Students Publishing in New Media: Eight Hypotheses – a House of Cards?

William Rifkin[a], Nancy Longnecker[b], Joan Leach[c], Lloyd Davis[d], Lindy Orthia[e]

Corresponding author: willrifkin@unsw.edu.au
[a]Science Communication Program, University of New South Wales, Sydney NSW 2052, Australia
[b]Science Communication Program, University of Western Australia, Perth WA 6009, Australia
[c]Science Communication Program, University of Queensland , Brisbane QLD 4072 Australia
[d]Centre for Science Communication, University of Otago, Dunedin 9016, New Zealand
[e]Centre for Public Awareness of Science, Australian National University, Canberra ACT 0200, Australia

Keywords: new media, authentic tasks, assessment, university

Abstract

Can science undergraduates learn effectively by activities that have them express science content in 'new media', the popular communication forms that increasingly impact on their lives? We describe here rationale, approaches to date, and a series of hypotheses to be tested in a project designed to develop the content knowledge and graduate attributes of science students via science communication. The project explores the educational value in fostering student publication on the web – a medium of learning and publication that, one can argue, students find engaging, staff increasingly see as practical, and employers value as relevant. We aim to determine the extent to which science lecturers should and can exploit a growing number of publication opportunities provided by the web to enhance learning and motivation to select science and to engage effectively in its study at university. This article draws on literature, as well as evidence from the authors' practice, to articulate hypotheses that are being tested in the project. Here, we set out a research agenda to be explored as academics in various fields turn to assignments involving production of 'new media'.

International Journal of Innovation in Science and Mathematics Education, 18 (1) 43-54, 2010

Rationale for students publishing in new media

Can you engage and motivate science students in simultaneous development of their content knowledge and graduate attributes via science communication, specifically through student publication on the web? This question rests on eight hypotheses concerning: (1) what engages students' interest; (2) effective ways to develop graduate attributes; (3) the link between learning science content and learning to communicate about that content; (4) scalability from small classes to large classes; (5) implications of engaging science lecturers in development in order to foster their adoption of new teaching approaches; (6) similarities in how to teach the ability to create different forms of 'new media', a blog and a video, for example; (7) issues of privacy and intellectual property in making student work publicly visible; and (8) the appeal to a youth audience of media created by their peers. In this article, we will address how these hypotheses have been assembled and how they need to be tested by employing a varied array of evidence. That evidence ranges from respected treatises on the nature of learning to well-documented studies of specific innovations in teaching in the peer-reviewed literature. It also includes unpublished experience of the authors that has been recorded for a decade in assessment outcomes, observed in class, and suggested in formal and informal student feedback.

This article argues that an experiment in how to engage and motivate science students can legitimately rest on what might be termed a 'house of cards', a range of variously-linked hypotheses that are supported individually and collectively by both published and as yet unpublished data. This argument for legitimacy has been endorsed already by peer review, by a panel assessing a grant proposal to explore student publication in 'new media' in large science classes as a way to develop the graduate attributes of university students in Australia. The Australian Learning and Teaching Council (ALTC) are funding our project to identify and evaluate, and where appropriate develop and disseminate, 'new media' teaching strategies and resources suited to large classes in science. We are engaging science academics in evaluating and testing approaches that have students creating 'new media,' such as podcasts, blogs, videos, wikis, webzines, and web sites.

Support for this project from the grant reviewers suggests that our argument for the value of such 'new media' approaches is sufficiently likely to be valid that it warrants funding, even though it rests on a range of well-founded inferences and unproven contentions, on the data and reputations of the authors and not simply on constructs derived from studies in the published literature. It does not seem to matter that the series of hypotheses that we listed, even if supported individually, have not been shown to be true in concert. One might conclude that certain forms of educational innovation are not based on science-like research, nor should they pretend to be completely scientific. Nonetheless, one can still make claims to scholarly rigour.

