

## **Using Web 2.0 Technology to Enhance, Scaffold and Assess Problem-Based Learning**

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### **ABSTRACT**

*Web 2.0 technologies, such as social networks, wikis, blogs, and virtual worlds provide a platform for collaborative working, facilitating sharing of resources and joint document production. They can act as a stimulus to promote active learning and provide an engaging and interactive environment for students, and as such align with the philosophy of Problem-based Learning. Furthermore, Web 2.0 technologies can provide the tutor or facilitator with an opportunity to scaffold and assess the PBL process. However, whilst it is recognised that technology has an important role in enhancing each step of a PBL exercise, academic staff can be reluctant to use it. This paper provides some illustrative examples of the technologies that have been used to enhance, scaffold and assess PBL and their evaluation by distance learning and on-campus students at the University of Ulster. The benefits and limitations of using technology for both staff and students to support PBL are discussed.*

### **USING WEB 2.0 TO ENHANCE, SCAFFOLD AND ASSESS PROBLEM-BASED LEARNING**

It is widely recognised that technology has an important role in education. The almost universal adoption of Virtual learning Environments (VLE) by UK Universities (Browne Jenkins & Walker, 2006) in the early part of this decade was driven by a need to improve the efficiency and scalability of education, and has facilitated the delivery of flexible, self-paced education. By using a VLE to deliver core content, students could access material at a time that suited them, whilst releasing staff-student contact time for more valuable interactions. However the traditional VLE has primarily been used as a broadcast medium; replacing face-to-face didactic lectures with on-line lectures, despite the growing availability of more

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interactive web based tools both within the VLE environment and outside of it. In 2004, the term “Web 2.0” was used to encapsulate the way that the internet or “Web 1.0” could be used to promote user participation by sharing control of content, and providing richer user experiences (Anderson, 2007). An accepted definition of Web 2.0 is that it has become “a group of technologies .....which facilitate a more socially connected Web where everyone is able to add to and edit the information space“ (Anderson, 2007, p.5). Web 2.0 has subsequently become shorthand for those services such as wikis, blogs, social networks, social bookmarking, podcasting and immersive worlds which instead of providing the user with static information allows them to add their own content. The potential of the Web 2.0 environment to facilitate collaborative and constructive learning has been demonstrated (Li *et al*, 2011, Stylianou *et al*, 2008 and Klamma *et al*, 2007); however it was recognised that the use of Web 2.0 based tools does not of itself promote collaborative knowledge production but requires that the teacher uses these tools to empower students to take control of their own learning (Tambouris, *et al* 2012). The characterisation of technology use through a ‘practice perspective’ by Dohn (2009) highlights the need for educationalists to consider how the technology is actually being used, by both the teacher and the student. Similarly, Leu *et al* (2004) concentrated on the skills or ‘literacies’ that are required to effectively use these tools and the tasks that can be accomplished using them:

“The new literacies of the Internet and other ICTs include the skills, strategies, and dispositions necessary to successfully use and adapt to the rapidly changing information and communication technologies and contexts that continuously emerge in our world and influence all areas of our personal and professional lives. These new literacies allow us to use the Internet and other ICTs to identify important questions, locate information, critically evaluate the usefulness of that information, synthesize information to answer those questions, and then communicate the answers to others.” (p1572).

The five functions identified by Leu can be related to the learning outcomes which are frequently identified for Problem-based Learning (PBL). PBL is a student-centred educational strategy that empowers students, promoting their engagement in constructive learning. PBL was originally developed in the 1960’s to deliver the whole-curriculum in Medical Schools. Central to the original Medical School or McMaster model of PBL are student-centered discussions of problems in small groups (Barrows, 1996), There are no formal lectures; rather the tutor takes on a role as a facilitator, prompting with questions rather than providing information. Some forty years on PBL has been adopted and adapted by many different subject areas. Whilst the McMaster model was effective with highly motivated and experienced learners, it was recognised that less experienced students required more guidance in approaching PBL. The Maastricht or seven-step model was developed to provide students with a structure though which they could analyse the problem (De Graaff & Kolmos, 2003, Wood, 2003). In Table 1 the seven steps of the Maastricht model, have been mapped to the

literacies identified by Leu, and some examples of how Web 2.0 technologies can be used to support and enhance PBL have been provided.

Some cohorts or individual students may require additional support in the PBL environment. Scaffolds can be used to help bridge the gaps between the current abilities of the students and the intended learning goals, and should be used when it is felt that the goals would be unachievable with unassisted efforts (Rosenshine & Meister, 1992, Kim & Hannafin, 2011). Scaffolding can be an important element of the PBL process, depending on the maturity of the cohort, their previous experience in PBL and the complexity of the problem. By using Web 2.0 technologies the tutor can 'observe' the PBL process and provide support more efficiently and in a more directed manner. Table 1 includes examples of how Web 2.0 can be used to release further information, prompts or resources at various stages of the exercise or in response to particular issues.

