The World-Wide Day in Science as exemplar of problem-based, blended learning with international scope

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Graduate attributes in science – is blended learning up to the challenge?

Science undergraduates at the University of New South Wales (UNSW) who have been identified as high performers face a special pair of subjects covering professional skills and insights, including a range of graduate attributes. These subjects are meant to help the students to select and successfully pursue a career in science, particularly in scientific research. No doubt similar subjects, and units within subjects, exist at other universities, both research-intensive and teaching-focussed institutions. A challenge in teaching this material is to interest and engage students in learning those skills and insights that are not covered in the discipline-based textbooks and laboratory manuals that they are driven to study. That is, we are pulling them away from scientific content to address what might be called ‘scientific context’.

The subjects at my university represent a mixture that could be ‘deadly’ – (1) students from a range of disciplines, mainly in the life sciences but some from the physical sciences; (2) addressing graduate attributes, such as writing, presenting, and teamwork, which high performing students tend to have a relative strength in; (3) students earn credit for only a half-subject, three units instead of six, meaning that they are dividing their attention among five subjects and not just four; and (4) historically, lecturers did not earn credit from their school for teaching this subject due to tight budgets and perhaps some meanness on the part of heads of school.

Within this context, the ‘Day in Science’ project was conceived as a whole-class undertaking (for the second subject in the series) leading to an authentic publication with a practical purpose and a growing global scope. What I now recognise as ‘blended learning’ was employed to provide drama to engage students in areas that might not otherwise capture much of their attention. In addition, some aspects of blended learning can be seen to pose very practical challenges, similar to those faced by scientists and popular presenters of science, who have captured students’ attention in their past.

This paper explores how the ‘Day in Science’ project employs blended learning to enhance graduate attributes and clarify career aims for science students at university as well as high school. I will explain how the Internet serves as more than merely a source of information, or an opportunity for students to build their capabilites with new media, but as a venue for authentic publication. I will also describe how other information technologies, ones with which many students have modest experience, such as e-mail, are folded into the mix to create a learning environment that more closely resembles the communication environment of a professional than that of a student. Blended learning in the ‘Day in Science’ project can then be seen to provide opportunities for practice in gaining, organising, sharing, and disseminating information that students recognise as being of value. The tale told here, though, depicts a work-in-progress, an adventure that invites collaboration and suggests new and creative undertakings, but one that is also ripe for deeper investigation.

A context of surging technology amidst unsteady enrolments

Illuminating career paths in science seems to take on a special importance in an age where enrolments in science are declining. Between 1994 and 2003, university enrolments in science in Australia dropped by twenty-percent (Krause, Hartley, James and McInnis 2005). Declines are said to be occurring in the US and UK as well.

At the same time, though, the capacity of the Internet has skyrocketed. One indicator is the growth in use of online components in classes within our universities. In The University of New South Wales (UNSW: an urban, research-intensive university of 40,000 students), where I work, the online platform WebCT was employed in just three-percent of classes in the year 2000, and use grew eight-fold, to twenty-five percent of classes, by 2003 (internal UNSW draft report 2004). First-year students in science report web-based lecture notes are now challenging textbooks as their resource of choice (Huon, Spehar, Adam and Rifkin *forthcoming*).

Growth in internet use in universities is accompanied by increasing student familiarity with creating web pages and entire web sites. Anecdotal evidence suggests that many students have assembled a web page for a high school class or on their own time, although some students report having subsequently forgotten how they created it. A class of fifty university students in science invariably includes several who know how to create an interesting and visually appealing web site via their own skills or with the assistance of friends who are more technically adept. Students at UNSW, for example, launched a student-run, online science magazine, which includes text, articles, and photo essays, as well as a science news service that is automatically updated daily from the BBC, *New Scientist* magazine, and other web sites. Student capabilities with information and communication technologies (ICTs) have proven to extend to facility with e-mail and the creation and use of online discussion boards and instant messaging. Not all current students are at ease with such technology, but those who do not have experience explain how they are learning from classmates. With whatever online technology, each new cohort of students promises to be even more capable than the last.

Students' multi-media abilities appear to be growing outside the realm of online capabilities per se. Again, experience in the 'Day in Science' project shows that a significant minority of students own or have access to a digital camera or digital video (DV) camera. A few have digital cameras now built into their telephones. An increasing number of students are equipped with an MP3 player, which leads some to have an ability to edit audio on their home computers.

These capacities have led a few of my colleagues in science to have student teams create web pages as elements in assessment. Such web pages are generally made visible to the lecturer, sometimes made visible to classmates, and, one would imagine, at times made visible to a broader public audience. However, I have no evidence that such web pages are advertised to the wider world on a regular basis.

