This document is a preliminary version of the publication:

E. Kaldoudi, S. Konstantinidis, P. Bamidis, "Web Advances in Education: Interactive, Collaborative Learning via Web 2.0", Chapter 2 in: A. Tzanavari, N. Tsapatsoulis (eds.), "Affective, Interactive and Cognitive Methods for E-Learning Design: Creating an Optimal Education Experience", pp. 32-50, Information Science Reference, IGI Global, Hershey, PA, USA, January 2010 (ISBN: 978-1-60566-940-3)

A reprint of the original publication can be obtained upon request (kaldoudi@med.duth.gr) or retrieved/purchased from the book homepage http://www.igi-global.com/book/affective-interactive-cognitive-methods-learning/37250

Web advances in Education: Interactive, Collaborative Learning via Web 2.0

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Chapter 2 in: A. Tzanavari, N. Tsapatsoulis (eds.), "Affective, Interactive and Cognitive Methods for E-Learning Design: Creating an Optimal Education Experience", pp. 32-50, Information Science Reference, IGI Global, Hershey, PA, USA, January 2010 (ISBN: 978-1-60566-940-3)

Keywords:

Collaborative learning, active learning, web 2.0, web 3.0, semantic web, medical education, continuing medical education, public awareness, wiki, blog, discussion forum, web technology, content sharing, learning management system, e-learning, blended learning.

Abstract

The evolving shift from ‘teaching’ to ‘learning’ in contemporary education is strongly related to an increasing involvement of information and communication technologies and the Web. Although the latter was initially of a static nature and merely required passive human viewers, this is currently changing towards a second generation of dynamic services and communication tools that emphasize on peer-to-peer collaboration, contributing, and sharing, both among humans and programs. In this chapter, this revolution, usually known under the collective term Web 2.0, is reviewed from an educational as well as a technological point of view. The issues and controversies arising are backed up by case studies from diverse educational contexts to illustrate the potential of the proposed solutions. The discussion is finally concluded with some exciting speculations on the envisaged arrival of Web 3.0 and collaborative content sharing with semantic technologies.

Introduction

Traditional education requires students at any level to sit through hours of lectures, and read through entire volumes of textbooks. However, advances in the understanding of learning processes suggest that such techniques may be suboptimal, and that learning should evolve from ‘learning by acquisition’ to ‘learning by participation’. Thus alternative learning approaches build on concepts of active learning, defined as the process of having students engage in some activity that makes them reflect upon ideas and how they are using these ideas. Such new educational approaches require students to regularly assess their skills and knowledge at handling real world problems. Some student centered, active learning approaches include problem-based or case-based learning, inquiry and discovery based learning, role and game playing based learning, as well as collaborative and interactive learning of all kinds. Such approaches rely on situational learning and are active, self-directed, student-centered, and experiential. Their aim is also to develop problem-processing skills, self-directed learning skills and group competence. Learning is thus regarded to address two types of knowledge: explicit knowledge (conveyed by books, lectures and scientific documents) and tacit knowledge (directly related to experience and practice, as shared by interaction and collaboration).

This evolving shift from ‘teaching’ to ‘learning’ in contemporary education is also strongly related to an increasing involvement of information and communication technology. There is currently an international trend to involve computers and the Internet in formal education as well as in continuing life-long learning. This practice is reinforced by active support and funding from bodies such as the European Union and local governments. Specifically, the European Council in its Lisbon meeting in March 2000 set forth the European policy for an information and knowledge-based society, stressing the need to encompass the emerging technological revolution and change in the exchange of knowledge affecting all institutions and various aspects of the society (European Council, 2000).

Like many other cognitive domains, education can be considered in terms of levels of increasing complexity and importance: information (i.e. processed data and simple facts), knowledge (i.e. information with a purpose), and understanding (i.e. conscious knowledge, achievement of

explanation and grasp of reasonableness), which leads eventually to ability, competence and professionalism (Ehlers, 2007). Technology has been employed in diverse ways to support different levels of the educational process, and especially conventional instructional teaching. Structuring and organizing information with a particular educational purpose refers to knowledge. On the other hand, understanding implies experience as well as inquiring. Managing and supporting these levels of the educational process is a rather complex issue. Although technology and the Web in particular have been extensively used to support conventional education, new active learning approaches that emphasize on active learning, participation, and competence have been less supported. However, the emerging Web 2.0 paradigm gives the perfect opportunity, because of its mere nature.

Although Web 2.0 emphasizes on participation, in its early days in supporting learning it is still used in the majority of cases to hold and provide content (albeit created dynamically and via peer participation and collaboration) and then systematically deliver it to students. However, there are emergent applications of web 2.0 tools to implement and support active, collaborative educational episodes on the internet, creating virtual places for learners and experts to collaborate and explore and thus create new knowledge and expertise.

This chapter elaborates on the potential of Web 2.0 for active and, potentially, effective learning and reviews current practices and emerging advances in the field. The chapter also presents case studies of how web 2.0 technologies can be used in different educational settings to support conventional instruction and active learning in undergraduate, post-graduate and continuing medical education, as well as, a case study of using web 2.0 technologies to disseminate physics and astronomy to the public. Additionally, discussion addresses open research questions regarding the evaluation of the learner in terms of practical skills gained, e.g. critical searching, critical appraisal of literature, collaboration, etc. Finally, the potential benefit and envisaged merit upon merging with Web 3.0 technologies is also discussed.

Background

Before going any further with discussing the issues of concern and proposing the necessary solutions it is wise to summarise important relevant background.

