WEB 2.0 TOOLS IN BIOMEDICAL AND PHARMACEUTICAL EDUCATION. UPDATED REVIEW AND COMMENTARY

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ABSTRACT

The use of Web 2.0 technology is rapidly being integrated into undergraduate and graduate education, which dramatically influences the ways learners approach and use information. Knowledge transfer has become a two-way process. Users no longer simply consume and download information from the web; they create and interact with it. Several theoretical works were developed in order to discuss the possibilities of integration of Web 2.0 tools in Pharmacy, Medicine, Allied Health, Nursing and many other Biomedical Areas. Other works have started gathering qualitative and quantitative evidence of the importance of Web 2.0 tools in the learning process. By performing this integrative review, this paper will provide an overview of what is being done in biomedical education, and elaborate some of the potential opportunities and challenges that these applications present. With this updated review we hope to give our contribution to consolidate research in this promising area.

Keywords: Web 2.0, Podcast, Vodcast, Blog, Microblogging, Wiki,Virtual Worlds

INTRODUCTION

Internet social applications, normally referred as Web 2.0 tools, are making their way in the new teaching paradigms of higher education. Since their early development, primarily for entertainment and social communication within the general population, applications such as blogs, social video sites, and virtual worlds (Barsky, 2006) are being adopted by higher education institutions in a vast range of scientific areas (Boulos, Maramba, & Wheeler, 2006). It has been argued that Web 2.0 technologies have the potential to change the education of healthcare professionals, from a didactic one way process, in which information is transferred from the "expert" to the student, to a collaborative and participative process, empowering the student to be an equal participant in the learning process(Ward, Moule, & Lockyer, 2009). However there are significant challenges and hurdles, which need to be considered (Boulos & Wheeler, 2007). Web 2.0 applications appear to offer exciting new ways to teach, however, research into the use and evaluation of Web 2.0 tools in Biomedical Education is still in its infancy, and the current pedagogic evidence about these tools is still lacking (Boulos et al., 2006)(Cain & Fox, 2009). In specific areas such has Pharmacy and Allied Health education, the examples are not wide, but the increasing use of teaching methodologies such as case based learning (Jesus, Cruz, & Gomes, 2011), might contribute to the implementation and dissemination of these tools. Wikis, blogs, podcasts and other tools have

already been mentioned in some papers regarding higher education (Poonawalla & Wagner, 2006) (Kamel Boulos & Wheeler, 2007). These Web 2.0 technologies are in fact emerging as platforms to enable or encourage students to collaboratively create and share their own insights into current and emerging themes within their education. The number of tools and users are increasing and finding a place in healthcare management, education and practice (Ward et al., 2009). While it seems Web 2.0 might offer the potential for online learning to support pedagogy, in higher education there is little understanding of how and where it is being used to support biomedical education (Ward et al, 2009). In order to try to draw some understanding of the current engagement this study is aimed to explore what specific Web 2.0 tools are being used, with what purposes and in what contexts.
In this update review we will also focus on the most recent evidence about the use o Web 2.0 tools in pharmaceutical education, and share our own experiences on this topic.

METHODOLOGY

The study design is descriptive (MacMillan & Shumaker, 1997) and adopted the format of an integrative review (Cooper, 1984) since the objective was to make a synthesis of results (secondary analysis) from previous studies (primary analysis), in order to respond to new questions, new hypotheses and to verify or establish new relationships (Fortin, 2009). It is well documented that research reviews are considered research of research, and therefore should meet the same standards as primary research in methodological accuracy (Cooper, 1998). Cooper (1998) has delineated the process of conducting a research review as encompassing a problem formulation stage, a literature search stage, a data evaluation stage, a data analysis stage, and a presentation stage.

Problem formulation stage

This study primarily aims to characterize the use of Web 2.0 tools in biomedical and pharmaceutical education between the years of 2004 to 2014, and gather data to assess the potential educational values and hurdles to overcome. To constitute the categories of analysis we kept in mind the specificity of the object. Accordingly, the following variables were considered: a) year of publication, b) type of web 2.0 tool, c) biomedical area d) type of publication, e) type of article and, finally, f) type of empirical study. For the variable “biomedical area” we started with 5 main categories – Medicine and Dental Medicine; Nursing; Pharmacy and Pharmacology, Allied Health and Other Topics. For the variable "type of publication" we considered three categories – journal article, proceedings and other. For the variable "type of article," we adapted the proposals of Coutinho (2008) and Poirier et al (2009), and considered four main categories – theoretical/ reflection, empirical, instructional design and assessment studies (IDEAS)[1], and study protocol descriptions. Finally, in the variable "type of empirical study" we started with an initial range of six categories adapted from the proposal of Gomes & Coutinho (2008): quasi - experimental, survey, case study, mixed study, action research and qualitative study. During the data analysis we didn´t found any paper that falls in the categories “case studies” and “action research”. Brief research design descriptions of retrieved studies are summarized in Table 1. Classification and definition are based in the proposals of O´Brien (2001), (Poirier et al., 2009) and Coutinho (2011).

[1] Coutinho (2008), proposes four categories : theoretical/ reflection, empirical, reports of educational experiences and study protocols. Poirier et al (2009), presents a more structured approach to reports of educational experiences – called Instructional Design and Assessment Studies (IDEAS).

Type of Article		Brief description
Empirical Study	Quasi-experimental	It is similar to an experimental design, where strict control and randomization of treatment conditions are not possible.Usually the groups of subjects are already created by some previous criteria whic are independent from the aims of the research study.This is typical in educational settings
	Survey	Structured questions given to participants, by means of interviews or questionnaires.
	Qualitative Study	Family of methods involving an interpretive, naturalistic approach of the subject.
	Mixed Study	Applies principles of Qualitative and Quantitative research
	Case Study	A form of qualitative research, the case study looks intensely at an individual or small group, drawing conclusions only about that participant or group and only in that specific context.
	Action Research	Action research involves utilizing a systematic cyclical method of planning, taking action, observing, evaluating (including self-evaluation) and critical reflection prior to planning the next cycle.
Theoretical/Reflection	Include expert opinions, reflections and theoretical aspects on the topic.	
Instructional Design and Assessment Studies (IDEAS)	Includes articles that describe new courses, parts of courses, integration of selected competencies across the curriculum, assessment of instructional outcomes,the use of technologies and new delivery methods	
Study Protocol	Described, proposed or ongoing research, providing a detailed account of the hypothesis, rationale, and methodology of the study	

Table 1. Brief research design descriptions of retrieved studies.

