tool in any context (professional, academic and personal) and has become a "transparent" infrastructure in the sense that it is always present without the intervention of users, like electricity. The possibility of connecting using mobile devices through wireless networks has enhanced this sensation of immediacy.

The Web has evolved technologically, but above all it has had an impact on how users relate and how they use the Web for their everyday academic and professional activities. The concept of Web Science, used for the first time by Tim Berners-Lee *et al*. (2006), seeks to embrace all the technological, organisational and social aspects relating to the Web, from a multidisciplinary perspective, with the aim of understanding what the Web is and how it is used by its users, so to speak, and how this use establishes an interdependence between what the users do and the evolution of the Web. Web Science includes aspects ranging from the micro, such as the protocols and technology used to provide support to the Web, to the macro, such as the social phenomenon represented by blogging, for example, and its social implications. This multi-level approach allows any question relating to the Web to be focused using different methodologies, each one geared towards resolving a specific aspect of the phenomenon under study, as the Web is impossible to explain from an exclusively technological or social point of view. The Web is like a human being with its biology and ecology which

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2. Visit: <http://www.internetworldstats.com/stats.htm>.
3. Visit:<http://news.netcraft.com/archives/web_server_survey.html>.
4. Visit: <http://www.wikipedia.org/>.

evolves constantly at a speed that hinders its understanding (Hendler *et al.*, 2008). From the Web emerges an intelligence, part artificial, part social, which is the driving force of these continuous changes (Salem, 2007).

A clear example of this is what is known as the Semantic Web. In 2004, Tim Berners-Lee said at the opening session of the 13th International Conference on the World Wide Web that the Web would be semantic or it would not be, in the sense that without a system that allows machines to extract information from the Web in a similar way to how humans do it, the net would be a huge information (or disinformation) dump from which it would be very difficult to get any use. It is necessary for all the resources (in the broad sense of the word) available on the net to be correctly described using the technology currently available, such as RDF. If the available information is well structured and labelled, it will be possible to retrieve it according to certain specific search criteria, permitting the location of the most suitable resources for a specific task or activity. In this respect, a well organised Web becomes a highly valuable educational space, since it enables two of the basic requirements of any learning process to be met: the existence of educational contents and the interaction with other users with the same interests. However, not only with regard to the users, but also with regard to automatic systems that locate and select resources according to the preferences and particularities of the users, essential tools for providing support to the users of virtual learning environments.

The future of the Web, called 3.0 by some authors (Spivack, 2006), involves achieving a higher degree of technological maturity, which will permit greater interoperability between all of its elements, including users, services and machines. Without intending to enter into philosophical disquisitions, Web 3.0 will incorporate a certain intelligence and semantics that will allow users to take a qualitative leap in its use (Salem, 2007). It is not a case of the Web becoming aware of itself (Tetlow, 2007, pp. 163-167), but of exponentially multiplying the possibilities that it offers users, facilitating their operations and anticipating their needs. In this sense, the concept of distance education using the Internet will also have to evolve, placing the student at the centre of the learning process and providing them with the adequate tools to achieve their short-, medium- and long-term aims. For example, reinforcing the feedback that the distance student receives or increasing the capacity to use educational resources.

E-learning As an Example of Web Science

It is clear, then, that the evolution that distance education has undergone since the appearance of the Internet has been radical, even though there is still a long way to go. Different movements and events have converged to change completely the traditional meaning of what was considered distance education, relegated to a second option for those who could not access the established education circuits. Often distance education has been seen only as a possibility for adults, without the time to attend master classes in the classic brick and mortar university model, which has led to a dangerous association between the distance education concept and the low quality of teaching, measured through the performance of the students, an association very often backed by the absolute lack of an educational and support model for the distance student, who is evidently highly prone to dropping out in a situation of complete isolation. The combination of limited technology with educational models based on the simple transmission of contents has been the reality to date of distance education that has only been of use to the most motivated students (Huitt, 2001).