This paper provides illustrative examples which demonstrate how technology has been used to support on-campus and distance learning (DL) students at the University of Ulster. In the first example a mind map was used to support on-campus students as they brainstorm and analyse a problem. The second case study demonstrates how a virtual world can be used to engage DL students in the social interactions that are central to PBL. The potential of wikis to support and scaffold independent learning and problem synthesis is demonstrated and the role of technology in assessment of PBL is examined. Finally, the barriers to the adoption of Web 2.0 technology are analysed and a strategy for improving staff engagement with Web 2.0 is proposed.

Seven-Step PBL Method	Leu Literacies	Web 2.0 Examples	Scaffolds
1. <b>Clarify Terms:</b> Identify all known and unknown concepts, words and phrases in the problem description	Locate information	<ul style="list-style-type: none"> <li>• Collabulary: The group can develop a collective vocabulary of terms and concepts needed to analyse the problem</li> <li>• Glossary: Develop a formal list of definitions, which can be shared within the wiki.</li> </ul>	<ul style="list-style-type: none"> <li>• Provide glossary</li> <li>• Encourage students to create their own glossary within their project workspace.</li> <li>• Prompt students to provide source of definition</li> </ul>
2. <b>Define the Problem:</b> What are the underlying issues, concepts, phenomena that need to be understood in order to solve the problem	Identify important questions	<ul style="list-style-type: none"> <li>• Mindmapping: promote brainstorming and creative thinking though visualising the problem.</li> </ul>	<ul style="list-style-type: none"> <li>• Provision of mind mapping tool can provide a prompt to structure and organise ideas and classify knowledge or it can be provided with predefined prompts.</li> </ul>
3. <b>Analyse the Problem:</b> Brainstorm the problem to generate ideas and hypothesis.	Critically evaluate information	<ul style="list-style-type: none"> <li>• Social networks: group communication</li> <li>• Wikis: Webpages produced and edited by the group</li> </ul>	<ul style="list-style-type: none"> <li>• Prompting questions can be added to wiki/ social network sites</li> <li>• Prompt students to identify personal skills and knowledge</li> <li>• Provide links to resources</li> <li>• Provide procedural assistance</li> <li>• Provide pages with title prompts (wiki)</li> </ul>
4. <b>Review collated ideas and Information:</b> Construct viable hypotheses		5. <b>Formulate Learning Objectives</b>	
6. <b>Independent Study:</b> To fill gaps in knowledge and meet learning objectives	Locate information  Synthesize Information  Disseminate Information	<ul style="list-style-type: none"> <li>• Develop folksonomy to tag information for sharing within group.</li> <li>• Provide updates to group through the wiki, share resources and definitions through creation of collabulary or formal glossary on wiki</li> <li>• Blogs: Keep a log of individual opinion, information, and/or diary entries throughout the period of independent study. This can be shared with the group, the tutor and made available for comments, or kept private.</li> </ul>	<ul style="list-style-type: none"> <li>• Tutor can comment on blogs/wikis to help diagnose misconceptions and promote evaluation of multiple perspectives</li> </ul>
7. <b>Synthesis and Reporting:</b> Share findings with the group to identify viable solutions to problem, or identify further learning objectives	Disseminate Information	<ul style="list-style-type: none"> <li>• Use wiki to publish and disseminate findings to group/ tutor.</li> </ul>	<ul style="list-style-type: none"> <li>• Prompting questions: What is presentation trying to achieve? Who is the target audience?</li> <li>• Prompt with examples of alternative reporting formats</li> </ul>

**Table 1:** The new literacies that can be afforded by Web 2.0 technology and how they can be aligned to the steps of the PBL process, with illustrative examples of the way in which Web 2.0 technology that can be used to enhance and scaffold PBL.

## **ILLUSTRATIVE EXAMPLE 1: USING MIND MAPPING TOOLS FOR STEPS 1-4 OF THE PBL PROCESS**

Concept or mind mapping was first suggested for use in organising and representing knowledge by Novak in the early 1980's (Novak & Cañas, 2006); it has been since used in a wide range of subjects and for different learning tasks and teaching methods (Daley & Torre, 2010) including problem-based learning (Alamro & Schofield, 2012 and Addae *et al*, 2012) . A number of open source mind mapping tools are available including Freemind® and X-mind®. These tools encourage students to structure the problem, integrate current knowledge and identify areas where they need to conduct research. They can also be used to identify skills within the group and assign tasks. In X-mind®, the mind map can be shared on-line, allowing members to update the group on their activities. The following example shows how a mind map was used to support postgraduate biotechnology students in the initial brainstorming of the PBL problem.