Literature search stage

Well-defined literature search strategies are critical for enhancing the accuracy of any type of review because incomplete and biased searches result in an inadequate database and the potential for inaccurate results (Cooper, 1998). Ideally, all of the relevant literature on the problem or topic of interest is included in the review; yet obtaining this literature can be challenging and costly (Jadad, Moher, & Klassen, 1998). Our literature search consisted mainly on electronic search of published articles and congress proceedings, in international educational databases and university repositories. Published journal articles and conference proceedings, between 2004 and 2011, relating to the use of Web 2.0 tool in Biomedical and Pharmaceutical Higher Education was made in the databases ERIC; EBSCO Academic Search Complete, MEDLINE, PubMed, JSTOR, CINAHL, Science Citation Index Expanded, Social Sciences Citation Index and Conference Proceedings Citation Index. Keywords, utilized in the search, consisted in: “blog”, podcast”, “virtual worlds”, “Wiki”, “Docs”,” Web 2.0”, “ Health Education”,” Biomedical Education”, “Medicine Education”, “Nurse

Education" and "Pharmacy Education" in several combinations. The titles, abstracts, and keywords of each of these articles were reviewed by two members of the research team, to assess their relevance to the research at hand. The references of the selected articles were also surveyed for appropriate articles. Computerized databases are efficient and effective; however, limitations associated with inconsistent search terminology and indexing problems may yield only about 50% of eligible studies (Whittemore & Knafl, 2005). Thus, and following the recommendations of Conn, Valentine, Cooper, & Rantz (2003), other approaches to searching the literature were included, such as, journal hand searching and searching research registries. A total of 56 articles were selected for further analysis.

Data evaluation

The final sample for this integrative review included empirical studies, theoretical reports instructional design and assessment studies, and study protocols. Empirical reports included a wide variety of methods. Due to the diverse representation of primary sources, reports were coded according to two criteria relevant to this review: methodological or theoretical accuracy and data relevance on a 2-point scale (high or low). Since there are limited studies on this topic, an in order not to compromise the review, no report was excluded, based on this data evaluation rating system; however, the score was included as a variable in the data analysis stage. High relevance was only attributed to empirical studies.

Data analysis

Data analysis in research reviews required that the data from primary sources was ordered, coded, categorized, and summarized into a unified and integrated conclusion about the research problem (Cooper, 1998). Data analysis comprised of data coding from primary sources to simplify, abstract, focus, and organize data into a manageable framework (Whittemore & Knafl, 2005). Relevant data of each subgroup classification was extracted from all primary data sources and compiled into a matrix. The matrix was created according to the assumptions and categories mentioned earlier. This approach provides succinct organization of the literature, which facilitates the ability to systematically compare primary sources on specific issues, variables, or sample characteristics.

Presentation

Conclusions are reported in table or diagrammatic form. Explicit details from primary sources and evidence to support conclusions will be provided to demonstrate a logical chain of evidence, allowing the reader of the review to ascertain that the conclusions of the review do not exceed the evidence (Oxman, 1994).

PROSPECTS

By performing this integrative review, this chapter will provide an overview of what is being done in biomedical and pharmaceutical education, and elaborate on some of the potential opportunities and challenges that these applications present. We hope to give our contribution to consolidate research in this promising area.

ARRAY OF LITERATURE

Autor	Year of publication	Web 2.0 tool	Biomedical Area	Type of Publication	Type of Article	Type of Empirical study
(Bouldin, Holmes, & Fortenberry, 2006)	2006	Blog	Pharmacy	Article	Instructional Design and Assessement	
(Boulos, Maramba, & Wheeler, 2006.)	2006	Wiki+Blog+Podcast	Other Topics	Article	Theoretical/Reflection	
(Sandars, 2006)	2006	Wikis+Blogs	Medicine	Article	Theoretical/Reflection	
(Boulos, Hetherington, & Wheeler, 2007)	2007	Second Life	Medicine	Article	Theoretical/Reflection	
(Mathieu, 2007)	2007	Wiki+Blog+Podcast	Nursing	Article	Theoretical/Reflection	
(Oomen-Early & Burke, 2007)	2007	Blog	Other Topics	Article	Empirical	Survey
(Chretien, Goldman, & Faselis, 2008)	2008	Blog	Medicine	Article	Instructional Design and Assessement	
(Forbes & Hickey, 2008)	2008	Podcast	Nursing	Article	Empirical	Survey
(Geyer, Beylefeld, & Alwyn, 2008)	2008	Podcast	Medicine	Proceedings	Empirical	Survey
(Goldman, Cohen, & Sheahan, 2008)	2008	Blog	Other Topics	Article	Empirical	Survey
(Kaldoudi, Bamidis, Papaioakeim, & Vargemezis, 2008)	2008	Web 2.0	Medicine	Proceedings	Theoretical/Reflection	
(Pilarski, Alan Johnstone, Pettepher, &	2008	Podcast	Medicine	Article	Empirical	Survey

Osheroff, 2008)						
(Sandars, Homer, Pell, & Croker, 2008)	2008	Web 2.0	Medicine	Article	Empirical	Survey
(Skiba, 2008)	2008	Twitter	Nursing	Article	Theoretical/Reflection	
(Sumer, 2008)	2008	Web 2.0	Medicine	Article	Theoretical/Reflection	
(Billings, 2009)	2009	Wikis+Blogs	Nursing	Article	Theoretical/Reflection	
(Bratsas, Kapsas, Konstantinidis, Koutsouridis, & Bamidis, 2009)	2009	Web 2.0	Medicine	Proceedings	Theoretical/Reflection	
(Cain & Fox, 2009)	2009	Web 2.0	Pharmacy	Article	Theoretical/Reflection	
(Grassley & Bartoletti, 2009)	2009	Wikis+Blogs	Nursing	Article	Theoretical/Reflection	
(Hansen, Murray, & Erdley, 2009)	2009	Second Life	Nursing	Article	Theoretical/Reflection	
(Honey, Diener, Connor, Veltman, & Bodily, 2009)	2009	Second Life	Nursing	Proceedings	Instructional Design and Assessement	
(Meade, Bowskill, & Lymn, 2009)	2009	Podcast	Pharmacology	Article	Empirical	Survey
(Miller, Bookstaver, & Norris, 2009)	2009	Wikis	Pharmacy	Article	Instructional Design and Assessement	
(Phadtare, Bahmani, Shah, & Pietrobon, 2009)	2009	Docs	Allied Health and Nursing	Article	Empirical	Quasi-Experimental