Education and learning

Training and education draws even more attention with the growing importance of a ‘knowledge society’, that is a society based on knowledge as a value, not only cultural but also economic. Nowadays, the competitive advantage of a nation is shown by the expertise and the behavior of its human resources. Current innovations in information systems and communication services mark the switch from the “information society”, characterized by a mass information seeking and based on the distribution of pre-defined and standardized data, towards a “knowledge society”, which emphasizes the cognitive advancement and, consecutively, the active involvement of each individual. The growing use of Internet not only modifies quickly and habitually the way people work but it also leads the race in this educational revolution.

New educational approaches build on concepts of adult education. They rely on situational learning and are active, self-directed, student-centered, and experiential (National Research

Council, 1999). Learning is perceived as a qualitative change of one's conception of phenomena and ideas (Marton et al, 1977) and, consequently, knowledge must be actively processed by the student. A fundamental idea is that learning is organized in small student groups, i.e. tutorial groups, and not around lecture meetings. In the tutorial group students actively work with reality-based situations to formulate problems and learning needs that will guide their further studies. The teacher's role is that of facilitating learning rather than transferring knowledge. In the tutorial group, the students discuss and defend their choices and standpoints. Using library resources, text books, databases, laboratory work, field studies, lectures and other forms of faculty resources, they are urged to find answers to and perspectives on their problems and learning needs. The aim is also to develop problem-processing skills, self-directed learning skills and group competences (Ehlers, 2007; Fyrenious, 2005). In response, professional organizations worldwide have called for increased emphasis on training in life-long self-directed learning. The emerging view is of learning as an active, constructive, social, and self-reflective process (Berliner & Calfee, 1996). These basic research findings on learning suggest the need for educational environments that are learner-centered and knowledge-rich, guided by assessment, and situated in a community of learners (Schuable & Glaser, 1996). In higher education, educational programs increasingly include case-based or problem-based learning and other small group instructional models, collaborative organizations to support student-faculty interactions, and technology-enhanced educational tools (Jones et al, 2001).

When new technologies were deployed in education about two decades ago (although experimental attempts date back to 1970s), there was a considerable hype about the emerging electronic teacher, which fortunately soon enough subsided to reveal serious limitations of the computer-to-student educational model (Dertouzos, 1997). In retrospect, it is possible to identify three generations of information technology supported learning, which usually come under the collective term of "e-learning" (literally translated as "electronic learning"). The first generation is based on multimedia technology support, such as videos, CD-ROMs or other stand-alone educational software. The second generation employs telematic technologies and it is basically set up as teaching via the Web, where conventional educational material, as well as entire educational courses, is delivered via the Internet to remote students. The last, emerging generation, is about web based learning, where the Internet is used as a means to create active, context based, personalized learning experiences. This last generation of e-learning shifts the emphasis from 'teaching' to 'learning' and from the notion of technology as a didactic mediator to the notion of sociable, peer-supported, involved learner.

Web and Web 2.0

The Internet and the Web were initially of a static nature with passive viewers. Moreover, they were mainly targeted to human users, with the central role of information distribution; programs had little to do in this environment. Currently the Web is changing towards a second generation of dynamic services and communication tools that emphasize on peer-to-peer collaboration, contributing, sharing, both among humans and programs. This revolution is usually known under the collective term Web 2.0. In Web 2.0 the user is seen as a contributor, rather than a recipient. Content is created by participation and collaboration as an emergent product of human interactions. In the core of Web 2.0 lies an ensemble of standards, protocols, technologies and software development architectures and approaches that enable the seamless communication of third party programs thus creating the communities and networks of services that bring people together. One can argue that a major characteristic of Web 2.0 is the fact that it continually

improves and grows in size, function, complexity and approach, thus making the term even more uncertain and difficult to define. An incomplete attempt to summarize what Web 2.0 refers to is given in Figure 1.

Initially, the term was coined by O'Reilly (2005) as an attempt to emphasize the fact that despite the late 90's shortcomings of the '.com' model, the Web still appeared strong and promising new features such as 'social software technologies' were emerging. Web 2.0 is not a program or an upgrade or a single concrete piece of technology; it is rather a more fully implemented Web. It is based on the same infrastructure and standard protocols, and on well-proven technologies and tools of the Internet and the Web. However, the term Web 2.0 encompasses a whole new meaning and a collective emergent behavior of the use of these technologies, tools and applications that create networks and communities of users (both humans and programs) that enhance and promote:

- Participation: People of any background, culture, age, etc. can participate without the need to understand the underlying technologies. Participation is perceived equally as accepting and as providing information (including new items as well as commenting and feedback). Core examples: wikis, blogs and personal profiles.
- Collaboration and sharing: Together with collaboration comes sharing of information and personal attitudes. For example, social bookmarking, where not only links and services are shared, but their collaborative tagging and rating gives a new dimension to information organization.
- Openness: Information is freely shared among humans and programs, thus promoting the notion that knowledge cannot be owned.
- Reuse: Content and information is discovered, used and re-used via notions such as content syndication and supporting technologies that allow programs and humans to build their own content aggregates and distribute them.
- Personalization: Content and service openness and reuse make it easier to customize information, function and their intertwining to create personalized experiences, such as personalized curricula, etc. Dynamically interlacing all this individual contribution, a 'wisdom of crowds' emerges. A striking example is the controversial new form of metadata for the organization of information, coming under the term 'folksonommies', as opposed to 'taxonomies'.
- Agility: Function and content from many sources (personalized and third party alike) are combined to create new added value for individuals. This can always be readily shared with others. Mashup applications are a major example.
- Apomediation: A term coined by Eysenbach (2007) to characterize the third way for users to identify trustworthy and useful information. The first approach is to use some sort of mediation, e.g. a librarian or a teacher, in the case of education. The second approach is to bypass such mediation (commonly referred to as disintermediation), and this has been the basic role of conventional Web, with students seeking autonomously additional information on a variety of web-based information sources. In this third approach, enhanced and realized by Web 2.0, the user seeks information with peer guidance, as a result of networked collaborative filtering processes.