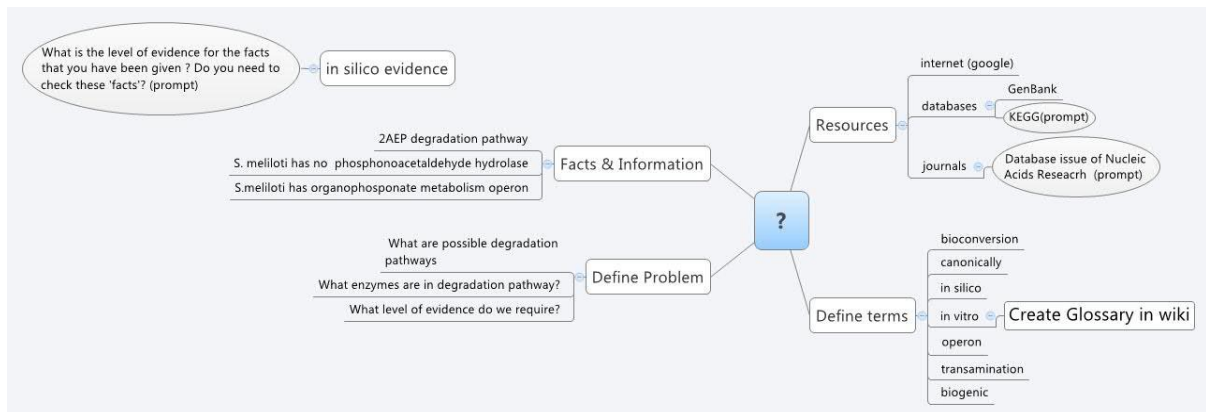
### **DELIVERING BIOINFORMATICS TO ON-CAMPUS POSTGRADUATE BIOTECHNOLOGY STUDENTS: PEDAGOGICAL BACKGROUND**

Problem-based learning (PBL) has been used to deliver bioinformatics to postgraduate students on a one year Masters programme in Biotechnology for over five years, as part of a module in Molecular Biotechnology. It was envisaged that at the end of this period students would be able to identify and implement appropriate computing, analytical or statistical solutions to solve problems in bioinformatics/systems biology and molecular biotechnology. A rich resource of challenging scenarios for PBL scenarios is the abstract databases for publicly funded research projects; several scenarios for this course have been developed from abstracts available on the Biotechnology and Biological Sciences Research Council (BBSRC) website<sup>1</sup>. A typical example of a scenario extracted from a grant application is explored in figures 1 and 3. It speculates on the presence of key enzymes required for the degradation of organophosphonates and requires that the students identify the potential degradation pathways and the associated enzymes, and then identify and search the appropriate databases. They are also prompted to consider the validity of *in silico* evidence. The students worked in groups of 5-6, the exercise included 2 x 2 hour classroom sessions supervised by a floating facilitator. The students had 3 weeks to complete the task.

In this example the group identified the software and databases that thought may be relevant, the terms that required definition, and the reaction kinetics (Figure 1). Summing up at the end of the first session was important in providing students with reassurance and for ensuring the pedagogical aim was met, without restricting independent and self-directed learning.

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<sup>1</sup> <http://www.bbsrc.ac.uk/pa/grants/default.aspx>.



**Figure 1:** Mind mapping tools such as X-mind® can be used during steps 1-4 of the PBL process to develop a schema allowing students to integrate prior knowledge, identify key questions and resources, and assign tasks.

## ILLUSTRATIVE EXAMPLE 2: USING IMMERSIVE WORLDS TO PROMOTE SOCIAL INTERACTION DURING STEPS 1-4 OF THE PBL PROCESS

Immersive or virtual worlds (VW) in which the residents can explore the three dimensional environment and interact with others, have the potential to enrich student learning environments, providing opportunities for engagement in challenging learning tasks and to encourage and enhance interaction and dialogue by students (Monahan, McArdle & Bertolotto, 2008). The ability to hold synchronous discussions with a spatial dimension offers the best opportunity to replicate and enhance face-to-face PBL activities in the digital world. A virtual campus, BioSim, was developed for our DL students, which had a number of bespoke classrooms designed for specific learning activities, including an E-library which contained additional resources and a problem-based learning room.

### DELIVERING BIOETHICS VIA DISTANCE LEARNING POSTGRADUATE LIFE AND HEALTH SCIENCE STUDENTS: PEDAGOGICAL BACKGROUND

BioSim was used to deliver bioethics to a group of post-graduate DL students. The aim of the module was to encourage students to examine the ethical issues raised by advances in the life and health sciences. Central to the module is the ability to construct and defend evidenced-based arguments. Three different scenarios were used during the module:

1. 'Enviropig'- the development of genetically modified pigs that have a reduced environmental impact;
2. Should egg donors and sperm donor be paid the same?
3. Should the research community have access to anonymised medical data?

For each scenario the trigger comprised either of a single video or a series of short videos providing alternative stakeholder perspectives, which were released at stages during the exercise. The videos were screened in the virtual world from public resources such as Youtube<sup>2</sup> and the BBC iPlayer<sup>3</sup> (available only in the UK). The students, working in groups of 6-8 watched the video triggers together ‘in-world’ and then discussed the issues arising. A series of slides were available as prompts to provide some focus and structure to the discussion; encouraging them to define the problem and formulate their learning objectives. Additional resources were also provided in the E-Library. (Figures 2(a), (b) and (c)). Having completed stages 1-4 in the virtual world, a wiki was then used to support independent study and as a workspace to develop the problem solution over the following two weeks.