(Rogers, 2009)	2009	Second Life	Nursing	Proceedings	Instructional design and assessement	
(Rosh, Jones, & Wahl, 2009)	2009	Web 2.0	Medicine	Article	Experiment Report	
(Shantikumar, 2009)	2009	Podcast	Medicine	Article	Empirical	Survey
(Woulfe, Williams, & Ryan, 2009)	2009	Wikis	Pharmacy	Proceedings	Empirical	
(Archambault et al., 2010)	2010	Wikis	Allied Health and Medicine	Article	Study Protocol	
(Bristol, 2010)	2010	Twitter	Nursing	Article	Theoretical/Reflection	
(Chu, Young, Zamora, Kurup, & Macario, 2010)	2010	Web 2.0	Medicine	Article	Theoretical/Reflection	
(Melissa Tan, K. Ladyshewsky, & Gardner, 2010)	2010	Blog	Allied Health	Article	Empirical	Qualitative Study
(O'Sullivan & McGlynn, 2010)	2010	Web 2.0	Allied Health	Proceedings	Instructional design and assessement	
(Mattheos, Schoonheim, Klein, Walmsley, & Chapple, 2010)	2010	Web 2.0	Dental Medicine	Article	Theoretical/Reflection	
(Varga-Atkins, Dangerfield, & Brigden, 2010)	2010	Wikis	Medicine	Article	Empirical	Mixed Study
(Younger, 2010)	2010	Wikis	Nursing	Article	Theoretical/Reflection	
(Schreiber, Fukuta, & Gordon, 2010)	2010	Vodcast	Medicine	Article	Empirical	Experimental

(Wiecha, Heyden, Sternthal, & Merialdi, 2010)	2010	Second Life	Medicine	Article	Empirical	Survey
(Mirk, Burkiewicz, & Komperda, 2010)	2010	Wikis	Pharmacy	Article	Empirical	Survey
(Boutin & Therriault, 2011)	2011	Wiki	Allied Health	Proceedings	Instructional Design and Assessement	
(Fischer, Haley, Saarinen, & Chretien, 2011)	2011	Blog	Medicine	Article	Empirical	Quasi-Experimental
(Fox & Varadarajan, 2011)	2011	Microblogging	Pharmacy	Article	Empirical	Survey
(George & Dellasega, 2011)	2011	Web 2.0	Medicine	Article	Empirical	Mixed Study
(Llambí et al., 2011)	2011	Wikis	Medicine	Article	Empirical	Quasi-Experimental
(Meade, Bowskill, & Lymn, 2011)	2011	Podcast	Pharmacology	Article	Empirical	Qualitative
(Ros-Rodriguez et al., 2011)	2011	Wiki	Pharmacy	Proceedings	Instructional Design and Assessement	
(Sparks, O'Seaghdha, Sethi, & Jhaveri, 2011)	2011	Web 2.0	Medicine	Article	Theoretical/Reflection	
(Stiffler, Stoten, & Cullen, 2011)	2011	Podcast	Nursing	Article	Empirical	Survey
(Zanussi, Paget, Tworek, & McLaughlin, 2011)	2011	Podcast	Medicine	Article	Theoretical/Reflection	
(Pierce & Fox, 2012)	2012	Podcast	Pharmacy	Article	Instructional Design and Assessment	
(Bussières, Métras, & Leclerc, 2012)	2012	Microblogging	Pharmacy	Article	Instructional Design and Assessment	

(Miller, Norris, & Bookstaver, 2012)	2012	Wikis	Pharmacy	Article	Empirical	Survey
(Stewart, Panus, & Hagemeier, 2013)	2013	Podcast	Pharmacy	Article	Instructional Design and Assessement	
(Camiel, Goldman-Levine, Kostka-Rokosz, & McCloskey, 2014a)	2014	Microblogging	Pharmacy	Article	Instructional Design and Assessement	
(Camiel, Goldman-Levine, Kostka-Rokosz, & McCloskey, 2014b)	2014	Microblogging	Pharmacy	Article	Empirical	Survey

Table 2. Array of Literature

RESULT´S PRESENTATION AND DISCUSSION:

Year of Publication

The documents retrieved were published over a time period between the end of 2004 and the third quarter of 2011 (see Table 2). As we can observe in Table 3, the year which shows the highest number of publications, was 2009 with 14 documents, followed by the years 2010 and 2011 with 10 records. These numbers are expected to increase with the growing number of educators publishing their experiences with Web 2.0 in Biomedical Education and represent a huge raise if compared with previous years.

Year	2006	2007	2008	2009	2010	2011
Number of Articles	3	3	9	14	10	10
% of total documents	6,1	6,1	18,4	28,6	20,4	20,4

Table 3. Number and percentage of articles published by year

Web 2.0 tools

One of the main aspects to consider in the literature search, and data evaluation, was the Web 2.0 tool utilized in the studies (Table 4). Taking into account the diversity of tools available, and the possible combinations, our option was not to previously set categories, but to categorize, according to the data evaluation. During the data analysis process we accounted for 9 categories: "Web 2.0"; "Podcast/Vodcast"; "Wikis"; "Blogs"; "Second Life"; "Twitter®"; "Wikis + Blog", "Wikis + Blog + Podcast" and finally "Google Apps® and Similar". The "Web 2.0" category was considered due to the number of theoretical and empirical works being published, regarding the general application of Web 2.0 tools in biomedical sciences, or the application of more than three specific tools in the same context.

Web tool	Total Number of Articles	Type of Articles			
		Empirical	Theoretical/ Reflection	Instructional Design /Assessment Studies	Study Protocol
Web 2.0	11	2	7	2	0
Podcast /Vodcast	11	8	1	2	0
Wikis	11	6	1	3	1
Blogs	6	4	0	2	0
Second Life	5	1	2	2	0
Twitter/Microblogging	6	2	2	2	0
Wikis + Blog	3	0	3	0	0
Wikis + Blog + Podcast	2	0	2	0	0
Google Apps/Similars	1	1	0	0	0

Table 4. Number of articles according with each Web 2.0 tool

Biomedical Area

Medicine is the largest biomedical area represented in this study. This result may be explained by the large literature being published by medical professionals, the large number of medical faculties, and also because other biomedical areas, like Allied Health and Pharmacy, represent a younger existence when compared with traditional Medical Education. During the development of the study we coded two new variables – "Allied Health and Nursing"; "Allied Health and Medicine"- which

are related to experiments conducted with both kind of professionals (Table 5). In this updated review we focused in newer studies regarding pharmaceutical education.

Biomedical Area	Total Studies Retrivied
Medicine and Dental Medicine	21
Pharmacy and Pharmacology	15
Nursing	11
Allied Health	3
Allied Health and Medicine	1
Allied Health and Nursing	1
Other Topics	3
Total number of Articles	56

Table 5. Number of articles according to biomedical area.

Type of publication

Regarding the variable type of publication, journal articles are the most common source and medium of dissemination of work being done in Biomedical Education with Web 2.0 tools, consisting on a total of 40. This may be due to two major factors. Firstly, conference proceedings, by themselves, do not constitute a characteristic and homogeneous group of scientific work that can be easily accessed through the web, mainly because only a few organizations with long-standing organization history of scientific conferences have indexing. Additionally, situations where proceedings are published (full text) in supplements of related Journals, we choose to categorize them as Journal Articles.

Type of Article and Type of Empirical Studies

As previously stated, four main categories were considered, for the variable type of article: theoretical/reflection; empirical study; instructional design and assessment study, and study protocol (Table 6) .The empirical studies relating to the topic in question, were categorized accordingly with the followed methodology. The following table summarizes the results. Surveys are the most common type of empirical study.