However, fortunately, this perception is changing thanks to the intervention of highly diverse factors, including technological (bandwidth, mobile devices, wireless communications networks, free software, calculation capacity, etc.), educational (user-centred learning models), methodological (the new European Higher Education Area) and legal (open source). Yet above all, the perception held by students of the classic university model is also changing, which is striving not to appear outdated in the face of all of these new technologies. The fact that all the brick and mortar universities currently offer part of their training in blended or purely virtual modes is also evidence that the classic model is considered to be obsolete. Consequently, e-learning has radically changed the concept of distance education as its key elements have evolved:

1. Today there is a cheap and very powerful technology that enables instant and continuous connection to the Internet using mobile devices. There is also technology to be able to create very complex immersive educational simulations and scenarios that allow the learning process to be improved in complex areas such as medicine and engineering. This is what is called Technology-Enhanced Learning.

2. The Internet today is a virtual space where not only can we search for and obtain information of all kinds, but also create, modify and share it. Web 2.0 has given end users the power held until now by the contents creators, who held a monopoly on what could be found on the net. The do-it- yourself philosophy is increasingly becoming do-it- ourselves. This has a great impact on the student's learning process, getting them involved more.

3. The guidelines set by the new European Higher Education Area promote a competence-based student-centred

learning that is more homogeneous among universities, which allows the students to study and work in any country (in terms of the European sphere). This can lead to greater competition between universities as, through quality distance education, the students will not be tied to an option that limits them due to geographical reasons, for example. The distance universities now not only aim at a small number of adult students, but at their whole lifecycle, from when they enter the university to continuous professional development.

4. The business world and employment market increasingly demand well-trained professionals who can adopt all technological and methodological changes quickly. Distance education is a key tool in ensuring a lifecycle of the student consistent with their professional development. In fact, businesses have been promoters of e-learning, now is the time to share experiences and needs with the university.

5. Students are aware of the changes fostered by the above factors and they demand greater participation in the learning process, taking decisions in this respect, at all times within the established framework of course, in line with their personal objectives and with a clearly professional interest. The net is a space where the different identities of each individual (academic, professional and personal) can converge, a clear example of this being communities such as MySpace and Facebook. In fact, we now speak of a generation of digital natives who do not need to learn to use a technology but where the use of technology is a competence they have already acquired. This group is not afraid of technology but demands it, rejecting experiences based on obsolete models.

6. Finally, there begins to be a significant critical mass of open educational contents that are available for use on open e-learning platforms under licences that allow the users to create and share the contents created by them freely (Megías, 2007). Although this point is still at a very early phase (more with regard to open contents than the platforms, which are more advanced), it is a subject that has received a great deal of attention in recent years (Minguillón, 2007). This possibility enables educational institutions to offer training via e-learning and disseminate their knowledge.

All of these aspects mean that distance education over the Internet is making a qualitative and quantitative leap. The following table shows the equivalences between the different concepts that have evolved (and continue to evolve) with and via the Web, all of which are related to distance education and resource management over the Internet.

Table 1. Equivalences of concepts related to distance education and resource management over the Internet

past/present	present/future
One-way dissemination (broadcasting)	Two/multi-way dissemination
Push model (the user receives)	Pull model (the user chooses)
Producer-consumer model	Create-mix-share model
HTML pages	CMS, content managers
Contents	Activities
Knowledge acquisition	Competence development
Portfolio	e-portfolio
Classroom, blackboard	Virtual classroom
Photocopies, notes	PDF, e-books
Exercises, examples	Educational resource repositories
Final exams	Continuous assessment
Modem	ADSL, Wi-Fi
e-mail	Instant messaging
FTP	P2P
Forums, noticeboards	Blogs, wikis
Copyright	Copyleft, Creative Commons
Institutional contents	Collective contents
Institutional web portals	Individual web spaces
Communities of interest	Learning communities
Virtual learning environments	Personal learning environments

The Future of E-learning

As Taylor (1999) describes, the fifth generation of e-learning systems will have to make the most of the possibilities that the Internet offers (or will offer), placing the emphasis on the student, centre of the learning process. Such a visionary as Stephen Downes (2005) already points to the use of tools that favour social learning, creating and sharing knowledge collaboratively in an increasingly informal scenario, yet one that is increasingly controlled and supported by the technology.