**Figure 2:** PBL in a virtual world.



**Figure 2(a)** Students watch a video clip trigger



**Figure 2(b)** Slides provided to scaffold the PBL process

<sup>2</sup> <http://www.youtube.com>

<sup>3</sup> <http://www.bbc.co.uk/iplayer>



**Figure 2(c)** 3 students are delegated to access further information to inform the problem construction.

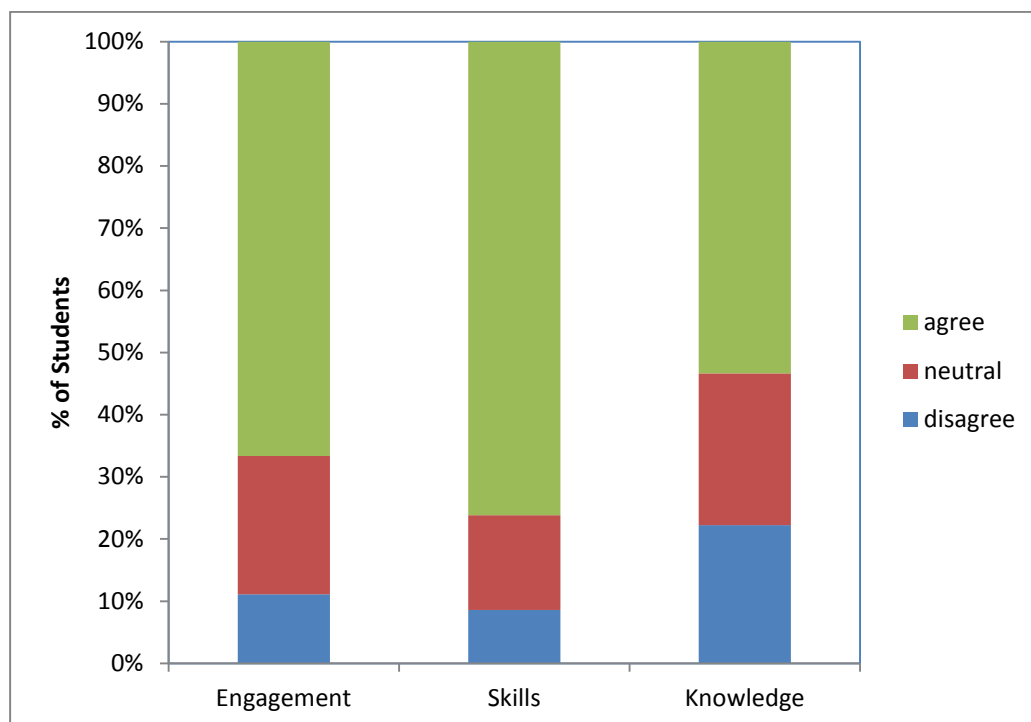
A questionnaire was developed which asked students how well they agreed or disagreed with twelve statements relating to three areas: skill development (communication and presenting ethical arguments), engagement with the module and subject knowledge. 19 students responded to the questionnaire and the responses were collated and shown in Figure 3. The majority of students agreed that the virtual world engaged them with their learning and helped them develop their communication skills. There were six positive responses in the ‘free-text section’ regarding the use of BioSim, typical examples were:

“Really enjoyed the video discussions. The virtual world interaction was particularly good for this type of exercise” and “I believe that using avatars would help to give all group work members the confidence to engage more fully with their colleagues.”

It was recognized that there was a learning curve for both staff and students in using the technology, and there were two negative comments from students who struggled with the technology:

“I enjoyed the Biosim discussions even though there were many teething problems” and “Biosim problems need to be sorted”.





**Figure 3:** Student Feedback on the use of the BioSim virtual campus to engage students with their learning, develop subject knowledge and communication skills.

### **ILLUSTRATIVE EXAMPLE 3: USING A WIKI AS A WORK-SPACE DURING THE PBL PROCESS**

A wiki is simply a piece of software that allows rapid creation, editing and publishing of a web page, possibly the most well-known example is wikipedia which is based on user-provided definitions. By providing each member of a group with read/write privileges to a wiki, it can be used as a project work space through which the group can collaborate to construct the solution to a problem. Internal and external links allow group members to share resources and provide cross-references to other contributions. Each group member can tag their contribution, which has benefits for both the student and the tutor. The student contributes to the group knowing that their individual contribution is recognised, whilst the tutor can monitor the PBL process without being actively visible on the wiki. Other evidence has indicated that the use of a wiki promotes interactivity and a sense of community within the learners (Dlouha & Dlouhy, 2009). This has obvious benefits for DL programmes, where students can feel isolated, wikis have also been used in work-based learning (Moteleb & Durrant, 2009), where they can support students on placement, helping them stay ‘connected’ to the university and their peer group.