This article describes rationale for our project and articulates a series of hypotheses that represent the project's research agenda. We will begin by describing the rationale for our project. Then, we will list the individual hypotheses and summarise evidence that supports each one and note gaps in that support. The article concludes with an overview of how our project is addressing these questions and reflections on how such strings of hypotheses can undergird educational innovation projects and their semblance, or not, to a house of cards.

Science and communication

It is widely accepted that science graduates should have good skills in oral and written communication (DEST 2002; Australian Council of Deans of Science 2001; Australian Council of Deans of Science, *unpublished expression of interest*, 2008; Hutton & Pluske 2005; Raison 2006; UNESCO 2003). Communication can be seen to be of increasing importance in contested areas of the life sciences, such as genetic engineering, in realisation of threats such as climate change, and as a strategy to stem declining enrolments in science among school and university students through outreach and enrichment programs run by science communicators (Davies, 2008; Dumlao & Duke, 2003; Trench, 2008).

Science communication elective subjects educate students to publicly communicate about research and the implications of research. University education in science communication addresses informal science education, public relations and journalism, and science-in-society as well as science content (Mulder, Longnecker & Davis 2008). Anecdotal evidence suggests that attention to communication outside science communication electives, in more mainstream science classes, has been growing, and the number of academic staff in science communication has been increasing.

A case is being made that science communication should become an obligatory part of all science degrees. Several hundred students are currently being taught in core 'graduate attribute' subjects in science degree programs at Australia's Monash University and the University of New South Wales. New Zealand's Ministry of Science and Technology is currently considering whether science communication should become an obligatory part of all science degrees, as is the University of Western Australia.

Publication opportunities for students

Until recently, student participation and responsibility for the content and organisation of publications has been an extra-curricular activity participated in by a self-nominated few. The law review and student newspaper are time-honoured traditions. The web now allows for cost-effective publication, which can enable student publication to become a mass learning activity, one that can be integrated into coursework. Many more students can now be challenged with learning how to understand and cater for target audiences as well as weighing up the advantages of employing video, audio, images, social networking, and hyperlinked text to enhance their communication. There is also the potential that, through the process of explanation and communication, students can increase their understanding of conceptually difficult content.

However, while today's students may be ‘web orientated’, they are not as web capable as popular belief suggests, according to findings of the ‘Net Generation’ project funded by the ALTC (Kennedy, Dalgarno, Gray, Judd, Waycott, Bennett, Maton, Krause, Bishop, Chang, & Churchwood 2007). These results echo observations of the authors in their classes. Hence, they represent a key area for attention of our project’s research and development efforts.

Despite the challenge that working with new information technology poses for many students, when those in our classes have engaged in online publication, our observations and reading of students’ reflective essays reveal that their effort and assessment have the characteristics of ‘authenticity.’ Submissions indicate that a vast majority of students recognise the relevance to their future professional work of: adhering to tight deadlines; a need to maintain open channels of communication with project teammates; being able to provide, as well as act on, constructive feedback; and tailoring their publications so that they appeal to their intended audiences. With a few exceptions, our students over much of the past decade have exhibited an engagement and enthusiasm that indicates that they appreciate that their output is available to a real, ‘authentic’, viewing public.

Experiences in this domain

Publication on the web is an attractive area to research due to the accumulation of evidence that it could be a way to develop graduate attributes of science students across a range of disciplines and contexts. A number of such approaches employed over the past decade have demonstrated worthwhile learning outcomes in the authors’ classes. For example, student-created *World-Wide Day in Science* web sites at the University of New South Wales (UNSW) provide career guidance for high school students (Rifkin 2004; Rifkin 2007; www.dayinscience.unsw.edu.au) and science videos produced by students at the University of Otago are reaping a high volume of visits on *iTunesUniversity*. Effectiveness is evident not only in the qualities of the publications created but also in the insights revealed consistently in reflective essays completed by the students involved (as noted above), in informal feedback, in formal feedback, and in communications from graduates. The literature, and six months of investigation by our project officers of unpublished approaches used by lecturers around Australia and in the UK, indicate that learning through online publication by science students has not been investigated thoroughly nor widely integrated into teaching (Tatalovic, 2008).

