

Web Technologies and Tertiary IT Education: A Case Study

Yogesh Deshpande

School of Computing, Engineering and Mathematics

University of Western Sydney

Locked Bag 1797, Penrith, NSW 2751, Australia

+61246203233

y.deshpande@uws.edu.au

ABSTRACT

The theme of the workshop on Emerging Web Technologies: Facing the Future of Education potentially covers a broad spectrum: schools, universities and other educational institutions; academic disciplines; pedagogy; administration; innovation; and, most importantly, the people involved, viz. students, teachers, administrators and, at a remove, parents and society at large. It is therefore necessary to define at the outset how much of this spectrum one wants to cover. This paper reports on efforts and experience of a group of academics in computing in a university who have used the Web as an emerging technology, from 1996 onwards, specifically in terms of how it affected the delivery of education at tertiary level. The paper describes initiatives that led to changes in curricula, pedagogy including assessment strategies and techniques, and administration of students and courses. In innovation terms, the initiatives started at individual levels and gathered momentum before the developments were adopted at a collective level. On the way, there were several lessons to be learnt. In chronological order, creation of a faculty Web site led to insights in introducing new subjects at undergraduate level and online delivery of educational material undertaken by a few academics, the 'innovators'. That generated pressure on others to emulate the effort, some of whom became 'early adopters', leading to demands from them for easy procedures to meet the demands from both students and administration. The overall experience over a few years forced the recognition that undergraduate students were ill-prepared to analyse and understand the implications of the emerging technologies. The outcome was the introduction of a specially designed postgraduate programme in IT with Web Engineering as a specialisation. Pedagogically, the emphasis shifted from quizzes and examinations to project work over a semester, at times continuing on to another semester. New technologies were introduced as assignments, short projects and group projects. Teaching and learning strategies dealt with practical matters such as creating Web sites and Web applications, performance analysis, security and social and legal issues. Finally, students were encouraged to 'innovate' using newer technologies, in a fairly well-directed manner by the academics. The paper reports on these initiatives resulting from the Web technologies and contrasts them with the

latest developments where student cohorts have started to create content themselves. In addition to the lessons learnt, a tentative conclusion is that the initiative to use emerging technologies in furthering education may henceforth be led more by students unless specific strategies are devised by the academic world.

Categories and Subject Descriptors

K.3.2 [Computer and Information Science Education]: Computer Science Education, Curriculum, Information Systems Education.

General Terms

Management; Human Factors.

Keywords

Emerging Technologies; Curriculum; Pedagogy; Project-based learning; Innovation.

1. INTRODUCTION

Introduction of Web technologies as an innovation in teaching and administration at the University of Western Sydney (UWS) started in 1996 as an initiative of a small group of academics in IT. Two members started the first faculty Web site within the University, followed by introduction of two undergraduate units in Web technologies. One member built an innovative application called PlatformWeb [7, 8], initially used by only a handful of academics but gradually adopted by the rest of the University. The collective experience with the Web sites, Web application (PlatformWeb), and the teaching led to the realization that the emerging technologies were seen by the computer science community in fragments that belonged to networking or programming or distributed computing but not as a whole, or a new area. Web Engineering [3, 4, 5, 6, 9] as a discipline at UWS came out of these experiments with the then emerging Web Technologies. Although Web Engineering took major inspiration from Software Engineering, annual workshops at the WWW conferences from 1998 to 2003, ICSE in 1999, 2000 and 2002, and as a stream on its own at WWW conferences from 2003 and other conferences over the years helped to establish it as an emerging discipline, finally acknowledged as such by the ACM-IEEE panel on curriculum.

The focus of this paper, Web Technologies and Tertiary Education in IT, is thus a subset of the broader and ambitious themes of the workshop on Emerging Web Technologies: Facing the Future of Education. Even so, our overall experience covers or touches upon pedagogy and curriculum to deal with the emerging Web technologies, content creation, youth and digital culture,

emerging knowledge society, new media, sharing knowledge and expertise, creativity, teamwork and collaboration skills within multidisciplinary networks.

The paper is structured as follows. Section 2 sets out the scope of the paper. Section 3 describes our work and relates it to various sub-themes. Dealing with emerging Web technologies directly implies innovative work. Section 3 also draws upon the work done on diffusion of innovations [10] to highlight the role of innovators. The description and discussion in Section 3 lead to formulation of eight propositions. Section 4 gathers the propositions in one place and reviews them in the light of related work elsewhere. Section 5 concludes the paper.