At the University of Ulster, the enterprise wiki, Confluence® is embedded within the VLE. An enterprise wiki combines a wiki with communication tools, such as blogs and RSS feeds. Embedding the wiki within the VLE provides security (so it can be used for projects involving confidential data), plus easy access, and a familiar environment for staff and students.

The wiki was used as students undertook independent study in the previous two examples. They could provide regular updates to the wiki, and share resources with the group. Figure 4 shows a screenshot of the wiki which was used to capture the individual study carried out by the biotechnology students. The wiki identifies the pages that the students created in the first stages of independent study which includes a glossary and identification of further resources they planned to explore. Each contribution was tagged with the author's name, making it easy for the tutor to monitor the PBL process. Finally the wiki could be used as a reporting mechanism for the project.

Home

Added by Administrator, last edited by Catherine Hack on Jan 26, 2011 (view change)

A novel organophosphate metabolism operon has been found during *in silico* analysis of the pSyrmB plasmid of *Sinorhizobium meliloti* 1021. The operon contains a 2-aminoethylphosphonate (2AEP) transaminase, a phosphonoacetate hydrolase and an uncharacterised aldehyde dehydrogenase. Canonically, 2AEP degradation proceeds via a transamination to 2-phosphonoacetaldehyde, followed by a phosphonoacetaldehyde hydrolase catalysed C-P bond cleavage to yield acetaldehyde and inorganic phosphate (Pi). *Sinorhizobium meliloti* 1021 has no phosphonoacetaldehyde hydrolase gene and the hypothesis is that following a transamination to phosphonoacetaldehyde, the uncharacterised aldehyde dehydrogenase (SMt21539) converts phosphonoacetaldehyde to PnAce; this is then acted upon by phosphonoacetate hydrolase to yield Pi and acetate for growth. Demonstration of these bioconversions *in vitro* will conclusively prove that PnAce is a biogenic molecule.

However you do not have funding for the lab work, how would you move forward with this project ?

Recently Updated

Page Name	Author	Time
Problem	Catherine Hack	less than a minute ago
What databases should we use to find sequence information?	Demo Student	about 5 hours ago
biogenic	Demo Student	about 6 hours ago
SMt21539	Demo Student	about 6 hours ago
Novel	Demo Student	about 6 hours ago
First thoughts	Demo Student	about 6 hours ago
Glossary	Demo Student	about 8 hours ago
What is PBL?	Catherine Hack	yesterday at 12:05 PM
Home	Administrator	yesterday at 11:42 AM

Navigate space

Search

Glossary

Problem definition

what databases should we use to find sequence information ?

Identify resources

Problem definition

Scaffold created by tutor

**Figure 4:** Screenshot from a wiki during the first stages of independent study in the PBL exercise

## SCAFFOLDS

In these problems the tutor could use both the mind map and the wiki to scaffold the problem. Typical prompting questions have been identified on the mind map and the wiki (Figures 1 and 4). For less mature cohorts the mind map can be provided with initial prompting questions Such as “What is the problem?”, “What do you know about the problem?” “What resources will help you solve the problem? , and “What do you need to do to solve the problem? At the end of each session, the mind map can be shared with the tutor or facilitator for reassurance or guidance on identifying the learning objectives. As students use the wiki to construct the solution to the problem, the tutor can observe the process and provide appropriate support and links to suggested resources as required without compromising one of

the central goals of PBL to encourage students to become independent and self-directed learners.

#### **ILLUSTRATIVE EXAMPLE 4: ASSESSMENT IN PBL**

PBL aims to develop higher cognitive and transferrable skills, as well to improve long-term knowledge retention; however assessment in PBL activities is often not matched to addressing these outcomes (Walker and Leary, 2009). Self and peer-assessment are important to meeting the learning goals of PBL. At Ulster we have used webPA<sup>4</sup>, an on-line tool which can be used for peer and self-assessment. It is open source software developed by a consortium led by Loughborough University through JISC<sup>5</sup> funding. The software allows students to assess both their own contribution and that of each team member to a project. This means that whilst the tutor has marked the product of the PBL exercise, such as a single report from the group, each student will receive an individual mark based on their contribution to the project, as assessed by the team members. Students can be engaged with the whole assessment process including setting the criteria, and provided an opportunity to evaluate the whole PBL process, rather than just the end product.

#### **INTRODUCTION TO BIOINFORMATICS FOR FINAL YEAR LIFE SCIENCE STUDENTS: PEDAGOGICAL BACKGROUND**

Problem based learning (PBL) was used to deliver bioinformatics education to final year biomedical science and pharmacology students, as part of a module in Human and Molecular Genetics. It was envisaged that at the end of this period all students would be able to take a DNA sequence, and identify the following: Which gene it came from? Which protein it coded for? What was the protein function? There was also the opportunity to explore the effect of the mutation, and to consider issues such as probability and risk. Furthermore the PBL exercise provides the opportunity to explore the ethical issues raised by genetic screening. The students were provided with the following problem:

“You are working in a Genetic Screening Laboratory which analyses DNA. You have been provided with a sample of foetal DNA. Please prepare for a meeting with the prospective parents”.