		Type of Empirical Study			
Type of Article	Number of Articles	Quasi-experimental	Survey	Qualitative	Mixed Study
Empirical	24	4	15	2	3
Theoretical/ Reflection	18				
Instructional Design and Assessment Studies	13				
Study protocol	1				

Table 6. Number of articles according with type of article and type of empirical study

RESULTS BY WEB 2.0 TOOL USED

Web 2.0

The use of Web 2.0 technology is rapidly being integrated into undergraduate and graduate education, which dramatically influences the ways learners approach and use information. Knowledge transfer has become a two-way process. Users no longer simply consume and download information from the web; they create and interact with it (Rosh et al., 2009). Several theoretical works were developed in order to discuss the possibilities of integration of Web 2.0 tools in Pharmacy (Cain & Fox, 2009), Medicine (Chu et al., 2010), Allied Health (O'Sullivan & McGlynn, 2010) and many other Biomedical Areas. Other works have started gathering evidence of the importance of Web 2.0 tools for students and even show some quantitative and qualitative results. Initial works like the one from (Sandars et al., 2008) propose a very straightforward approach. With a survey type study, they aimed to determine the nature and extent of the use of social software by first year medical students. From a sample of 212 students, they discovered that over 90% used instant messaging and 70% social networking sites. There was no significant difference between males and females. Blogs were read by about a fifth of the students and 8% wrote their own blogs. A fifth of males stated that they were users of media sharing and contributed to wikis. Social bookmarking was rarely used by either sex. On a more complex approach George & Dellasega (2011) used and evaluated the integration of new social media tools into the curricula of two graduate-level medical humanities electives offered to 4th year students at Penn State College of Medicine. Five social media tools were selected - Twitter®, YouTube®, Flickr®, Blogger® and Skype® - to promote student learning. At the conclusion of each course, students provided quantitative and qualitative course evaluation. Results demonstrate that students gave high favorability ratings to both courses, and expressed that the integration of social media into coursework augmented learning and collaboration. Others identified challenges such has demands on time, concerns about privacy and lack of familiarization with technology. These reports represent an integrated approach to the use of Web 2.0 technologies in Biomedical Higher Education. Reports relating to the use of specific tools are presented below.

Podcast and Vodcast

Much that is written about podcasting refers to its ability to enhance convenience, flexibility and accessibility to learning (Nathan & Chan, 2007). It appears that when one examines the purpose behind the use of podcasting, it falls into three broad categories: enhancing the flexibility of learning, increasing accessibility to learning (particularly in relation to enabling mobile access) and enhancing the student's learning experience (particularly in on campus courses through the use of more blended learning experiences) (McGarr, 2009). We encountered 10 articles relating to the use of podcast/vodcast in biomedical education. Six of them were surveys. Meade et al. (2009) tried to provide an evaluation of the usefulness of pharmacology podcasts as a supplementary learning tool for Non Medical Prescribing Students. The focus of this evaluation was on student use of the podcasts, perceptions of the usefulness and any potential impact on students' pharmacological knowledge. The podcasts were made available to students through WebCT and the authors tracked two successive cohorts of nurse prescribing students (n = 69). Survey data, investigated reasons for podcast use and perceived usefulness of podcasts as a learning tool. Their results showed that not only 91% of students accessed at least one podcast but also that 93% of students used the podcasts to revisit a lecture. Only 22% used the podcasts because they had missed a pharmacology session. Most students (81%) generally listened to the entire podcast rather than specific sections and most

(73%) used them while referring to their lecture handouts. More than 90% of students found the podcasts helpful as a learning tool, as a revision aid and in promoting their understanding of the subject. Of the 69 students, 64 completed the pharmacology exam. In order to examine any impact of podcasts on student knowledge, their exam results were compared with those of two historical cohorts who did not have access to podcasts (n = 70). Evaluation of range of marks obtained, mode mark and mean mark suggested improved knowledge in students with access to podcasts compared to historical cohorts of students who did not have access to pharmacology podcasts(Meade et al., 2009). Also in the UK, but with medical students, Shantikumar (2009) aimed to investigate medical students' perceptions of a series of enhanced podcasts for revision of contents. Thirteen audiovisual podcasts covering general surgery were developed, consisting of a PowerPoint slideshow with a voiceover narrative. A questionnaire was distributed to 211 final year medical students, two months after the podcast became available. Results showed that students who used the resource felt that the enhanced podcasts were straightforward to access, were a useful learning supplement, and felt that similar resources for the remainder of the undergraduate medical syllabus would be useful for revision purposes (Shantikumar, 2009). Similar results were described by Pilarski et al (2008) in first year medical students. According to their results, the availability of lecture recordings aided medical students in their studies and reduced stress and anxiety. Student response to the recordings was positive, and no negative outcomes were noted by students or faculty (Pilarski et al., 2008). Analogous methods were utilized in Nursing Education (Forbes & Hickey, 2008), (Stiffler et al., 2011). In both cases, the authors provided an overview of the potential uses and techniques for implementing podcasting in nursing education, and described students perceptions and attitudes. The results are in consonance with the above-mentioned studies. Although these are promising results we must not be drawn to generalize their conclusions. First of all, the survey type study does not provide all relevant information about context on the application of podcasts. Secondly, student performance in these cases, except Meade et al (2009), is not categorized or even measured in a consistent way. We can agree that student's perceptions and responses to these implementations are crucial for their success, but more detailed, in-depth studies are required in order to truly account for an impact in Biomedical Education. This will imply bigger samples and longer studies.
We only came across with one qualitative study exploring the use of podcast in biomedical education. Meade et al. (2011) conducted semi-structured interviews with seven non-medical prescribing students. Their results determined that students used podcasts for revisiting lectures, preparing for exams, to clarify or revise specific topics and, to a lesser extent, to catch up on a missed lecture. Barriers to podcast use were identified, mainly around technological issues. Lack of experience and lack of access to suitable technology to access podcasts proved a barrier for some students. Students found that using podcasts allowed them to have greater control over their learning and to gauge their learning needs, as well as helping them build their understanding of a complex topic (Meade et al., 2011). The qualitative methods provide a depth of understanding of issues that is not possible through the use of statistically based, quantitative investigations. The qualitative approach can be a useful tool since it centralizes and places primary value on how students understand experience and operate with web 2.0 tools. The results of qualitative studies can be of interest to educators and policy makers when design a strategy for the implementation of such tools in their specific academic context.