2. SCOPE OF THE PAPER

Each of the two constituent parts of the workshop theme, viz. emerging Web technologies and education, covers a very large area. Within education, this paper restricts itself to the tertiary sector (undergraduate and postgraduate levels), and the discipline of IT. It may be possible to generalize from what we have learnt to benefit other disciplines and correlate that with the work carried out elsewhere. That is out of scope here. As mentioned above, the paper also touches upon innovation and the role of innovators within an institutional context. Within this remit, the paper covers pedagogy, curriculum development and student administration. The pedagogical considerations include “growing need for creativity, teamwork and collaboration skills within multidisciplinary networks in order to solve the kind of problems faced by an increasingly complex world”, content creation, sharing knowledge and innovative strategies.

The paper does not go into any detail of youth and digital culture or new media or advantage or disadvantages of tagging, social networking or collaborating through Web 2.0-related activities.

On the technological front, the paper describes our experience of what makes for their successful adoption. The strategies have been borrowed from the general understanding of diffusion of innovations. They are still applicable to the current lot of emerging Web technologies, albeit with some caveats.

3. CASE STUDY

3.1 Background

University of Western Sydney is a medium sized university in Australia (about 20,000 full-time equivalent – FTE - students and 2,000 staff of whom about 900 are academics). In 1996, UWS was a federated university with three members. Our work started in what was then UWS Macarthur. Department of Computing and Information Systems had approximately 16 staff members and 600 FTE students. The university unified in 2001 and has since undergone several structural changes which are irrelevant for this paper. The major work in dealing with the emerging Web technologies, reported here, was carried out between 1996 and 2000.

3.2 Dealing with Emerging Web Technologies

As mentioned above, chronologically, the work started in 1996 with the creation of a faculty Web site, which allowed the interested staff members to get well acquainted with some of the new technologies. Web technologies at that time were not part of the IT curriculum in any course. We thought that this should be remedied even though our colleagues more inclined to Compute Science perspective did not agree that Web technologies were

anything special. In fact, they regarded HTML as below par, not being a ‘programming language’ and Web site creation as a frivolous activity. Nevertheless, we were able to introduce two new subjects in 1997 at the second and third year undergraduate courses in IT to teach the new technologies. We formed a research group, Web-based Information Systems and Methodologies (shortened to a now-pretentious sounding acronym WebISM) which again met a lot of resistance from our IT colleagues but better reception from non-IT researchers and the Dean of the faculty. One of the group members took the initiative to create an application, called PlatformWeb, for online delivery of content, quizzes, and student administration, for his own use in second half of 1997 (see section 3.3 below).

With the new subjects, we discovered that students did well technically but could not grasp the social, legal, security and other implications of the Web. Being students in IT courses, they did not even relate well to the *raison d’être* of the Web, viz. delivering information to users anywhere in the world. Technical wizardry does not correlate, either positively or negatively, with deeper understanding of other issues. A more mature level of students was required to do full justice what the Web technologies could do. That led to the formulation of specialised course in Web Engineering, first delivered in 1999 [5] (see section 3.4 below).

The state of Web development within the University during this period was not uniform. The library had a well-developed site, independent of the other units, including the centralized IT services which themselves maintained a very simple Web site for the University. Other faculties lagged behind in their Web development.

The description above leads to the first proposition.

Proposition 1: Sociology of the Emerging Web Technologies -The potential benefits and drawbacks of the emerging Web technologies are unlikely to become easily apparent to people and organizations. People bring different foci, at times radically so, rooted in their disciplines and roles within organizations, which affect the take-up of the technologies.

3.3 PlatformWeb and Innovation

PlatformWeb was essentially the creation of an enthusiastic academic, who had also become an expert in the relevant Web technologies. He created it strictly for himself although, like any enthusiast, he was more than willing to share it with others. A few other staff members discovered it through the grapevine, found it useful, asked for a few more features and the project grew. We canvassed UWS Macarthur for support, gave a demonstration to the top-most hierarchy and secured limited funding for further development with a view to its university-wide adoption. From 15 members in the first half of 1998 using PlatformWeb, the numbers grew on a voluntary basis, semester by semester to 55 (1999/1), 220 (1999/2), to 430 in the first half of 2000, across the university. This was our direct experience of how an innovation might take off [7, 8, 12].

Emerging technologies, by their very nature, are unfamiliar to the population at large. They have to be taken up by the so-called ‘innovators’ and ‘early adopters’ for it to spread. Even the viral spread of social Web demonstrates this phenomenon, albeit at a much more rapid pace than in the first decade of the Web. Proposition 2 encapsulates this.