All this emergent behaviour that characterizes Web 2.0 is enabled one way or the other by a variety of applications and tools that form the core of Web 2.0, and are empowered by an ensemble of technology, embracing both familiar technology from the early days of the Web as well as innovations. Among common Web 2.0 tools that are being explored for their possible use in education are wikis, blogs, podcasts, social networking tools and virtual worlds (Alexander, 2006).

FIGURE 1
(removed due to copyright issues)

Figure 1. A pictorial summary of what Web 2.0 refers to.

Wikis are dynamic, group-developed websites that can be edited, updated or changed by anyone who has access to them (usually any visitor). The current status for wiki technology includes pages with fruitful discussions on each entry and there is always the ability to view the evolving history of any entry and recover previous versions. The most well-known wiki is Wikipedia (www.wikipedia.org), the online editable encyclopedia.

Blogs is a short form of the term Weblogs, because it started as online diaries (logs) written by individuals on the Web. They are basically dated entries in reverse chronological order, and this is where the similarities with a conventional diary end. Blog entries can contain a variety of multimedia material and links to other web resources; can be commented by other users, while information can be organized by user defined and generic tags. An newer form of blog, known as microblogging, restricts the size of each posting, allowing it however to be submitted by a variety of means, e.g. conventional blog entry, instant messaging, email, etc., thus allowing for easy and often updates.

Mashups are web applications that merge data from one or more sources and present it in new ways. In many cases this is made possible by data providers that develop application programming interfaces (APIs) for their data. These APIs follow standard web service protocols and/or generic internet formats to represent data (such as RSS) and can easily be implemented in different programming languages. At the same direction, notification services offer continuous updates of web sites in a standardized form for use in mashups and in a variety of other applications. Usually under the term "RSS feed", which is borrowed from the commonly used data representation standard RSS (meaning Really Simple Syndication or, as renamed, Rich Site Summary), they include summarized text and respective metadata and they can be read either by standalone special purpose software or by software embedded in commonly used Internet tools (e.g. web browsers, mail clients, etc). RSS feeds and similar syndication technology is also used to distribute streams of audio and video data files to personal computers and portable media players – what is known under the term podcasting.

Social networking websites focus on creating online communities of individuals who publish their content and activities while exploring others content and activities. Such sites cover a variety of topics and provide most of web 2.0 tools and technologies for users to interact. Therefore an astonishing number of simple or more sophisticated social networking sites are

currently emerging ranging from mere casual social networking to collaborative web bookmarking and searching, school teacher rating, collaborative document and spreadsheet editing, etc.

Virtual worlds are simulated environments were individual users participate via fictional avatars. Their implementation on the Internet provides a unique way to realize fictional communities for individuals to freely meet others, communicate, participate in a variety of activities and eventually learn.

Most often Web 2.0 sites combine more than one of the above applications, and have in common a variety of tools and features that enhance participation and collaboration such as search engines, links to other resources, ability for the user to add content and/or comments, tools for organizing content (e.g. tags, extensions by similarity, rating, etc), and signals for updates (McAfee, 2006).

Web 2.0 tools and applications make use of a range of technologies, mainly based on common Iinternet and Web technologies, that is the HTTP protocol and the suite of web development technologies, such as all variations of HTML and XHTML and CSS, XML and XSLT, Javascript, etc. Currently the core of this basic suite of technologies comes under the collective term AJAX (Asynchronous Java Script and XML), an interrelated group of web technologies used to develop interactive web pages that process user requests immediately. AJAX brings together data, content and presentation: presentation by XHTML and CSS, interaction with the page by DOM (an interface to allow Java scripts and programs to update content style and structure of documents dynamically), data interchange based on XML and XSLT, and JavaScript, a language that integrates all the above to create dynamic web pages. Applications created with AJAX use an engine that acts as an intermediary between a user's browser and the server from which it is requesting information. Instead of loading a traditional Web page, the user's browser loads the AJAX engine, which displays the page the user sees. The engine continues to run in the background, using JavaScript to communicate with the Web browser. User input or clicking on the page sends a JavaScript call to the Ajax engine, which can respond instantly in many cases. If the engine needs additional data, it requests it from the server, usually using XML, while it is simultaneously updating the page.

However, it can be argued that the real predecessor of Web 2.0 notions and technology is the programming paradigm of web services and service oriented architectures. Web services are a middleware technology for developing service-oriented architectures (SOAs). A SOA refers to a collection of interconnected software entities (services) that provide some capability through exchange of messages, and can be described, discovered and invoked over a network. Web services are loosely defined as self-contained, self-describing, modular applications that can be located and invoked over the Internet. Web services are based on open Internet standards: built on the HyperText Transfer Protocol (HTTP), they use XML for data presentation while messaging is described in an XML-based messaging protocol, SOAP (Simple Object Access Protocol). Web services describe themselves through a standardized Web Service Description Language (WSDL) document, and can be published to one or more Intranet or Internet repositories for potential users to locate through a standard Universal Description, Discovery and Integration (UDDI) registry. A whole suite of additional standards have been developed to formally address issues such as security, reliability, transactions, etc. REST is a technologically simpler approach to web services that bypasses the SOAP communication protocol and concentrates on getting information content of a web page via the HTTP protocol from its published XML file that contains desired information.

This core technology that supports Web 2.0 is continuously evolving and growing, as new specialized formats, standards, and protocols emerge. Examples include the RSS data/metadata XML format, the FOAF (Friend of a Friend) and XFN (XHTML Friends Network) protocols involved in social networking applications.