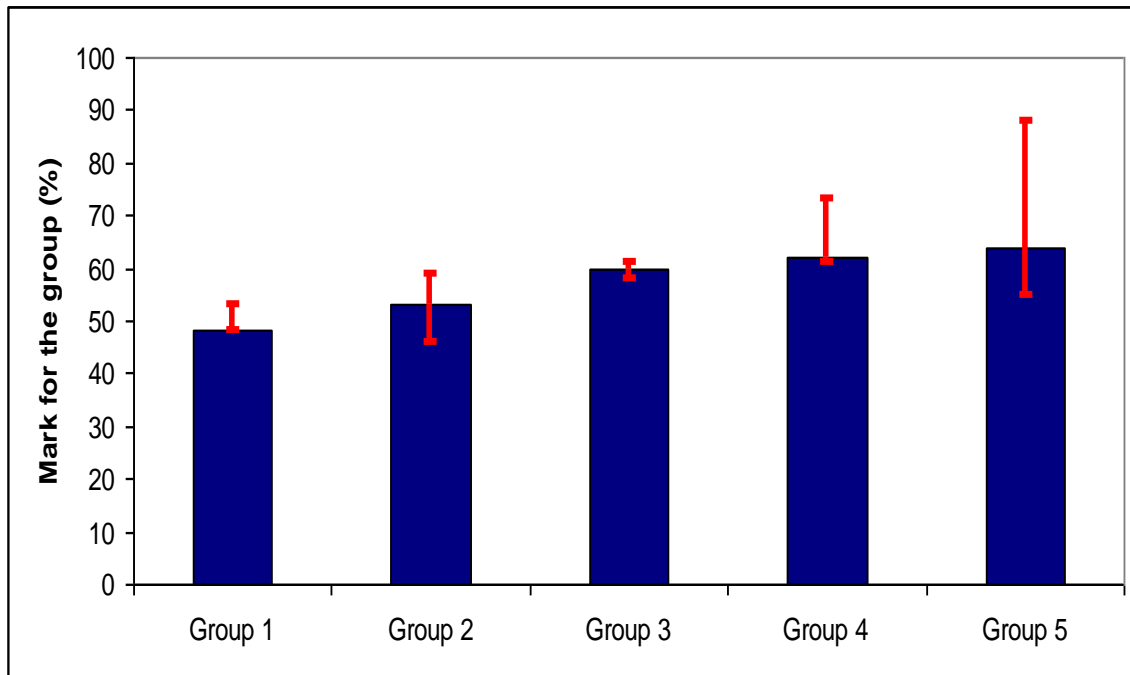
The students (n~ 50) were randomly assigned to groups of ~6-8. The exercise included 2 classroom sessions, plus a final role play and review session. The students had 3 weeks to complete the task, which involved a significant amount of independent study and group work. The anonymous assessment process encouraged students to provide an honest mark,

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<sup>4</sup> <http://webpaproject.lboro.ac.uk/>

<sup>5</sup> <http://www.jisc.ac.uk>

evidenced by a wide distribution of marks both within the group and across the categories (Figure 4).



**Figure 5:** Distribution of group marks for PBL activity. The solid bar is the mark that was awarded for the final submission produced by the group. The error bars (|) indicate the maximum and the minimum mark achieved by individual students in the group.

However whilst it is acknowledged that peer and self-assessment are in and of themselves important higher-order thinking skills, students are not always competent at assessment and several ‘rating’ errors have been identified (Sluijsmans *et al* 2001). Other evidence has indicated that peer assessment in PBL exercises can create tension within the group, and harm the intended collaborative nature of the exercise (Papinczak, Young & Groves, 2007). An alternative is to use the wiki for assessment of the PBL process. Each contribution to the wiki is automatically tagged, enabling the identification of individual submission, facilitating the assessment of individual group members at various stages of the PBL exercise.

### NON-ADOPTION OF TECHNOLOGY

An internal audit to identify the barriers to the use of Web 2.0 technology at the University of Ulster received almost 180 (24%) responses from academic staff across all faculties. Over 90% of respondents used the VLE to deliver information to students, but the numbers using more interactive forums that were embedded within the VLE were much lower: discussion boards (39%), wikis (12%) or blogs (10%). This data supports a previous study (Ward *et al*, 2009) of staff delivering health care education in higher education institutions. Over 80% used technologies associated with the VLE, whilst less than half used Web 2.0 technologies

such as blogs (44%) and wikis (32%) The response rate to the Ward (2009) survey was approximately one quarter of those invited, similar to the response rate in the Ulster study; accepting that staff interested in using technology for teaching may be more inclined to respond to the survey, the actual use of Web 2.0 technology might well be lower than that reported. The Ulster survey was promoted as an ‘Audit to identify the barriers to using technology’ and may have prompted a higher response rate from non-adopters, resulting in a higher number of respondents (~1/3) indicating that they had no intention of using Web 2.0 technology, than observed in the Ward study.