Colleagues are experimenting with using the web for collaboration among student teams at different universities (Takayama 2004; Bennett 2005). I have relied in recent years on an existing online student peer review system (*Calibrated Peer Review*), despite my mixed technical capabilities (limited ability with *Macromedia Dreamweaver* web page software, no capacity with *Microsoft PowerPoint*, and frustration with *Microsoft Excel*). In such instances, the lecturer either creates or enables the online environment in which students work, such as composing a *WebCT* or *Blackboard* site for a class. This effort places an extra demand on the lecturer's time, at least during the period of initial adoption. Such sites tend to highlight to students what the lecturer considers to be important, whereas student-created sites seem to more readily highlight the students' interests.

Although lecturers' skills with ICTs promise to be outstripped by those of our students, abilities of science students in interpersonal communication do not appear to have not kept pace. Both employers and recent science graduates continue to call for more university training in areas such as written and oral communication, managerial ability, project management insights, and capacity for teamwork (McInnis, Hartley and Anderson 2000; Gray, Barnard, Franco, Rifkin, Hine and Young 2003).

It is within this context of growing student abilities in ICTs, limited lecturer time and ability, and a need to develop graduate attributes of science students that the World-Wide Day in Science was conceived as a semester-long class project leading to student publication on the Web. How my students over the past three years have created their ‘Day in Science’ web sites is outlined below along with the project’s capacity for international growth. That is followed by a discussion of various forms of feedback received to date and what it implies. The paper concludes with a discussion of the promise of blended learning in this problem-based learning context, particularly how ICTs may be giving students choices, both welcome and challenging, rather than merely presenting text selected by the lecturer. The variety of threads being woven together in this paper might suggest a complexity in teaching the ‘Day in Science’ class. However, it has been one of the easiest classes to establish and teach that I have faced in twenty years. Perhaps therein lies one of the true promises of blended learning, opportunities for students to personalise their efforts in ways that lighten the load for the lecturer.

Problem-based learning leading to web publication

The World-Wide Day in Science (WWDS) project has university students employing a wide range of information technologies in an example of blended learning. The project enables problem-based learning with ‘authentic assessment’ within a single university subject and in a coordinated effort that stretches across universities and across continents.

Students engaged in this project at UNSW rarely gather as a whole class, although they are all frequently on campus. They do meet as teams, suffer the frustration of unanswered e-mails, lament not writing down each others’ phone numbers, and grudgingly recognise the value of an online discussion board. By the same token, though, they are impressed to see their work published on the Web at http://www.adayinscience.net and linked to http://www.science.unsw.edu.au/worldwide. It resides alongside submissions by university students in Uruguay and Spain, high school students in suburban Sydney, and scientists themselves from every continent, including Antarctica.

For the past three years, development has been under way on this global activity to reveal the day-to-day charms of scientific work to university students and their high school kin. It is a career guide assembled by students for students, thus offering a measure of credibility where glossier university publications might fail. The World-Wide Day in Science project incorporates the drama of capturing a single day’s events around the world; the allure to students of working in print, images, and sound to tell the stories that they produce; and the scope of the world wide web as a venue for publication.

University students create a web site to depict a ‘day in the life of a scientist’, a particular day, this year being 15 April 2005. Student reporters from Australia, Spain, and Uruguay captured a snapshot of the world of science in their locale by shadowing willing scientists for the day. The scheme worked in 2003 with eighty-one students at the University of New South Wales, which is why I decided to see if the event could run worldwide. Postgraduate students in science communication at Pompeu Fabra University in Barcelona took up the gauntlet in 2004 along with undergraduate and postgraduate volunteers in science and science communication at the University of the Republic of Uruguay in Montevideo.

The class works by having students submitting resumés and nominating themselves for two roles that they might like to undertake. Based on the resumés, I select three planners for the class (this year, fifty students), who then allocate other students to roles and determine key deadlines and guidelines for the project. Student team managers then guide producers and reporters toward the target date for reporting, 15 April. Interviews, observations, photographs, audio, and video are captured on the day. Reports are drafted in the fortnight that follows and then handed to student editors and production staff, who slave for the four weeks that follow to hone the text, select images, and assemble a coherent web site.

Along the way, the students do not have regular class meetings. I organise for a workshop for student team managers on managerial issues and two workshops for student reporters and producers, one on journalism and the other on project management in video production. My involvement is then basically coaching the planners informally, providing the odd piece of advice to the class, and deflecting questions from anxious students who have not found a scientist to follow or not heard from their teammates. The students are encouraged to employ a free, online, discussion forum (outside the university) in order for teammates and students with similar roles in different teams to keep in touch. For the past two years, the forum used has been Ezboard (go to http://www.ezboard.com/, and search for the LIFE2001 forum).