Issues, Controversies, Problems

Initial involvement of the web to support education was based on the metaphor of a virtual classroom, where by the web application follows the model of a real classroom transferring there the conventional lecture, discussion, workshop and other educational activities (Cronje, 2006). About a decade ago, a systematic and critical meta-analysis of more than 330 studies by Russell concluded that there is no significant difference between various learning/teaching methods, the focus being the comparison between technology-enhanced versus conventional education (Russell, 2001). Today, it is widely accepted that this is an inappropriate comparison, as the use of technology not only changes the way education is deployed, but has a profound effect in the pedagogy, as it carries a meaning by itself. So, nowadays the discussion is about how technology, and the Web in particular, can stimulate a new learning culture. In these terms, to make a difference implies harvesting the potential of learning via the web to equip the learner with competences rather than mere subject knowledge (Ehlers, 2007).

Active education towards understanding and competence poses certain requirements that include:

- communication among peers,
- collaboration among peers,
- ample access to alternative sources of information,
- some sort of reporting and rating of information, to account for information overload and limited quality control,
- potential for different representations of the same content (for people with special needs, with different cultural backgrounds, different ages, different background),
- support for content evolution, as knowledge data banks are growing quickly,
- contextual learning, i.e. content and process initially designed to have a specific meaning and purpose for an intended audience,
- mutated learning, i.e. content and process re-purposed and re-engineered from original design for a different purpose and/or audience, while attaining an acceptable level of validity, and
- context based organization of resources and activities.

From the list above, it is evident that Web 2.0 behaviors and application seem best suited to support such educational action. However, although Web 2.0 emphasizes on participation, collaboration and meets at least partially all the above requirements, in its early days it is still used in the majority of cases to hold and provide content (albeit created dynamically and via peer participation and collaboration) and then systematically deliver it to students.

Educators are using blogs in various educational settings and in many different ways, but mainly as a replacement of other forms of asynchronous computer mediated communication, merely because of their additional functionality, such as updates via feeds, notion of ownership, decentralization, tagging, and archiving (Kim, 2008). Blogs in education are mainly used to publish articles and other educational material, as well as to keep track of class activities, often spanning across semesters and years of studies. An alternative approach involves using blogs to create dynamic learning maps and help students find easily and quickly qualified course material (Wang et al, 2008). However, this blog use is still based on the traditional learning environment with the teacher being the primary contributor of resources.

Some preliminary blog uses within the Web 2.0 paradigm, involve personal input from students and teachers in an attempt to create a learning community. An example involves use of blogs to record personal experiences of students and teachers as a reflection of one's own ideas, for feedback from peers or just as a means of communication (Hammond, 2006). Another example involves structured personal student blogs that post course assignments for evaluation and assessment together with participation on a course blog for informal communication and for collaborative story development in creative writing (Armstrong & Retterer, 2008).

Wikis are increasingly used in education, as an ideal tool for collaborative work done by both students and teachers. At first, educational wiki implementations involved the mere development of material in a collaborative manner. Additionally, wikis have been used to allow collaborative data collection for certain educational set ups. Both uses do not really exploit the Web 2.0 paradigm for peer collaboration, engagement and participation. Currently new applications are emerging where wikis are used as a classroom metaphor for student to collaborate on a group report, compile data or share the results of their research, while faculty might use the wiki to collaboratively author the structure and curriculum of a course.

Tonkin argues that different educational uses of wikis can include single-user wiki used more like a blog without the date format to hold and edit over time personal thoughts and output of the educational endeavor, while collaborative wikis can be used along the metaphor of a lab book, collaborative writing assignment, or with the aim to produce a knowledge base (Tonkin, 2005), and a comprehensive review of published work supporting this is given by Parker & Chao (2007). Yet, wikis can find their place in education when used not for substituting the handing in of paper reports or the in-class conventional collaboration, but rather when their potential for distributed peer educational engagement is fully exploited. An interesting example involves using wikis for initial ice-breaking collaboration among students during the initialization phase of a course (Augar et al, 2004). More fully implemented applications employ wikis to support collaborative learning, for example in the case of social learning within communities of practice (Wenger, 2000), that is, networks of individuals and institutions that share common practices, goals and problems about a certain topic. In this case, wikis can act as an evolving knowledge platform where members can share pieces of information, discuss and collaborate (Schaffert et al, 2006). Some more interesting examples are presented in the next chapter.

Podcasting can be used for archiving and distributing lectures in video or audio format. Video and slide sharing websites can be used to publish lectures and conference presentations more widely and as part of a curriculum to enhance mobility in learning (Evans, 2008). It can especially enhance the learning experience in demanding hands-on educational environments such as in medicine as suggested by Boulos, Maramba, and Wheeler (2006). Although such podcasting uses are closer to traditional passive learning and web paradigms, they can free class

time to be used for problem-solving, project sessions and other active learning activities (Kurtz et al, 2007). An example of using podcasting to support collaborative and active learning can be found in the initiative of the Duke University, where podcasts are created both by teachers and students, covering not only formal educational material, but discussions as well as feedback comments on assignments, etc. (Belanger, 2005).

Teachers and learners are also turning to video-sharing sites (such as www.teachertube.com) to share educational videos. Social networking sites are also used in various educational settings. Collaborative writing is supported by a number of respective websites that offer tools for collaborative text editing (such as www.thinkfree.com and docs.google.com). A striking example that fully realizes the Web 2.0 paradigm is del.icio.us (http://delicious.com/), a collaborative bookmarking web site, that allows users to share their bookmarks, creating their own tags and organizing dynamically bookmarks (on any possible topic and within any context, including educational subjects and contexts), thus creating a vibrant bookmark folksonomy that evolves over time.