Both surveys indicated that the main barrier to the use of technologies was an unwillingness to invest time in developing skills in this area, without a full appreciation of the benefits of the technology. Other issues raised were relating to cyber security, the requirement for monitoring forums, and concerns about the barriers between social and professional networks. The most often cited reasons for the non-adoption of new technologies include the lack of time / heavy workload and the lack of IT skills or support. The adoption of the VLE was driven, in part, by institutional demands for efficient course delivery, however the incentives for adopting other technologies are less obvious, and staff are concerned about investing time in a technology that may rapidly become obsolete. Furthermore staff may be nervous about introducing technology, as they can feel that the new generation of students, the ‘digital natives’, are much more familiar with the technology (Prensky,2001). Other concerns reflect issues with security, on-line safety, cyber bullying and uncertainties over the boundaries between social and professional networks.

At Ulster we have developed an on-line Community of Practice for academic staff, which allows staff to use Web 2.0 technology in a professional arena, and increase their knowledge of the potential benefits as well as their own aptitude and skills of the technology. This approach is in-line with recommendations from Amundsen & Wilson (2012) who suggested that interventions aimed at developing mastery of a new teaching method should place emphasis on learning about a particular teaching method and how to use it and design training such that it models the method being taught. Engagement with both the technology and their peers via the Community of Practice will provide staff with experience of the learning environment that students will encounter, and it is hoped this will provide staff with the confidence to use Web 2.0 in their own teaching.

## CONCLUSIONS

As the provision of distance learning programmes increases to meet the growing demand for flexible learning and continuing professional development; effective use of Web 2.0 technology can improve engagement for DL students and provide opportunities for the social interactions and collaboration required for effective learning. However it is argued that Web 2.0 technology, used appropriately can provides additional benefits, supporting and promoting

collaborative learning, facilitating scaffolding and providing mechanisms for self and peer-assessment, and as such should be offered to both on-campus and DL students. Thus, whilst PBL has been traditionally characterised by the social interactions that occur during group working and the central role of the facilitator, our experience has indicated that Web 2.0 technology can enhance the PBL experience for on-campus students. The alignment of Web 2.0 with the goals of PBL, has been recognised and studies have reported the use of wikis to share resources (Varga-Atkins *et al*, 2010) and social network sites to communicate (Drohan & Widger, 2008). By incorporating technology into the PBL process, students will be given the opportunity to develop their skills in these literacies, and enhance their exploration and understanding of the problem, creating a virtuous circle of skills and knowledge. One of the key features of Web 2.0 technologies is their collaborative nature, and as such they lend themselves to PBL learning environments where no one member of a group, including the tutor or facilitator, may be considered an expert. Many other aspects of Web 2.0 conform to the learning goals of PBL; facilitating sharing of resources and joint document production, furthermore they can promote active learning and provide a platform for the development or construction of knowledge. Additionally, basing the PBL process within the on-line environment can facilitate the provision of multimedia triggers, and promote students to consider the medium through which they should disseminate the problem outcomes.

As Web 2.0 technologies mature, and become embedded in VLE's or other University supported information technology such as a PDP system, the boundaries between wiki's, blogs, E-portfolio's, discussion boards, and chat rooms may become less distinct. The effect this has on uptake and the way that these tools are used has yet to be seen. Evidence has indicated that students wish to keep their social networks separate from their professional or academic life (Ward *et al*, 2009); however, this does not preclude having a social interface and an academic interface. In PBL it is expected that students identify appropriate resources to solve a problem, this should include the use of appropriate information and communication technologies. The embedding of Web 2.0 within the University IT infrastructure should provide the opportunity for a less prescriptive approach to the use of technology, allowing students to identify the most appropriate tools for the task. Educational scholarship can be transformed with Web 2.0, and providing further opportunities for staff to develop their skills and gain an appreciation of the benefits will reduce the barriers to the adoption of the technology.