Initially we did not consider a category for vodcasts, however, in the array of literature, one study referring to vodcast in medical education was found (Schreiber et al., 2010) and one in Pharmacy (Pierce & Fox, 2012). In the first study the authors compared information recall and student experience and preference after live lectures and video podcasts in undergraduate medical education. A crossover trial was performed with a total of 100 students. The first group attended a live lecture on arthritis and then a video podcast on vasculitis, while the second group attended a live lecture on vasculitis and then a video podcast on arthritis. The study hypothesis was that knowledge after vodcast would not be significantly different from knowledge after live lectures.

The primary outcome was the score on the multiple-choice questionnaire after each intervention. This study found that students showed similar information recall after video podcasts and live lectures, but preferred live lectures. Students appreciated the convenience and control over vodcasts, but found them, generally, less engaging. Design strengths in this study included testing the students only after the interventions, to avoid influencing the educational intervention with the test itself and keeping the two interventions as similar as possible using the same speaker, the same PowerPoint® slides, and the same verbal information. Authors, point out however, that selection bias might have been present, since participation was out of hours and voluntary and also a significant dropout rate occurred.

Pierce and Fox (2012), promoted vodcast of lectures prior to the scheduled class and then discussed interactive cases of patients with end-stage renal disease in class. Students' performance on the final examination significantly improved compared to performance of students the previous year who completed the same module in a traditional classroom setting. Althought these results are very promissing, we must consider taht this experiment was based ina "Flipped Classroom" model , which may also contribute to the performance improvement.

These studies open possibilities for future interventions, and although conclusions were not always favorable to the Web 2.0 tool (Stewart et al., 2013), several factors were identified as confounding factors. We suggest that any pursue in this type of designs take in consideration the duration of the intervention, the possible selection bias and of course a better isolation of threats to the internal validity. The incorporation of podcasts in biomedical education, namely in support of a mobile form of learning, may have potential, but the reason given to justify its use should be student led, and not technology led. Educators need to be cautious of the claims made in relation to new and emerging technologies, particularly in the assumptions made by proponents of the technologies (McGarr, 2009). The development of future policies in institutions should be cognisant of the limitations of the technology in supporting a more mobile form of learning. If used to provide access to records of previous lectures, or to provide summaries and syntheses of course material, careful consideration should be given to how the students should use the material. If seen as the primary source of material and learning by the students, this type of technology may not contribute to the students' learning experience. So it is important to ensure that students possess the study skills needed to use the support material effectively.

Blogs

The use of blogs may serve as a potential teaching tool, as well as an important channel for Biomedical Education. Previous research has shown that blogging, integrated into curriculum, may increase student's motivation, critical thinking, class interaction, and student's course satisfaction (Beldarrain, 2006)(Olofsson, Lindberg, & Hauge, 2011). Blogging may even propel students to take social and political actions outside of the virtual environment (Oomen-Early & Burke, 2007). Concerning the use of blogs, in Biomedical and Health Education, a total of 6 articles were retrieved. Regarding instructional design and assessment, two examples were found, in Pharmacy (Bouldin et al., 2006) and Medicine (Chretien et al., 2008), respectively. Bouldin et al., (2006) applied blogs to a reflective journaling exercise in a communication course during the second-professional year at the University of Mississippi School of Pharmacy, in order to encourage students to reflect on course concepts and apply them to environments outside the classroom, and to assess their communication performance. Seventy-eight students enrolled in the study. Two blog entries per week were required for full credit. Blogs were evaluated at three points during the entire term, and at the end of the course, students evaluated the assignment using a survey. Results

showed that the assignment contributed to student learning and increased awareness level for approximately 40% of the class, however, there were some limitations. Because of the proximity to the end of the semester, student responses may have been influenced by the total curricular workload; moreover this attitudinal evaluation was only taken at one point in time.
Chretien et al.(2008) performed a similar study with 91 medical students during a basic medicine clerkship rotation at an academic institution over a one-year period. Students were asked to contribute with reflective postings to the class blog during their rotation (each rotation was four weeks long). They were able to read each other's postings and leave feedback in a comment section. An instructor provided feedback on entries, aimed to stimulate further reflection. Students could choose anonymous names if desired. One hundred and seventy seven posts were written, and only a minority was not reflective. The instructor's feedback stimulated additional reflection and one-third of students left feedback comments. Both studies show that it is possible to foster reflective thinking by the use of blogs in such different biomedical areas as Pharmacy and Medicine and even provide opportunities to support student professional development. It is notable that the number of students in each study is quite considerable, a quality not often seen in these types of studies. However, the number of tutors /instructor wasn´t proportional, and this caused an incomplete and not as frequent feedback. Additionally, both studies were conducted in only one institution, which may limit generalization. Nevertheless, as instructional design and assessment studies, these studies show and describe thoroughly the process by which any educator can implement and assess the opportunities promoted by blogs in their classrooms, or even during clinical practice.
Regarding the survey type study, Goldman et al (2008) evaluated whether "seminar blogs" enhanced learning in a graduate-level introductory public health school class. An online survey was conducted and the main questions were about blog use, perceived impact on learning, and interactions with classmates. The survey also asked about the "ease of blogging" compared with speaking in class, the development of group dynamics, potential usefulness of blogging in student´s work, and advantages and disadvantages of seminar blogs. Results generally favor the study objective, however several limitations are addressed. First of all, the study was conducted in a post-graduate setting, where subject's age and maturity may (or may not) contribute for the study objectives. As referred by the authors, the short time frame (8 weeks) may have been too brief to fully determine the developing of group dynamics or social presence. And finally we should keep in mind that this a descriptive study based on student self-report of effects on learning and participation and only with a comparison group would we be able to assess the impact of the blogs on specific measurable educational outcomes.
Oomen-Early & Burke (2007) also conducted a survey to explore faculty and students' perceptions of blogging as an effective teaching and learning tool within the online health education classroom. The researchers measured if blogging increased students' interaction, engagement, and feelings of connectedness with peers. Results are favorable to the study objective, but again we are dealing with a small sample of students who responded to the survey. This study, shows however a great deal of care in developing a survey (validated by expert and tested in a group of students), and points out several limitations and challenges regarding the use of online free blog hosting services.
Using a much more robust study design Fischer et al. (2011), conducted a comparative study of student reflective writings, produced using either a blog format or a traditional essay to assess differences in content, depth of reflection and student preference. Students were quasi-experimentally assigned to one of the two groups, and although no significant difference was determined in themes addressed, or levels of reflection, the authors showed that it´s possible, and quite achievable to promote the use of blogs in biomedical teaching. The study suggests that the use of blogs, in no way diminishes the ability for reflective writing. Moreover the fact that blogs support features such as, image, sound and video, can in fact enhance the participation and may even encourage those who feel greater reluctance in participate in these reflective activities. Nevertheless one should not draw hasty conclusions, since more studies in different biomedical areas, with a greater number of students and over a period longer than are necessary.