Finally, virtual worlds on the web are increasingly used to create fluid learning communities that can be engaged in real world didactic situations, collaborate to approach solutions to problems, seek knowledge, and communicate and interact with peers; a comprehensive review is given in (De Lucia et al, 2009). Although there is a large number of virtual worlds dedicated to learning, when generic virtual world web environments are used, such as Second Life (http://secondlife.com/) and There (http://www.there.com/), there is the additional advantage of the vast size of the community that participates and can potentially engage in learning activities (Kelton, 2008).

As a final comment, it should be stressed that nowadays most of the above applications and tools are combined and intertwined within the same web site or service to give hybrid added value applications, enhancing the Web 2.0 paradigm and the corresponding emergent behaviors mentioned above.

Solutions and Recommendations

Web 2.0 tools have crossed Moore's chasm, easily reached early majority and are currently under rapid development and evolution (Ebner et al, 2007). However, the idea of social learning software itself, especially in educational scenarios, is not as far developed as one may imagine, since too few innovators and early adopters are actually using Web 2.0 technology to enhance existing curricula designs and learning behaviors.

What is also true is that Web 2.0 technologies have led to a flood of new healthcare applications and services, with the potential to revolutionise the entire spectrum of health and medicine (Boulos, 2007). With areas such as consumer-led preventive medicine, public health, home care, telemedicine, clinical care and biomedical research strongly affected and enriched by the use of Web 2.0, it is mandatory that health and medical education should also follow and exploit this media, content and collaboration rich revolution (Bamidis & Pappas, 2008). Thus the following of this chapter will concentrate on specific examples of novel solutions and recommendations of employing Web 2.0 for supporting active learning mainly drawing from the demanding field of medical education. All three levels of medical education are affected, namely, undergraduate,

postgraduate and continuing medical education (or profession development). In all three levels the tools to be used may be similar, but the way of using them should be different, so as to conform to the diverse skills and learning outcomes envisaged and mandated by the particular curricula or portfolio designs. For example, in undergraduate medical education emphasis might be placed upon the skill of recognizing information taught in a traditional classroom and attempting its sideways expansion so as to ease comprehension and knowledge acquisition. For postgraduate learners the focus is shifted more towards skills related to analyzing and/or synthesizing different facets of information from contexts of existing formal and/or tacit knowledge. In continuing life long learning or professional development level the need is shifted towards familiarization with new technology and/or new (evidence based) knowledge in a specified area as well as the exchange of peer experiences, activity or practice based training, and point of care or pervasive learning. In public education (or else communicating science to the public) challenges are associated with the wide diversity of the public scientific background and their differences in pursuing knowledge.

Some of the efforts to cover the above needs by exploiting the aforementioned Web 2.0 technologies are presented below. The first three cases may be categorized as "blended learning" examples, since e-learning and Web 2.0 are used in addition to traditional class lectures. In all cases, emphasis is placed on how collaboration is enhanced and learning is enriched with web 2.0 technologies as opposed to conventional Web approaches.

Example 1 – Undergraduate Medical Education

Medical students at the first semester of their studies at Medical School of Aristotle University of Thessaloniki register with the School's e-learning environment which is based on Moodle (www.moodle.org) learning management system and is facilitated by numerous Web 2.0 tools. The purpose here is to accompany traditional large audience lectures in the amphitheatre, where specific topic discussions and instructor-student interactions are minimal if not absent, with a virtual class example facilitated by a discussion forum. The forum module is a virtual place of knowledge. The instructor poses a topic threaded by a topic taught in the lecture, and the asynchronous discussion is kicked off. In the figure below, a screenshot where a "first week of the semester" discussion is evolved around the "pros and cons of the Computer Science intrusion in the health care sector" is illustrated as part of the School's Medical Informatics Module. Initially some students give short, strict answers/inputs, but as the discussion evolves, at some point students start to argue. In their effort to build these arguments and convince the others about their points, the "pros and cons" are gathered. The instructor intervenes, in order to evaluate the arguments, as well as, to bridge disparate opinions or recap when points are headed away the envisaged goals. In a further expansion, the notion of collaborative learning is enhanced by a "voting" scheme, where in the very same paradigm students "rate" the relative merits of certain technological applications in the health care sector in an effort to materialize any "abstract" points of the on-going and afore described discussion.

FIGURE 2
(removed due to copyright issues)

Figure 2. An illustration of the undergraduate discussion forum on a topic touched upon in the class but virtually discussed though student-student or student-instructor interaction in the discussion forum of the e-learning system.

In a similar way, another discussion forum is populated by an exercise set (in this case "numerical systems transitions") initially provided by the instructor. Wrong student answers are corrected by other student inputs, while the instructor role in those forums is merely advisory.

FIGURE 3
(removed due to copyright issues)

Figure 3. An illustration of the undergraduate discussion forum populated by "exercises" solved by the students online and corrected by the evolving inputs.

Example 2 – Postgraduate Medical Education

Another case is from a course on Medical Informatics taught at a postgraduate level. Emphasis is placed not only in creating and promoting information, but also how to best utilise Web 2.0 as an active support mechanism towards a problem (or case) based learning. In our approach, students and instructors use the web as a virtual place to collaborate and create new knowledge and new educational experiences. Three web 2.0 applications are utilized, namely, discussion forums, collaborative wikis, and blogs. Forums were used in addition to the wiki and several (topic/tag marked) personal blogs within a specific problem related to Electronic Health Records (Bamidis et al, 2008). Every student had to complete each task in their own personal blogs and when they felt the answer was complete, they had to publish it to the wiki. All students were able to see each other's blogs and comment in there. In this way, these tools are not utilized to create, store and provide information, but as active tools to support problem based learning (PBL) in medicine.