In an ideal future scenario, the student uses one or more devices to access the Internet, where all their academic, professional, etc. records are stored, as are all their preferences and particularities. The student, who wants to attain educational objectives, needs to acquire and develop a series of competences through an itinerary designed especially for them. The virtual learning environment guides the student on this itinerary, providing them with all the resources that they need at all

times, either automatically or on demand. The system records all the student's actions in order to obtain valuable information for the institution, improving the design of itineraries, usability aspects of the user interface, detecting problematic educational resources, measuring the student's degree of interaction with the system and the other students and lecturers, etc. This record also serves to assess the student, as the learning process is considered to be as or more important than the results obtained, storing information in their profile on the activities carried out (information searches, interaction, etc.) and the results obtained, with the aim of improving the degree of personalisation of their learning process. When students have a problem or query, the system helps them to resolve it or puts them in touch with other people who can help them, providing continuous feedback that prevents the feeling of isolation felt by online students.

We are still a long way from the above. However, the world's top distance universities today are leading the way in research in fields related to e-learning, such as the Open University (United Kingdom), the Open Universiteit (The Netherlands), and the UOC with its Virtual Campus. Such subjects as personalisation of the learning process, semantic repositories of learning objects and intelligent tutors offer solutions to each of the problems to be resolved in this ideal scenario. In turn, all of this technology generates new needs, such as open source for educational contents, authorship tools, business models, quality measures, privacy and security aspects, etc., which clearly shows that e-learning needs a formal multidisciplinary and multi-level approach like the one proposed by Web Science.

Conclusions

Virtual learning environments are a reality used by educational and business institutions of all kinds, from small schools to large universities, or training departments in companies. These virtual environments partially reproduce the elements present in the teaching and learning process through a series of processes, services and resources. The evolution of content management systems and the learning process towards genuine virtual learning environments is coming about, in part, due to the pressure that initiatives such as the new European Higher Education Area are exercising on educational institutions, but also so as to meet the new educational needs of their users, who demand more active, collaborative and personalised learning, where the student has control over most of the learning process. This is what some authors have called *fifth-generation e-learning.*

In the not too distant future, users will access their work space using mobile devices, where all their identities (academic, professional and personal) will converge, with the borders between them becoming ever more blurred, especially for users

immersed in lifelong learning strongly related to their professional development but also to their private interests. As the technology evolves and the mobile devices become increasingly more powerful and allow for huge quantities of information to be accessed and stored instantly, the concept of virtual learning environment will cease to be a model based on a centralised system that provides all the necessary processes, services and resources and become a virtual space that every student will carry with them at all times. The centralised model will continue to exist but only for enormous resources such as institutional repositories, digital libraries and super-computing centres, which the student will access from their device.

Today we are at the point where the necessary conditions have arisen to take a step forward in the concept of e-learning, as described by Web Science. A combination of key factors at micro and macro levels have come together to make what was known as distance education evolve. E-learning has replaced this concept through a technology, the Web, and has also changed the perception that users have of it, obliging every educational institution to adopt it in order not to be left behind in the race towards quality lifelong education.

Unfortunately, this scenario faces various problems. One possible one is the digital divide posed by this new scenario, based on a tool such as the Internet, which has different points of access at very diverse speeds and costs. This barrier also exists in the form of the knowledge needed, as not everyone has received the adequate training in working with ICT. There is also still some reticence in terms of the quality of a form of teaching that continues to be associated with a secondary option. Despite this, e-learning is unstoppable because the Web is unstoppable, with a technology that is evolving rapidly and users who adopt and adapt it to their needs in a continuous circle of improvement.

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E-learning from the Perspective of Web Science: Looking to the Future

Julià Minguillón
Assistant Director of the IN3 (UOC)
jminguillona@uoc.edu

Julià Minguillón gained his PhD from the Autonomous University of Barcelona in September 2002, where he is associate lecturer in the Information and Communications Engineering Department. In 2001, he joined the UOC as a lecturer in the IT, Multimedia and Telecommunications Department, where he carries out teaching work in the areas of programming, languages and compilers, graphic computing, statistics and data-mining. He has taken part in the creation of teaching resources on object-oriented programming, information structure, abstract data types and compilers. He leads the UOC NET2LEARN research group, where his interests include the description and standardisation of educational contents and the learning process using ontologies, semantic repositories of learning objects for personalisation using training itineraries, and modelling the behaviour of users in a virtual learning environments using Web-mining techniques. He has taken part in a number of national and international projects related to e-learning, among which he has co-managed the OLCOS project on open educational contents. He currently manages the PERSONAL(ONTO) project on personalisation and the E-MATHPP project on learning object repositories. He organised the second SPDECE 2005 symposium on reusable learning objects and has played an active role in the UOC UNESCO Chair in E-Learning since 2006.

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