The stories and images collected by student reporters and producers are tailored to reach an audience of high school students who are exploring the possibilities of different career paths. Having life on a typical day in science captured in the words of other students is intended to have a particular appeal for this young audience. At the same time, the university students learn about where science can take them, how non-linear a career path can be, and what drives a research scientist or professional to spend endless hours on seemingly tedious tasks.

This effort engages university science students in a range of ‘good practice’ learning strategies – problem-based learning, authentic assessment, and multi-media and information technologies used in a ‘blended learning’ strategy. At the same time, students need to employ and develop the graduate attributes that are in demand by employers (Gray et al. 2003) as well recent graduates themselves (McInnis, Hartley and Anderson 2000) including oral and written communication, teamwork, and managerial abilities. For example, students need to demonstrate the very basic capability of identifying, locating, and making an appointment with a scientist or other professional, something that many indicate they have never before done. In essence, the students are coordinating organisation of a ‘virtual event’, simultaneous meetings in different locations around Sydney. This effort parallels the student-organised science conferences facilitated by Marjan Zadnik at Curtin University of Technology and Paul Gruba at the University of Melbourne.

A virtual event has the capacity for an international dimension. However, the simultaneous ‘Day in Science’ activities in Sydney, Barcelona, and Montevideo to date have been more ‘coordinated’ (meaning simultaneous) than ‘collaborative’ (meaning relying on mutual support). Invitations to other university classes to participated have not been taken up, despite interest expressed by lecturers. Individual undergraduate and postgraduate students have submitted diary entries on their activities on 15 April as have three-dozen scientists (with all describing their interests when in high school in order to help the high school audience see them as coming from ‘normal’ stock). Such diary submissions in 2005, as noted earlier, are from every continent, from particle physicists in North America to an actor-director in science theatre in South Africa. One can see on the web site that we have also piloted another mode of participation, having three high school students shadow three UNSW students on 15 April and subsequently submit web-based reports.

Based on this description of the ‘Day in Science’ learning activity, some might conclude that it has much promise. How has it worked in reality, though, and how can we tell what is being learned?

Feedback on how well it works

Feedback on how well the ‘Day in Science’ has been working and what is being learned by students has been collected in a range of forms. There is, of course, the informal feedback from students who work on the project at the computers outside my office door. Students occasionally send me a copy of emails sent to other students in relation to the project, and I can readily monitor their online discussion board. The few class meetings and coaching sessions also provide opportunities for students to air concerns and insights. I do not gather any intermediate assignments for formative assessment during the semester, though. My insights into what students are learning are gauged through marking how the whole web site turns out as well as by assessing two reflective essays, one retrospective and including peer evaluation and one prospective, explaining how lessons learned may be used in the future.

Feedback on attitudes and experiences is gathered through an evaluation form that asks students about topics such as ways in which they might have felt challenged, how relevant the lessons learned appeared to be, and how they felt about the learning process. Collaborating lecturers in Montevideo and Barcelona were asked about how the course went on their end.

Feedback to date has been collected for purposes of improving the design of the 'Day in Science' activity rather than for reporting as research. As a result, a lack of research ethics clearance prevents me from presenting details. However, I am able to provide general comments on the nature of what seems to be occurring in the minds of students and other participants. I can describe quantitative figures on my class survey from 2003 and impressions from the untallied responses in 2004. In addition, I have marked the final submissions of the students in 2005 and can relay impressions from them.

Student comments on a class feedback form (from the 2004 group with a similar trend in 2003) often referred to a desire for more clarity about their role in the project, e.g., a request for 'clearer instructions'. However, things seem to have become clearer as the semester progressed because that is what a majority of students (in 2004) marked when the survey form asked 'Although I felt confused early in the session in this class, responsibilities and concepts fell into place as time went by.' That process occurred despite a lack of guidance from me. That is, students relied on each other to clarify details. Thus, aligned with my intentions, students overwhelmingly reported that 'The lecturer made students take responsibility for their learning,' and most students reported feeling that I knew what I was doing and cared about their learning. Interestingly, half of students indicated that they were not sure or disagreed that 'What I learned has proven relevant in my life; for example, it has helped me to be clearer about my choice of major and/or career.' So, although responses to most of the eighteen questions posed on the survey form make the course look like quite a fruitful learning experience, that impact seems not to have been interpreted by that first cohort of students (in 2003) in terms of relevance to their life in the future. A quick review of feedback from the second cohort suggests that they feel similarly. Contrasting with this result, reflective and prospective essays submitted by students indicate that many can explain how scientists employ some of the very same strategies and skills that the students themselves employed in the 'Day in Science' project.