The approach is summarized as follows. Instructors collaboratively develop a problem in the wiki. Discussion is initiated via the problem's discussion forum, where students and instructors collaborate to analyse the problem, identify conquered knowledge and argue about possible solutions. Then students search and collaborate to solve the case. Student progress and gained experience and competences are recorded, shared and commended on via their personal blogs, while updates of the collaborative class wiki with "each student's final solution" presumably enhance the problem solving capacity and skill acquisition of the students even further.

FIGURE 4
(removed due to copyright issues)

Figure 4. An illustration of the post-graduate PBL setting through use of a wiki. The instructor(s) set the problem and the steps here, while students are expected to update it (once ready) by their replies to the problem question(s). The dynamic nature of the evolving effort is characteristic of the collaborative web 2.0 use of the internet based course, as well as, the active learning approach.

FIGURE 5
(removed due to copyright issues)

Figure 5. An illustration of the post-graduate student blog entries on the problem originally posed in the course's wiki by the instructor. Students work online and record their activities in these blogs. The evolving effort is not only monitored by the instructor, but also adds "collaborative value" to the acquired skill/knowledge of the students, as these are open to all for inspecting and commenting.

Example 3 – Continuing Medical Education & Professional Development

Similar ideas and tools may be also exploited to enhance Continuing Medical Education (CME) and professional development. In this case an e-learning environment may consist of links to evidence by use of mashup technologies and interlinked content web sites/portals. However, this by itself is a mere advanced compilation of conventional Web functionality, while it fails to exploit the full potential of Web 2.0, and in particular dynamic collaborative content development by a number of distributed contributors and/or educators. A wiki or a blog here may function as medical case repositories. The cases may be initialized by one or more experts but may be continued, updated, corrected, enriched and argued by the same or other experts in an effort to collaboratively seek for the best possible prognosis or diagnosis, treatment plan, or follow up guidelines. Such an effort, taken from a smoking cessation network developed at the Medical School of the Aristotle University of Thessaloniki, Greece, is illustrated in the figure below. A blog dedicated to a relevant case repository together with a collaborative wiki for defining relevant medical terms, pharmaceuticals, epidemiology techniques etc, accounts for the aforementioned collaborative content development for this specific online learning community.

FIGURE 6
(removed due to copyright issues)

Figure 6. A simplistic illustration of the smoking cessation wiki set for use within the Continuing Medical Education scheme for pulmonary experts/residents. The wiki is collaboratively developed by several contributors to account for a medical case encyclopaedia for smoking cessation specialists.

Example 4 – Disseminating Science to the Public

Communicating science to the public is a main concern of contemporary societies and presents the core of numerous initiatives. However, public education presents certain significant challenges: (a) highly specialized scientific knowledge is disseminated to an audience of a disperse scientific background, often without extended and/or uniform scientific education and skills; (b) the audience is of a wide age range, preferences and goals regarding their pursuit of professional knowledge; and (c) the audience has a diverse daily time-schedule while scattered over a region considerably larger than a university campus. Most importantly, considering the amateur, sideline nature of this form of education, the whole educational procedure ought to be more of a leisure activity rather than formal learning. Web 2.0 learning paradigm may be the proper way to meet such requirements.

An example is the educational activities at the regional Amateur Astronomy Club of Thrace, Greece, that aim to disseminate the basics of astronomy and related physics to the public and especially the young (Antoniou et al, 2008). Their approach involves the use of wikis and blogs to entirely re-create the process of problem-based learning approach on the internet. Astronomy problems at various levels of difficulty and specialization are deployed on the internet. Problem deployment and presentation is collaboratively performed via the internet by a number of instructors using wiki technology. Participating students and instructors can resolve and discuss the problem via a dedicated blog, while they can record their educational experiences in their personal blogs, thus providing a way for a temporal recording of attitude, experience and skills progress. Problem solution is then performed collaboratively via a wiki. User (student and instructor) satisfaction analysis shows that the endeavour is well accepted.

Future Trends

Effective online learning experiences require a successful alignment of the learning approach with the technology used. Such an inherent alignment exists between the notion of active, collaborative learning and the paradigm of Web 2.0 technologies, as they both rely on and emphasize social skills (such as collaboration, interaction and peer activity) as opposed to mere content. Within this framework, it is expected that future work will put emphasis to individual's competences for knowledge management, rather than knowledge itself. Work in progress elaborates on mechanisms to process and analyze the learning procedure as recorded in personal blogs, wikis and social networks so as to extract meaningful information about capturing expert's practical skills competences and share this with the novice (Kaldoudi et al, 2008). The interesting issue is that via web 2.0 tools, tacit knowledge can be recorded, archived and mined, via personal blog entries. Thus, experts and instructors can record interesting and important steps in exploring and appraising information, acquiring knowledge and addressing educational problems, thus implicitly recording their expertise in scientific problem solving. On the other hand, learners can record their own process of tackling information, searching literature, resolving ambiguities etc. These personal or group entries may help evaluate personal progress and especially reveal skills mastered.