We also came across with a qualitative study, conducted by Melissa Tan et al. (2010) who aimed to determine the impact of blogging on the clinical reasoning of physiotherapy students. With a sample of 83 students, the authors divided them randomly in 8 groups. Each group had a tutor/moderator (faculty member), and all students were required to contribute to and participate in reflective practice discussions within their blog group for the duration of their clinical program with at least one post and comments on two of their group members' original posts per week. Data was retrieved and analyzed using NVivo®. About 475 blog posts were analyzed. Results demonstrated that the students applied a range of clinical reasoning skills categorized as collaborative; diagnostic; ethical; interactive; and procedural reasoning. Of these, 90% were procedural, ethical and interactive reasoning. The authors concluded, even though the students were dispersed across facilities and changed locations every four-five weeks, that blogging provided these physiotherapy students with opportunities to explore clinical reasoning dilemmas, in a safe space. The blog enabled the students to maintain connections with their peers and supported them in their fieldwork practice. This apparently promoted the development of metacognition at both an individual and collective level. This research indicates a promising result, that blogging can be used to promote learner self-discovery and to assist self-regulated learning in biomedical science. Evidence suggests that blogs help to create connections between students with diverse opinions and interests. This encourages critical thinking and teaches the value of respect towards other students' points of view. Discussions in blogs may also promote higher levels of thinking, because people can think before answering back. They can be used for individual students, or for groups, fostering collaborative learning. Some limitations were however addressed by the authors, of the studies reviewed, but they were attained as ways to improve the experience, and none of them could theoretically diminish the main conclusions.

Wikis

Wikis are increasingly being used as means of sharing and communicating medical knowledge. The Medpedia Project, is a good example of an up-to-date, unbiased medical information repository, maintained by health experts from all around the world, and of free access (Park, Crocker, Nussey, Springate, & Hutchings, 2010). The use of wikis is quite common in other educational levels (K-12). But their potential is already being discovered by faculty members. The use of wikis (as tools for group authoring and collaboration) in biomedical education has substantial applications. Often group members collaborate on a document by emailing to each member of the group a file that each person edits on their computer, and some attempt is then made to coordinate the edits so that everyone's work is equally represented; using a wiki pulls the group members together and enables them to build and edit the document on a single, wiki page (Parker & Chao, 2007). Students can even use a wiki to develop research projects, with the wiki serving as ongoing documentation of their work, build a collaborative annotated bibliography or develop map concepts. Wikis can also be useful for brainstorming, and editing a given topic, to produce a linked network of resources. Teachers can also use wikis as a knowledge base, enabling them to share reflections and thoughts regarding teaching practices, documentation or presentation tool in place of conventional software. The use of wikis, is one of the most documented, with a total of 10 articles retrieved, ranging from theoretical works (Younger, 2010), to instructional design and assessments' (Miller et al., 2009), (Ros-Rodriguez et al., 2011), (Boutin & Therriault, 2011), surveys (Mirk et al., 2010; Miller et al., 2012) study protocols (Archambault et al., 2010) and mixed studies (Varga-Atkins et al., 2010) . There are even studies associating Wikis to Blogs (Billings, 2009),(Grassley & Bartoletti, 2009), (Sandars et al., 2008) and Podcast (Mathieu, 2007), (Boulos et al., 2006) however, all of them are theoretical works, in several biomedical areas. Even teachers are discussing the use of wikis to promote and update study materials for their students (Rodríguez, Carrillo, & Alvarez, 2010). Focusing on instructional design and assessments', Miller et al. (2009) described their use of wikis in Advanced Pharmacy Practice, with an overall student answers with more 90% of respondents

either strongly agreeing or agreeing that wikis helped reinforce concepts and ideas and that they enjoyed working with wikis. Within the same study type, Ros-Rodriguez et al. (2011) recently published their experience in the development of a Virtual Classroom of Pharmacology. Using wiki utilities the students had to transform an initial pdf outline to a wiki format. The students had to create or edit one wiki for each lesson outline and to include hyperlinks for the main concepts to additional material located in the "Virtual Classroom of Pharmacology" and had also to create a glossary with those terms. The student involvement in the task led them to relate, integrate and assimilate the knowledge about those particular aspects of pharmacology. Besides, the authors conclude that the generation of these materials reinforced the learning and promoted work as a team. Also in instructional design and assessments, Boutin & Therriault (2011) presented a pedagogical experience in an Occupational Therapy program that used a wiki to enable the learner to become a" knowledge producer and actor of hi/her learning"(Boutin & Therriault, 2011). The authors targeted three courses, each with different objectives intended for the wiki. Following application of the wiki, the degree of satisfaction of students and professors and the impact thereof on the acquisition of skills was evaluated through an online survey. The published results, from both student and faculty, seem to indicate that using a wiki as a learning tool contributes to the acquisition of knowledge and the development of skills in this new competency-based program of occupational therapy.

On a different approach, Llambí et al. (2011) developed a quasi-experimental model in which they designed and implemented a blended-learning course on tobacco cessation. Three hundred thirty-five health professionals participated in the course. Of these, 145 attended the on-site workshop, 216 participated in the online activities, and 109 completed both phases. When comparing pre and post test scores, the authors found a statistically significant difference among those who completed both phases compared with those who only did the online phase ($p = .003$ and $p = .009$, respectively), demonstrating that wikis, could be a useful tool in promoting continuing education activities for health professionals. We must however mention that tests were completed by a minority of the participants, since fewer than half performed the pretest and fewer than a third completed both and allowed paired analysis. The fact that tests were not compulsory became a weakness of this study. Using a mixed approach, Varga-Atkins et al. (2010) tried to discover whether the use of wikis could enhance medical students' development of professionalism. Using both survey and interviews, 32 students were questioned. The authors described that the wikis helped students finding, compiling, evaluating and sharing resources related to their learning objectives on professionalism. Secondly, it was demonstrated by the study that the online wiki spaces could have a role in enhancing students' development of "professionalism in a wider sense". Although, using quite a small sample and limited time span, this is a pioneer study, which can be a launch base for more broad research in several subjects of biomedical education. More outcomes are expected as Archambault et al. (2010) develops also a mixed study on the use of wikis. The authors published the study protocol for the mixed study, that aims to develop and test the metrological qualities of a questionnaire for the assessment of healthcare professionals' intentions and the determinants of those intentions to use wiki-based reminders that promote best practices in trauma care. This promising work may contribute even further for the use of wikis in biomedical and health education.