Proposition 2 - Innovative applications exploring the potential benefits of the new technologies are crucial in persuading others to adopt or facilitate the adoption of such technologies. As well, the support has to be generated from the top level of the organizational hierarchy.

There are three striking differences, in terms of speed of adoption, content creation and speed at which the new technologies arrive, between the model of adoption referred to above and how the current crop of emerging Web technologies are spreading.

The new trend in adoption is far more individualistic and faster than any organization can cope with and manage to match. Organisations, of whatever size, lag behind the individuals and, especially, the younger, net-savvy generation. Research in innovation diffusion and its validation, for us via PlatformWeb, point to the centrality of an institutional or organizational perspective, a position that is still relevant. We, therefore, have a fairly obvious proposition to consider.

Proposition 3: In the new technological world, where millions of users take to some emerging technology, and also desert it, and where the technologies themselves take time to mature, adoption by organisations is necessarily going to lag behind the users.

The implications of this proposition in terms of which emerging technologies to concentrate on, resource allocation, training and changes to work practices need to be thoroughly analysed.

The second major difference is that a majority of users are creating content for themselves and their social circles. This contrasts with our experience with PlatformWeb which allowed creation of content by relatively smaller fraction of the population (the academic staff) for its delivery to a much larger number of passive users (the students). Dealing with user content and incorporating it in educational practices is a completely new area for most academics. Proposition 4 captures the problem.

Proposition 4: The net generation creates content for itself, for immediate use, and in small chunks. To take advantage of their spending time online, in terms of teaching and learning, the appropriateness of delivery modes and the size of learning modules delivered are open questions.

Proposition 4 raises the questions about how Social Web, multimedia and other developments could be effectively used. The way Powerpoint has replaced conventional notes is indicative of what is convenient and what is effective.

The third major difference is the higher speed than before at which new (Web) technologies arrive. Effectively, we took about three years before PlatformWeb matured and before Web Engineering curriculum was formulated. This period allowed the academic staff to master the Web technologies ahead of (most of) the students. Now, students have the latest gadgetry and experiment with the new applications constantly. On the other hand, academic staff, the 'older' generation collectively, is comparatively less knowledgeable and less familiar with the emerging technologies including the ways in which their personal lives could be affected or enriched. The fifth proposition is about the effective way to bring the older generation up to speed.

Proposition 5: In the academic world, it has been generally left to individuals to 'pick up' and 'learn/master' new technologies, techniques and other developments. This laissez faire policy is too arbitrary and ad hoc. It is unlikely to match in speed the way the net generation picks up the emerging technologies.

If the problem of uneven speeds of technological uptake is not tackled successfully, there is a real danger that students would come to see their teachers as belonging to the 'stone age' with consequent loss of willingness to learn from them.

3.4 Curriculum Development and the Emerging Web Technologies

The curriculum development for the Web technologies and Web Engineering has been reported in several places, over the years [3, 4, 5]. At present, UWS School of Computing, Engineering and Mathematics has five subjects at the undergraduate level and a major covering Web technologies: Technologies for Web Applications, Web Systems Development, Web Application Development, Developing Web Applications with XML, Java programming. Undergraduate students also study Human-Computer Interaction and do a capstone project in their final year, a majority of which are Web sites, Web applications and mobile applications. The master's course has a specialization in Web Engineering, going back to its start in 1999. All the courses undergo periodic reviews and changes. For the latest description of Web Engineering curriculum, see [5].

The relevant question here is how do we incorporate the emerging Web technologies in any curriculum? For all the expertise and the ease with which the net generation deals with them and uses them in innovative ways, they will not be able to effect the desired changes in any curriculum. Philosophically and practically, curriculum development is entirely within the province of the academic staff and the educational institutions. It is unlikely that, at least in the short term, students will know what should be included in the curriculum and how. This may change, however, if students get so far ahead in technological terms that they demand suitable adjustments to the curricula, aligning the fundamental knowledge with the practical technologies they use. In any case, there is potentially a serious problem in getting the older staff up to speed on the emerging technologies. Proposition 6 is not new to academics. In fact, there is a constant movement in creating relevant and new curricula across the world.

Proposition 6: It is an open question as to when and which technologies should be regarded as sufficiently mature for their inclusion in appropriate curricula.