Additionally, the current enormous expansion in knowledge (including expert competences as well) constitutes a fundamental educational challenge. Higher academic institutions are

increasingly required to invest in order to enrich their curricula with courses given by external experts, while experts working within an academic institution often restrict their state-of-the-art knowledge to a very limited audience (Papaioakeim et al, 2006). In order to support the emerging integrative curricula structures and accommodate the over-specialized knowledge available by different experts, Web 2.0 applications can be employed to develop virtual distributed pools of autonomous specialized educational modules and provide the mechanisms for searching, retrieving, evaluating and rating, adapting and revising educational content in medicine and life sciences (Kaldoudi et al, 2008). This is the scope of the European mEducator Best Practice Network (project ECP 2008 EDUCATION 418006, funded under the EU eContePlus2008 program), which aims to enable seamless content sharing in medical formal education (www.meducator.net). Specifically, mEducator addresses a comprehensive collection of different types of health educational material. These include conventional educational content types also used in other areas (e.g. lecture notes, books, exam questions, practicals, graphs, images/videos, algorithms and simulators, etc), educational content types unique in medical education (e.g. teaching files, virtual patients, evidence based medicine forms, clinical guidelines, anatomical atlases, etc,) and alternative educational content types, either reflecting active learning techniques (extensively used in health education) and/or stemming from newly introduced web 2.0 technologies (e.g. problem/case based learning sessions, serious games, web traces, wikis, blogs/discussion forums, etc). Additionally, mEducator focuses on implementing and comparing two alternative solutions for educational content discovery and retrieval on the web. The first solution is based on traditional isolated learning content management systems (LCMS), loosely associated via commonplace web 2.0 technologies, using RSS feeds for notification and updates of newly published content. The second solution is based on a federated architecture which is founded on a reference Semantic Web Service (SWS) architecture for search, interchange and delivery of learning objects.

Such current research focusing on data semantics, ultimately leads to a further interesting advancement that is currently emerging and shows potential to grow into the next Web revolution, what is commonly referred to as Web 3.0. The notion and the prediction of this evolution is attributed to the founders of Web Berners-Lee and colleagues (2001) almost a decade ago. However, the explosion of Web 2.0 has really prepared both technology and users to emerge in the paradigm of semantic networking of information and services, thus the Web 3.0 is currently arising with a promising potential for educational applications (Bratsas et al, 2008). Among other things, Web 3.0 is about making information and services more meaningful to individuals as well as programs. Such an environment is expected to shift focus from 'finding information' to constructing 'meaningful and relevant information maps', leading to personal learning agents that will eventually support individuals in maintaining and administering their personal education and personal learning network (Ohler, 2008). Thus, collaborative, participative learning within Web 2.0 will be transformed to a context based personalized learning shared within a network society. Web 2.0 applications such as wikis, blogs, mashups and RSS feeds will contain context related 'intelligence' and the problem will not be to find relevant information, but to identify information of quality and to learn how to use it best. Last but not least, for the aforementioned developments to be well accommodated within education systems and curricula, the pivoting importance of standardising content sharing should be understood and exploited (Bamidis et al, 2008). In other words, much work will need to be carried along the paths of describing in standard ways the content to be shared and the various learning attributes associated with it (i.e. the context).

To conclude, recent technological advances have shifted the core focus of education towards more active learning approaches. This shift is certainly related with evolutions on the Internet and the Web, and certainly the emergence of Web 2.0, which is being stressed as a promising tool for advanced support of education. However, emphasis with Web 2.0 should be geared along collaboration and participation and not the mere provision of content if it were to play a key role in education. The slow but sure emergence of Web3.0 in combination with Web2.0 creates even greater hopes and anticipations.

References

Alexander, B. (2006). Web 2.0. A new wave of innovation for teaching and learning? *EDUCAUSE Review*, 41(2), 32-44.

Antoniou, P., Delidou, E., Aggeioplasti, K., Kaldoudi, E. (2008) Astronomy Education for the Public via Web 2.0 technologies. In Proceeding of ICERI2008 – International Conference of Education, Research and Innovation, Madrid, Spain.

Armstrong, K., & Retterer, O. (2008). Blogging as L2 writing: A case study. *Association for the Advancement of Computing in Education Journal*, 16(3), 233-251.

Augar, N., Raitman, R. & Zhou, W. (2004). Teaching and learning online with wikis. In R. Atkinson, C. McBeath, D. Jonas-Dwyer & R. Phillips (Eds.), *Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference* (pp. 95-104). Perth.

Bamidis, P.D., Constantinidis, S., Kaldoudi, E., Maglaveras, N., Pappas, C. (2008). The use of Web 2.0 in teaching Medical Informatics to postgraduate medical students: first experiences. Published as Multimedia Appendix in: Eysenbach G. Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. J Med Internet Res;10(3):e22. http://www.jmir.org/2008/3/e22/ doi:10.2196/jmir;.1022-23

Bamidis, P.D., Pappas, C. (2008). Medical Informatics and the Internet in Contemporary Healthcare Services. Authority of the 3rd Health Region, Thessaloniki, Greece, (In Greek).

Belanger, Y. (2005). *Duke University iPod first year experience final evaluation report*. Durham, NC: Duke University. Retrieved November 14, 2008, from http://www.duke.edu/ddi/ipodfye.html

Berliner, D. & Calfee R. (Eds.). (1996). *Handbook of educational psychology*. New York, NY: Macmillan.

Berners-Lee, T., Hendler J., Lassila O. (2001). The semantic web. *Scientific American*, 184(5), 34-43.

Boulos MK (2007). Healthcare on Web 2.0. Healthcare Information and Management Systems Society, Retrieved on 30 Dec 2007 from http://emea.himss.org/news/expertviews_archive.asp.

Boulos, M., Maramba, I., & Wheeler, S. (2006). Wikis, blogs and podcasts: A new generation of web-based tools for virtual collaborative clinical practice and education. *BMC Medical*

Education, 6: 41.

Bratsas, C., Bamidis, P.D., Kaimakamis, E., Maglaveras, N. (2008). Usage of Semantic Web Technologies (Web-3.0) Aiming to Facilitate the Utilisation of Computerized Algorithmic Medicine in Clinical Practice. Published as Multimedia Appendix in: Eysenbach G. Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. J Med Internet Res, 10(3):e22. http://www.jmir.org/2008/3/e22/ doi:10.2196/jmir;.pp1038-39

Cronje, J.C. (2001). Metaphors and models in internet-based learning. *Computers & Education*, 37 (3-4) 241-256.