The only survey type study regarding wikis in biomedical education at this point is the research conducted by Woulfe et al. (2009). The authors applied a "wiki approach" to Master of Pharmacy students at The University of Sydney. Normally these students were required to submit a series of group-generated PBL cases. However faculty members often reported a fragmented approach and a lacking in "patient-focus". After a successful pilot study in 2007, the authors introduced a wiki format, with a view to encourage a whole patient approach to the task. A total of 38 students were divided into 6 tutorial groups in each semester, producing one PBL case summary per group per week for a total of 10 weeks. In the first semester, students were required to submit their case summaries on paper. In the second Semester, they were required to write their case summaries in a

wiki. The results are not favorable to the study objective. The technical difficulties reported by students appear to have greatly affected the quality of their case summaries, as well as influenced their perceptions of the wiki. This increases the awareness of educators for the necessity for training in the use of the wikis, before instructional changes.
We also introduced a "wiki iniciative" in our own pharmacotherapy course (Jesus, Gomes, & Cruz, 2012, 2013), mainly as an e-portfolio for the students, in Wikispaces. The choice of platform was based on the capabilities provided by the same level of editing (integrating text, images, links, videos, audio, documents, presentations and other features embed), the issue of privacy and access and log edits, and you can follow in detail the contributions of each group member. Students should produce a new page for each case would be presented with only one case per week. In total 20 were developed e-portfolios with different characteristics. A systematic analysis of the contributions made by the students allowed the observation of commitment and motivation from them and formed the basis of a quantitative evaluation.

Microblogging

Microblogging is the practice of posting small pieces of digital content on the Internet (EDUCAUSE, 2009). Microblogging has become popular among groups of friends and even professional colleagues who frequently update content and follow each other's posts, creating a sense of online community (EDUCAUSE, 2009). Although literature about this Web 2.0 tool is still in its infancy, we uncovered two theoretical studies in nursing education(Skiba, 2008), (Bristol, 2010) , and four studies relating the use of Twitter® in Pharmacy Education (Fox & Varadarajan, 2011; Bussières et al., 2012; Camiel et al., 2014b, 2014a). The first study describes implementation and effectiveness assessment of Twitter® use, in encouraging interaction between faculty members, guests, and students in a pharmacy course taught simultaneously on 2 campuses. Students were required to tweet a minimum of 10 times over several class sessions. The course instructor and guest professionals also participated but no limit of tweets was established for them. One hundred forty-three students were enrolled in the course: 119 in one campus and 24 at the satellite campus. Course requirements were the same across campuses. The Twitter® activity, was worth 2% of the grade. Students were also given an opportunity to earn 5 bonus points by completing an online, anonymous evaluation of the Twitter® activity. The results presented by Fox & Varadarajan (2011), indicate that more than eighteen hundred tweets were made by students, guests and the instructor. Students tweeted most frequently with each other and found value in reading each other's tweets. From the 131 students that completed the optional evaluation survey 71% percent indicated that Twitter was distracting, 69% believed it prevented note taking, and more than 80% indicated that it facilitated class participation and allowed an opportunity to voice opinions. These results led the researchers to conclude that the use of Twitter in pharmacy courses (or any other biomedical course) balanced the potentially positive aspects of the technology, such as increased interaction among students, with potentially negative aspects, such as the interruptive nature of Twitter® use and the large volume of tweets generated by assignment. Far from extolling the benefits of Twitter®, this study shows clearly and objectively the results obtained, even if they do not translate into a steadfast discovery the potential of microblogging. The study design, the number of professionals involved and the methodological description shows a high robustness, which can definitely be a starting point for other researches or experiments in the biomedical classroom.
In 2012, Bussières and colleagues (2012), examined the use of Twitter in a first-year pharmacy law course , as a backchannel. Backchannel is an electronic discussion that occurs simultaneously in real time during a lecture or conference where students may post questions, comments, or respond to other posts. The authors compared the frequency of questions either through Twitter or hand-

raising. Of 200 students, only 8 asked questions using Twitter vs 30 questions with hand-raising. Despite the authors' feelings that the use of Twitter was a failure, students reported that backchannel allowed those students to express themselves who otherwise might not have. The idea of using Twitter as a backchannel was also pursued by Camiel and colleagues (2014a). In their paper, the authors describe the use of Twitter in a "large required, lecture-based, team-taught nonprescription drugs/self-care products course". The students were remineded students at the beginning of each lecture that backchannel was being used. The feed was continuasly monitored, and after class, responses to unanswered questions were posted on the course learning-management system discussion board. The author promoted a survey at the end of the year, where 266 students completed an anonymous voluntary survey, where thirty-nine percent (and 40% neutral) felt that being anonymous to their classmates was important to them. In their written comments, a number of students commented positively about not needing to raise their hand to ask a question in front of the entire class.

In more recent article, the authors (Camiel et al., 2014b) explore the use of Twitter for the building of a personal learning network. Although the initial results showed a high percentage of students (36%) that were not confortable using Twitter, and even considering that the use of a personal learning network was a new concept, the final results were very promising, with more than 50 % students planning to continue using Twitter as a social network.

One must consider that as diverse as microblogging may be, it has some shortcomings. Although microblogging promotes writing and editing as fun activities, and therefore may be used in informal learning (Ebner, Lienhardt, Rohs, & Meyer, 2010) there is the possibility that students get distracted and carried away during ongoing lessons due to microblogging with their mobile phones. Not only is this addiction harmful to their education but it is also disrespectful to the teachers or lectures. Further, educators insist that due to microblogs being limited to adopting 140 characters for message updates, it could potentially lead to bad grammar usage by students (Grosseck & Holotesku, 2008).

Google Apps and Similars

The use of Google Apps or other similar applications isn´t particularly widespread in Biomedical Education. Only one study (Phadtare et al., 2009), using GoogleDocs® was retrieved. With a heterogeneous sample of 48 participants (from a medical, nursing and physiotherapy background from US and Brazil) randomly assigned to two groups, the authors proposed to compare on-line vs. traditional classroom-based methods for teaching scientific writing. In the on-line group, participants used virtual communication, GoogleDocs® and standard writing templates, and in the standard group participants received standard instruction without the aid of virtual communication and writing templates. Outcome variables consisted of manuscript quality and self-reported participant satisfaction. The quality of each manuscript was evaluated according to well-defined parameters using a scale. The obtained results suggest that the on-line scientific writing group performed significantly better than the standard writing guidance group in terms of writing quality. They also reported greater overall satisfaction and a greater number of participant-mentor communication events. The authors agree that the use of GoogleDocs® enhanced participants' familiarity with this method of collaboration, as well as improved the mentors' efficiency. Although being a study with several statistical procedures and high strength study design, Phadtare et al. (2009) also address the problems associated with using imperfect measurement scales, which can be prone to subjective bias. The authors also reflected on the lack of tools to objectively evaluate manuscript quality and participants' self-assessment, which makes it difficult to interpret the results of this type of study. Several other factors are also pointed out, as possible influences, including participants' previous experience with on-line courses, their grades, computer competency, and interaction with the system in question, as well as the instructor skills and the presence or absence of supervision.