3.5 Pedagogy and the Emerging Web Technologies

While students are unlikely to be active in curriculum development, they could very well demand major changes to the delivery of content and the assessments they have to complete. The changeover within UWS from PlatformWeb to WebCT to Blackboard (which has bought WebCT and discontinued some popular, easy to use features) did displease both the academic staff and a large body of student cohort. Facebook, Twitter, Google Groups and Documents, Dropbox and other new technologies are gaining in use, both for student projects and exchanging information. A side effect of the new technologies, such as smart phones, is that it is now easy to cheat during examinations and online quizzes. Apart from banning use of such devices and online help, it is not uncommon to find examinations being conducted in the old fashion when students have to write in long hand. Ironically, most students, and teachers, have lost the art of writing well and quickly in long hand, leading to poor

performances. Proposition 7 is about learning new modes of delivery.

Proposition 7: Students are likely to expect different ways of content delivery, in tandem with their own use of technology. Academic staff will need to be pro-active in using different technologies for content delivery.

There is already a movement across the university sector to appoint staff experienced in the new modes of delivery, as academic advisors. Examples of best practices are also collected and made available to the staff.

At UWS, we have moved on from end-of-semester examinations to multiple assignments, quizzes, short and long projects, as appropriate, depending upon the subject being taught. Assignments and projects frequently involve students learning a completely new topic or some latest technology that would not be covered during the regular sessions. Students then have to present those topics to the class in the form a tutorial as well as a report with full instructions on what to do should another student get interested in a particular topic and must therefore start from the beginning. In this way, many more topical themes are explored; students learn to search for and use the available materials from the Web, experiment with them and present them in an intelligent way.

Projects are also mostly done in groups. Collaborative learning, life-long learning and understanding and handling group dynamics are part of these projects.

Proposition 8 is about this part of pedagogy.

Proposition 8: Assessments cannot be about rote learning or only whatever has been covered during the regular teaching sessions. Students are likely to remain ahead of the academic staff in using the emerging Web technologies. New teaching strategies are needed to turn their collective expertise as users into a systematic body of knowledge and practice which engage the students.

Proposition 8 is not new in itself. However, it is necessary to acknowledge it explicitly.

4. THE 8 PROPOSITIONS AND RELATED WORK

Constant review of one's discipline and incorporation of new knowledge form an integral part of an educationist's brief. This paper has attempted to encapsulate our experience over a 16-year period into workable propositions. In a similar way, thousands of academics all over the world have dealt with and continue to address the problems of coping with the emerging Web technologies. This section contains a brief review of some of the published work and relates that to our experience.

The review is based on a selection of papers from two of the largest conferences, SIGCSE and ITiCSE, for years 2010 and 2011. The selection is not entirely arbitrary. Approximately 300-350 papers were presented during these conferences. They covered all the areas in Computer Science as well as innovation and technology in CS education. Of these, 38 papers related to the Web technologies in CS education. A full list of these references is available with the author. It is skipped in this paper since it will only add to the bulk without much enlightenment.

A caveat is in order here. These conferences are about CS and education. It can be safely assumed that there would be relevant

papers from other non-IT conferences as well as journal publications. As mentioned before, a comprehensive review of the relevant literature is beyond the scope of this paper.

The 38 papers consulted can be broadly classified under three headings: i) tools; ii) technologies; and iii) curriculum and pedagogy. In general, most of the papers devoted themselves to one of the three categories although there were some which addressed more than one area. Contributions to each area are briefly described below.

Tools – Nine papers could be classified as coming under tools. Their titles mostly reflected the authors' efforts to create new tools and the experience of using those tools. Tools are essential to make the new Web technologies work for everyone, not just the enthusiasts or specialists. Content Management Systems (CMS) are a good illustration for this. Just over ten years ago, CMSs did not exist. Everyone who wanted to create Web sites had to learn (X)HTML, CSS, JavaScript and server side scripting in a language of their choice. They also had to be reasonably comfortable with databases and associated scripting. Overall CMSs have now reached a stage where a lot of these details are behind the scene, leaving non-experts to create what they want. In a similar way, various frameworks, such as JavaScript, PHP, .Net, have taken on the responsibility of enabling users to create Web sites and applications quickly while, at the same time, mostly sticking to the Web standards. This is a positivist view of various developments. There is also a downside to this, the main ones being the learning curve(s) associated with each framework and the trust one must repose in the efficacy of those frameworks.

There is another reality for the tools. They come and go, they are well maintained or not, or abandoned, they are overtaken by the latest developments. PlatformWeb is an example of all these traits. Created by academics, it was not well supported and could not be maintained in spite of its high popularity with academics, administration and students.