De Lucia A., Francese, R., Passero, I., & Tortora, G. (2009). Development and evaluation of a virtual campus on Second Life: The case of SecondDMI. *Computers & Education*, 52(1), 220-233.

Dertouzos, M. (1997). *What will be*. London, UK: Judy Piatkus Ltd. (pp. 175-189).

Ebner M., Holzinger A., and Maurer H. (2007). Web 2.0 Technology: Future Interfaces for Technology Enhanced Learning. In Stephanidis C. (Ed.): Universal Access in HCI, Part III, HCII 2007, LNCS 4556, pp. 559–568, Springer-Verlag Berlin Heidelberg.

Ehlers, U., (2007). The new pathway for e-learning: From distribution to collaboration and competence in e-learning. *Association for the Advancement of Computing in Education Journal*, 16(2), 187-20.

European Council (2000). *Employment, economic reforms and social cohesion - towards a Europe based on innovation and knowledge* (Document submitted to Lisbon European Council, official number 5256/00). Lisbon, Portugal: European Council. Retrieved November 4, 2008, from http://ue.eu.int/ueDocs/cms_Data/docs/pressdata/en/misc/05256.en0.html

Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education, *Computers & Education*, 50(2), 491-498.

Eysenbach G. (2007) From intermediation to disintermediation and apomediation: new models for consumers to access and assess the credibility of health information in the age of Web2.0. *Studies in Health Technology and Informatics*, 129(Pt 1):162-166.

Fyrenious, A. (2005). Lectures in problem-based learning—Why, when and how? An example of interactive lecturing that stimulates meaningful learning. *Medical Teacher*, 27(1), 61–65.

Hammond, M. (2006). Blogging within formal and informal learning contexts: Where are the opportunities and constraints? In *Proceedings of the International Research Conference on Networked Learning 2006*, Lancaster, UK.

Jones, R., Higgs, R., de Angelis, C. & Prideaux, D. (2001). Changing face of medical curricula. *Lancet*, 357(9257), 699-703.

Kaldoudi, E., Bamidis, P.D., Papaioakeim, M., Vargemezis, V. (2008). Problem-based learning via Web 2.0 technologies. In *Proceedings of CBMS2008: The 21th IEEE International Symposium on Computer-Based Medical Systems, Special Track: Technology Enhanced Learning in Medical Education.* (pp. 391-396). Jyväskylä, Finland: IEEE Computer Society.

Kaldoudi, E., Papaioakeim, M., Bamidis, P.M., Vargemezis, V. (2008). Towards expert content sharing in medical education. In *Proceedings of INTED2008: International Technology, Education and Development Conference*. Valencia, Spain: IATED.

Kelton, A.J. (2008). Virtual worlds. Outlook good. *EDUCAUSE Review*, 43(5), 5-22.

Kim, H.N. (2008). The phenomenon of blogs and theoretical model of blog use in educational contexts. *Computers & Education,* 51(3), 1342-1352.

Kurtz, B., Fenwick, J., & Ellsworth, C. (2007). Using podcasts and tablet PCs in computer science. In *Proceedings of 45th ACM South East Conference* (pp. 484 - 489). Winston Salem, NC: ACM.

Marton, F., Dahlgren, L.-O., Svensson, L. & Saljo, R. (1977). *Inlarning och omvarldsuppfattning*. Stockholm, Sweden: Almqvist och Wiksell forlag AB.,.

McAfee, A. (2006). Enterprise 2.0: The dawn of emergent collaboration. *MIT Sloan Management Review*, 47(3), 21-28.

National Research Council. (1999). *How people learn*. Washington, D.C.: National Academy Press.

O'Reilly, T. (2005). What is Web 2.0: Design patterns and business models for the next generation of software. Retrieved February 1, 2008, from http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html

Ohler, J. (2008), The semantic web in education. *EDUCAUSE Quarterly*, 31(4), 7-9.

Papaioakeim, M., Kaldoudi, E., Vargemezis, V., Simopoulos, K. (2006). Confronting the problem of ever expanding core knowledge and the necessity of handling overspecialized disciplines in medical education. In *Proceedings of ITAB 2006: IEEE International Special Topic Conference on Information Technology in Biomedicine.* Ioannina, Greece: IEEE.

Parker, K.R. & Chao, J.T (2007). Wiki as a teaching tool. *Interdisciplinary Journal of Knowledge and Learning Objects*, 3, 57-72.

Russell, T.L. (2001) *The no significant difference phenomenon*. Montgomery, USA: IDECC.

Schaffert, S., Bischof, D., Buerger, T., Gruber, A., Hilzensauer, W. & Schaffert, S. (2006). Learning with semantic wikis. In *Proceedings of the First Workshop on Semantic Wikis – From Wiki To Semantics (SemWiki2006),* (pp.109-123). Budva, Montenegro.

Schuable, L. & Glaser R. (Eds.). (1996). *Innovations in learning*, New Jersey, NY: Mahwah.

Tonkin, E. (2005). Making the case for a wiki. *Ariadne*, Issue 42. Retrieved November 14, 2008, from http://www.ariadne.ac.uk/issue42/tonkin/

Wang, K.T., Huang, Y.-M., Jeng, Y.-L., & Wang, T.-I. (2008). A blog-based dynamic learning map. *Computers & Education,* 51(1), 262-278.

Wenger, E. (2000). Communities of practice and social learning systems. *Organization,* 7(2), 225-246.