Virtual Worlds

Virtual worlds, such as Second Life®, are described as online computer-based simulations where the user is given the impression of being in another place/location through replications of real life objects(Honey et al., 2009). Second Life® enables learners to manipulate information and synchronously interact with other people, via a digital representation, also known as an avatar (Rogers, 2009). Virtual worlds, like Second Life®, have the ability to create an artificial social structure where problem-based scenarios can be created and developed, allowing students to actively (co) construct mental models of technical and interpersonal skills (Dickey, 2005). While some literature discusses the biomedical educational uses of Second Life® in positive terms (Boulos et al., 2007,,Kirriemuir, 2008, Hansen et al., 2009) citing its ability to support interaction and collaborative learning there is little research about actual projects. Our research retrieved one instructional design and assessment study, one qualitative study and one survey type study. Rogers, (2009) proposed to discover how virtual world simulations can assist nursing students developing characteristics and skills essential to future roles as healthcare professionals. In order to accomplish his goal, the author compiled a series of investigative interviews that researched the attitudes and experiences of a sample of sixteen nursing students enrolled in a Bachelor of Nursing Program, who were previously exposed to six simulated clinical scenarios created in Second Life. Students were placed into groups based only on their year level and exposed to the simulation in separate locations to replicate the intended purpose of the simulation (Rogers, 2009). The students agreed that the simulation in Second Life assisted them in the development of technical and non-technical skills and in most cases the students found the technology quite easy to use. Also, the online simulation enabled the students to collaborate and solve the scenarios as a team (even though they were isolated in the real world), allowing students to actively co-construct technical and interpersonal skills (Rogers, 2009).

Also in nursing education Honey et al. (2009) conducted a pilot study based around a simulation of a woman having a postpartum hemorrhage. The focus of the scenario was on recognizing abnormal presentation in a postpartum assessment, nursing interventions for hemorrhage, and communication among health care professionals. Although the project led to significant publication on technical issues and simulation development in Second Life, results about student's participation as assessment are scarce and insufficient for a detailed analysis. With a more structured approach, but with a different objective Wiecha et al (2010), proposed, designed and delivered a pilot postgraduate medical education program in Second Life. They enrolled and trained 14 primary care physicians in an hour-long, highly interactive event in the virtual world on the topic of type 2 diabetes. Participants completed surveys to measure change in confidence and performance on test cases to assess learning. The post survey also assessed participants' attitudes toward the virtual learning environment. On a seven-point Likert scale, participants' mean reported confidence increased from pre to post online event with respect to insulin selection, initiation and dose adjustment on test cases, the percent of participants providing a correct insulin initiation plan increased from 60% pre to 90% post. All participants agreed that this experience in Second Life was an effective method of medical education, that the virtual world approach was superior to other methods of online education. Although these last conclusions are in fact favorable, most of the results retrieved show that insufficient evidence is still available about the potential of Virtual Worlds in Biomedical education.

There are also potential problems with using a virtual world as an educational tool. It's not intuitive, it contains many types of environments, some of which are inappropriate for educational and professional uses. Non-student avatars may appear in student locations, and some of those avatars can manipulate and even act aggressively toward others. Nevertheless, where problems arise, the teacher must see ways to overcome them. The careful planning of activities, and an on-demand technical support, are undoubtedly two features to keep in mind while developing an online

educational experience in virtual worlds. Further research is also necessary to investigate the attitudes of students towards technology-supported learning and to identify and further explain links between the students' personal online practices and their experiences in Virtual Worlds. Moreover it is advisable to demonstrate real, quantifiable outcomes (with large number of students) of these types of interventions in order to objectively assess their impact on student learning.

FUTURE RESEARCH DIRECTIONS

Despite the great deal of opportunities for the implementation of Web 2.0 applications within higher education, there are several challenges that are not permitting a widespread use. These include finding faculty members who are willing to accept change and adopt new pedagogical approaches. Increasing faculty members' acceptance of these new tools may require efforts at improving the perceived usefulness and benefits of the applications (Cain & Fox, 2009). Institutions have great deal of power on these challenges, and the role of leadership and management is crucial in promoting short-term workshops/seminars to increase informatics literacy and promote pedagogical innovations/adaptations. Another aspect to consider, especially in survey studies is standardization. Standardization provides survey research with some of its great strengths, because standardization makes it possible to seriously consider surveys as measurement tools (Beatty, 2001). Studying students is always difficult and always involves subjectivity, but the potential for measurement gives survey research great scientific credibility. It also allows for efficiency in handling data, provides for clear quality control criteria, and minimizes random error introduced by the interviewer (Beatty, 2001). Validating these instruments can take long periods of time but it will benefit outcomes and the validity of the conclusions.

All the conclusions and results presented in this chapter are about professionals who are trained in several types of methodologies and study designs. They must know how to perform and assess studies like clinical trials and other experimental studies that have strong design strength. Similarly, studies performed in order to assess the impact of Web 2.0 tools in Biomedical Education need to follow the same principle. We are aware that we cannot be so straightforward in Educational Sciences, but there are options and ways to better control and predict threats to the study conclusions, giving more strength to our results. IDEAS studies and surveys have their role in creating evidence, but quasi-experimental studies and qualitative studies can provide a stronger, wider and more reliable research. The privacy issue has also arisen during the use of Web 2.0 tools, with focus in wikis and blogs. The issue can be easily controlled, if blogs are password protected, or accessed by invitation only, and if wikis are developed inside LMS Systems, like Moodle and accessible only to members. This will also avoid vandalism and promote student participation (Boulos et al., 2006). Nevertheless an active tutor role is required in order to readily access, edit or comment on new materials posted by students. Last but not least, the technical difficulties felt by students in some of the studies referred are an alert that, although we live in a society of information, maybe we need a little more care in educating our students about these technologies in order to truly benefit from them.

Indeed, Web 2.0 tools and applications have a powerful place in instruction and in the classroom, but caution is warranted regarding the strategies used. Instead of beginning instructional planning with these tools in mind, the learning objectives and instructional strategies should guide the adoption process. An awareness of the different tools gives faculty members additional mechanisms from which to choose, but selecting an appropriate instructional strategy is even more important.

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KEY TERMS & DEFINITIONS

Web 2.0: Web 2.0 is a loosely defined intersection of web application features that facilitate participatory information sharing, interoperability, and user-centered design.

Podcast: is a type of digital media consisting of an episodic series of audio files subscribed to and downloaded through web syndication or streamed online to a computer or mobile device.

Vodcast: is a type of digital media consisting of an episodic series of video files subscribed to and downloaded through web syndication or streamed online to a computer or mobile device.

Blog: is a kind of journal published on the World Wide Web consisting of posts typically displayed in reverse chronological order so the most recent post appears first. Blogs are usually the work of a single individual, occasionally of a small group, and often are themed on a single subject.

Microblogging: Micro blogging is the practice of posting small pieces of digital content on the Internet

Wiki: is a website whose users can add, modify, or delete its content via a web browser using a simplified markup language or a rich-text editor. Most are created collaboratively.

Virtual Worlds: are described as online computer-based simulations where the user is given the impression of being in another place/location through replications of real life objects.