The analysis above points to both the importance of creating and evaluating all types of tools but it also lays out the limitations of those tools. In terms of the propositions, attention to tools, while absolutely essential, misses out on the main thrust of propositions 1 to 3 and 5.

Here, it is worth collecting all the propositions in one place for a quick summary and reference.

Proposition 1: Sociology of the Emerging Web Technologies -The potential benefits and drawbacks of the emerging Web technologies are unlikely to become easily apparent to people and organizations. People bring different foci, at times radically so, rooted in their disciplines and roles within organizations, which affect the take-up of the technologies.

Proposition 2: Innovative applications exploring the potential benefits of the new technologies are crucial in persuading others to adopt or facilitate the adoption of such technologies. As well, the support has to be generated from the top level of the organizational hierarchy.

Proposition 3: In the new technological world, where millions of users take to some emerging technology, and also desert it, and where the technologies themselves take time to mature, adoption by organisations is necessarily going to lag behind the users.

Proposition 4: The net generation creates content for itself, for immediate use, and in small chunks. To take advantage of their

spending time online, in terms of teaching and learning, the appropriateness of delivery modes and the size of learning modules delivered are open questions.

Proposition 5: In the academic world, it has been generally left to individuals to 'pick up' and 'learn/master' new technologies, techniques and other developments. This laissez faire policy is too arbitrary and ad hoc. It is unlikely to match in speed the way the net generation picks up the emerging technologies.

Proposition 6: It is an open question as to when and which technologies should be regarded as sufficiently mature for their inclusion in appropriate curricula.

Proposition 7: Students are likely to expect different ways of content delivery, in tandem with their own use of technology. Academic staff will need to be pro-active in using different technologies for content delivery.

Proposition 8: Assessments cannot be about rote learning or only whatever has been covered during the regular teaching sessions. Students are likely to remain ahead of the academic staff in using the emerging Web technologies. New teaching strategies are needed to turn their collective expertise as users into a systematic body of knowledge and practice which engage the students.

Technologies – Another nine papers, in the two conferences during 2010 and 2011, referred to above, covered emerging Web technologies, such as blogs, wikis, Facebook, YouTube, Web 2.0, recommender systems, Google technologies and those that facilitate collaborative work. These are likely to be among the ones of interest to the Workshop participants. In terms of propositions, the papers address various issues of propositions 4, 6, 7 and 8. They are valuable because they report on specific experiences of their authors, which may or may not be replicated elsewhere. Nevertheless, they advance our understanding and help individuals in deciding whether a particular technology would be appropriate for them to adopt in their own deliveries and getting the students enthused.

Curriculum/Pedagogy – This combined category dominates the papers, with 20 out of 38 qualifying as one or the other. It is natural for educationists to worry and think a lot about the curriculum development, delivery of instruction and assessment of students. Tools and technologies, in this mindset and with justification, take a back seat since they are more ephemeral while imparting knowledge is the main theme. The papers are mainly aimed at other academics and the battle here is in terms of providing answers to propositions 4, 6, 7 and 8. Proposition 5 is taken for granted, reflected in the dictum, “anyone with a PhD should be able to teach any subject”, thus leaving it to individuals to pick up new areas of knowledge and gaining sufficient expertise before making changes to the curriculum and pedagogy. The general trend across much of the world whereby academics face administrative hurdles in creating new curricula and/or teaching strategies are taken for granted. Propositions 1 to 3 and 5 are thus not acted upon in a vigorous manner to counteract the inertia and the resistance to change that are inherent in any bureaucratic set-up.

5. CONCLUSION

This paper has described, reviewed and analysed our experience in incorporating the emerging Web Technologies in terms of tertiary education in IT. Our experience encompassed what can be described as Web 1.0 and some parts of Web 2.0. As part of the

analysis, the paper has formulated eight propositions which are likely to hold for other emerging Web technologies and other disciplines as well.

The area covered by the paper is only a subset of the agenda set for the workshop on Emerging Web Technologies: Facing the Future of Education. Education covers a vast number of disciplines and a wide range of pedagogy and curricula. This paper can only hope to make a small but meaningful contribution to the ambitious agenda.

A final note is appropriate here. Most of the effort to include the emerging Web technologies is still driven by the academics. In contrast to this, Campbell et al [1] describe a persona or a ‘vignette’ called Hayden, a student in a high school, whose day starts with Facebook, Google calendar, iPhone, texting and who then gets into more serious and concentrated, collaborative work in a laboratory, through which her group adds to the content of their science course.

The challenge before us is to be able to cater to such personas without adversely affecting the quality and the depth of education we deliver.

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