My collaborators in Spain and Uruguay are sufficiently pleased with their students' learning to continue participating. They cite student enthusiasm for the project and report no concerns about student learning or student management (beyond an apparent inability of the Barcelona students to comprehend that their thirty-minutes of video cannot readily be downloaded from a web site). The NSW state science education office indicates that teachers do indeed see relevance of the web site created to the science syllabi for the last two years of high school. The Faculty of Science at UNSW agreed to finance production of 500 'Day in Science' CD-ROMs containing the web site for distribution to teachers, careers advisers, and students involved in science enrichment programs. This feedback suggests that the 'publication' has pleased a number of stakeholders, but it does not yet indicate the direct impact on high school students. That is the focus of survey research currently under way, which addresses whether the 'Day in Science' web site indeed has a positive impact on high school students, clarifying their views, if not increasing the attractiveness, of career paths in science.

Feedback overall suggests a useful learning experience for the university students. However, there appear to be equivocal results on specific questions about the long-term relevance of the exercise. These results need to be taken in the context of the students being in the second year of their university studies. An appreciation of graduate attributes training increases as students progress through university, according to informal surveys that I have conducted of science students in first year, second year, third year, and honours. To accelerate this process of increasing appreciation, this year's final essay assignment asks more pointed questions about scientists' daily tasks and how they involve graduate attributes that students have been developing during the semester. A class-evaluation survey in the coming months should reveal whether such efforts to embed graduate attributes can be appreciated in the short term extending beyond completion of the subject and into the next semester of study.

In terms of the impact of technological (i.e., blended learning) aspects of the 'Day in Science' project, informal feedback during the semester as well as reflective essays have proven the most telling. Students overwhelmingly recognise the importance of keeping in contact with team mates as well as classmates with 'upstream-downstream' working relationships, like the reporters who need to submit stories 'downstream' to editors. However, different students express preference for different modes of communication. A few recommend relying on the online discussion forum, and some lament not relying on it. Others prefer online instant messaging, while some find e-mail to be a lifesaver. Others dislike the delays and unreliability of classmates in responding to e-mail and favour mobile phone texting and phone calls or face-to-face meetings. Students generally report being favourably impressed by the web site that they have produced. These responses indicate that ICT as product and process indeed played a very visible role in the class.

The extent to which lessons learned remain embedded and are subsequently employed in professional situations, from honours research to job seeking to eventual employment, could be revealed by a long-term assessment of the 'Day in Science' students, ideally when contrasted with a control group.

Discussion and conclusion

Various forms of technology were selected and employed by students to achieve a goal. Their immediate goal was to produce a web site, a form of ICT that plays an increasing role in their formal and informal learning. They produced an online career guide in science for high school students, an audience in whose shoes they had been a mere two years before. This practical outcome made the exercise an example of problem-based learning with authentic assessment.

Developments in ICT and students' technical capabilities enabled me to hand over a large measure of control to the class. Students identified and set up the online discussion board. They selected the web host and determined what capacity, in terms of how many megabytes of downloads over the next year, they required me to purchase. They explored and commented on the efficiency and effectiveness of different modes of communication, from phone calls to e-mails to team meetings, and they discussed the need for 'getting to know you' activities within their teams. Aside from providing advice, such as asking teams to avoid creating long videos or making sure to have their web site design vetted by an experienced student web designer, I could stand back.

ICTs were not used to deliver content that I selected but for the students to personalise the class to their own individual styles of working and relating. This notion of ownership extended to their choice of which scientists to shadow, how long to make the reports, how many photographs to include, etc. The process of handing over control to the students – and the degree of personalisation that students undertook – is what made the class so easy to teach.

I would like to encourage other science lecturers to have their students engage in some aspect of the 'Day in Science' effort, from shadowing or corresponding with a scientist on 15 April to providing a diary entry on their own day. The process seems to engage students in processes of deep learning – a number of students noting how much 'time' they spend on the class, which I suspect is as much time spent worrying as doing. Educational theory, peer commentary (development of this course contributed to my receiving UNSW's teaching award), and student feedback to date seem to support the efficacy of the 'Day in Science' endeavour. Plus, there is the promise of growing international cooperation and collaboration, realising the 'world-wide' nature of the Web.

In sum, a problem area, intensively addressing graduate attributes for science students – the 'scientific context', has been turned into a creative endeavour through use of blended learning. The increasingly ubiquitous nature of the web and other ICTs in students' lives has been employed to make the class more authentic and more challenging for the student to tackle but easier for the lecturer to teach (which some might argue is the exact opposite of what often happens in blended learning). What the students produce and publish provides career insights for themselves, for younger audiences in their locale, and for audiences of students like themselves in other parts of the world. Such multi-faceted possibilities of blended learning in science deserve to be further explored and exploited.

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