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**References**

- Addae, J Wilson, J and Carrington, C (2012) Students' perception of a modified form of PBL using concept mapping, *Medical Teacher*, 34,11,E756-E762.
- Alamro, A and Schofield, S (2012) Supporting traditional PBL with online discussion forums: A study from Qassim Medical School, *Medical Teacher*, 34,1,S20-S24
- Amundsen C and Wilson M (2012) Are we asking the right questions? A conceptual review of the educational development literature in higher education. *Review of Educational Research*, 82, 90-126
- Anderson, P (2007) What is Web 2.0? Ideas, technologies and implications for education, JISC Technology and Standards Watch, Feb. 2007, Retrieved March 1, 2013 from <http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf>.
- Barrows, H (1986) A taxonomy of problem-based learning methods, *Medical Education* **20**,6, 481-486
- Browne, T, Jenkins, M & Walker, R. (2006). A longitudinal perspective regarding the use of VLEs by Higher Education institutions in the United Kingdom. *Interactive Learning Environments*, 14, 177-192. doi:10.1080/10494820600852795
- Daley, B and Torre, D (2010) Concept maps in medical education: an analytical literature review, *Medical Education*, 44,5,440-448
- De Graaff, E & Kolmos, A (2003) Characteristics of problem-based learning, *International Journal of Engineering Education*,19,5,657-662
- Dlouha, J. & Dlouhy, J. (2009). Use of Wiki tools for raising the communicative aspect of learning. *Proceedings of the 8th European Conference on E-Learning*, 165-173.
- Dohn, N (2009) Web 2.0: Inherent tensions and evident challenges for education, *International Journal of Computer-Supported Collaborative Learning* , 4,3, 343-363.
- Drohan, S and Widger, L.(2008) Social Networking the Problem-based Learning process, In F. Welsch, JV Carrasquero and CB and Chen (Eds) IMSCI '08: *2nd International Multi-Conference on Society, Cybernetics and Informatics*, Vol III, Proceedings, 47-51.
- Kim,M.C. & Hannafin, M.J.(2011). Scaffolding problem solving in technology-enhanced learning environments (TELEs): Bridging research and theory with practice. *Computers and Education*, 56, 403-417.
- Klamma, R., Chatti, M. A., Duval, E., Hummel, H., Hvannberg, E. H., Kravcik, M., Law, E., Naeve, A., & Scott, P. (2007). Social software for life-long learning. *Educational Technology & Society*, **10**, 3, 72-83.

- Leu, D.J., Kinzer, C.K., Coiro, J.L. & Cammack, D.W. (2004). Toward a theory of new literacies emerging from the internet and other information and communication technologies. in Ruddell, R.B. & Unrau N.J. (ed) in *Theoretical Models and Processes of Reading*. (5th ed.) International Reading Association, Ch 54.
- Li, Y, Dong, M. Huang, R (2011) Designing collaborative E-Learning environments based upon semantic wiki: From design models to application scenarios. *Educational Technology and Society*, **14**, 4, 49-63.
- Monahan, T, McArdle, G & Bertolotto, M. (2008). Virtual reality for collaborative e-learning *Computers & Education*. **50**, 1339–1353.
- Moteleb, A. & Durrant, A. (2009). Using Web2.0 technology in work based learning. *Proceedings of the 8th European Conference on E-Learning*, 391-399.
- Novak, J. & A. Cañas, The Theory Underlying Concept Maps and how to construct them, Technical Report IHMC CmapTools 2006-01 Rev 01-2008, Florida Institute for Human and Machine Cognition, 2008, available at:  
<http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf>.
- Papinczak, T. Young, L & Groves, M. (2007) Peer assessment in Problem-Based Learning: A qualitative study. *Advances in Health Sciences Education*, **12**, 169–186.
- Prensky, M (2001). Digital Natives, Digital Immigrants, *On the Horizon*, **9**, 5. from: <http://www.marcprensky.com/> accessed 14/01/2011
- Rosenshine B. & Meister C. (1992). The use of Scaffolds for teaching higher-level cognitive strategies, *Educational Leadership*, **49**, 26-33.
- Sluijsmans, D.M.A., Moerkerke, G., van Merriënboer, J.J.G. & Dochy, F.J.R.C. (2001). Peer assessment in Problem Based Learning. *Studies in Educational Evaluation*, **27**, 153-173.
- Stylianou, V, & Kokkinaki, A (2008) Employing Web 2.0 tools to enhance active learning in courses requiring group projects, Williams, R and Remenyi, D (Eds) *Proceedings of the 7th European Conference on E-Learning*, **2**, 555-561.
- Tambouris, E, Panopoulou, E, Tarabanis, K, Ryberg, T, Buus, L, Peristeras, V, Lee, D, Porwol, L (2012) Enabling Problem Based Learning through Web 2.0 technologies: PBL 2.0, *Educational Technology & Society* **15**, 4, 238-251
- Varga-Atkins, T, Dangerfield, P, Brigden, D (2010) Developing professionalism through the use of wikis: A study with first-year undergraduate medical students, *Medical Teacher*, **32**, 10 824-829.
- Walker, A and Leary, H (2009) A Problem Based Learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels *The Interdisciplinary Journal of Problem-based Learning* **3**, 1, 12-43



Ward, R., Moule, P. & Lockyer, L. (2009). Adoption of Web 2.0 technologies in education for health professionals in the UK: Where are we and why? *Electronic Journal of e-Learning*, 7, 165 – 172.

Wood, D.F. (2003) Problem Based Learning, in ABC of learning and teaching in medicine, *British Medical Journal*, 326,328-330.