Successful use of publication on the web by science students, though promising, has had an uncertain long-term impact as training often fails to continue beyond a single university subject. Furthermore, observation of project work in the authors’ classes indicates that students, while increasingly familiar and engaged with camera phones, *FaceBook*, *Wikipedia*, *YouTube*, and other ‘new media’ capabilities, are not entirely expert with them. Our experiences suggest that a majority of students not only lack technical ability (as found by Kennedy et al., 2007), but they lack the capacity to compose professionally effective messages with these media, an observation that is not as yet documented in the literature. Even less adept with new media technology would be many of their lecturers (Kennedy, Dalgarno, Bennet, Judd, Gray & Chang, 2008). That may explain why, even though interest is growing among lecturers in assigning their students to participate in online publishing (e.g., assignments to contribute to the *World-Wide Day in Science*), actual implementation has been infrequent. This particular hurdle is compounded by factors affecting university teaching of science.

The Carrick Institute for Teaching and Learning in Higher Education (2007), now the ALTC, explained their initial grant-giving focus on improving university teaching of science by stating that science lecturers had proven to be particularly refractory to efforts to change teaching practices, with new approaches not taken up readily. One can argue that successful interventions need to attend to familiar aspects of the culture and context of university science teaching: a heavy focus on covering content; a predominance of didactic teaching; a concern about accountability fueled by a rise in managerialism in Australian universities; increasing workloads for academic staff; continual changes in university systems of information and communication technologies (ICT); and lecturers' aversion to time-consuming marking, particularly of students' writing.

This array of concerns underlines the need for lecturer engagement in research and development processes, such as our own. Teaching materials must be tested to determine whether they provide appropriate learning of content, genuinely reduce workloads, produce evidence of positive outcomes that can be cited for reasons of accountability, etc.

For students, the report of the ALTC-funded 'Net Generation' project, already mentioned, recommends 'appropriately structured and scaffolded access to emerging technologies at university' and 'designing learning activities that model sophisticated "real-life" uses of emerging technologies as they are applied in the professional and scholarly communities' (Kennedy et al., 2008). On the cautionary side, studies of the impact of ICTs in university classrooms (e.g., Gosper, Green, McNeill, Phillips, Preston & Woo 2008) underline the fact that introduction of new technology does not, in and of itself, result in more effective learning.

However, there is now opportunity to employ ICTs to add authenticity to student assignments via, as we have noted, publication of student work for real audiences on the web. Crebert, Bates, Bell, Patrick and Cragnolini (2004) present initial evidence supporting the contention that authentic learning tasks, particularly forms of 'work-integrated learning', are effective in developing students' graduate attributes. This evidence is consistent with the authors' observations of student assessment submissions, including reflective essays, over the past decade, where we have employed strategies that can be recognised as 'authentic'. Our student publication projects can be categorised as work-integrated learning in how they require teamwork among students acting in different roles, handing products of their efforts to other students for editing or graphics or other refinement, and working to tight deadlines.

The overview above of the literature and the authors' experience support the argument that online publication for the development of graduate attributes in science is, at the very least, an area worth investigating.

Eight hypotheses

This project to explore the potential scope for science student publication of new media can be seen to rest on a series of hypotheses, which are described and listed below. We examine each hypothesis in turn, identifying or reiterating evidence that supports the hypothesis, questions that might undermine it, and strategies for determining its validity. Then, we will follow with an overview of the research and development strategies that are addressing these hypotheses within our current project.

Readers will note that some of the hypotheses below appear to be more strongly supported than others. In addition, the veracity of our train of logic as a whole has not been documented in peer-reviewed literature. The authors' classroom experience to date does provide support, though. We suggest that readers consider the extent to which this carefully balanced 'house of cards' situation, with support from published and unpublished evidence as well as accepted theory, is common in innovation processes in teaching and learning in higher education. One might speculate that it is particularly prevalent in areas involving rapidly-changing technology and potentially significant shifts in student capabilities.

Hypothesis 1. – Engagement: New media engage students in authentic tasks & work-integrated learning.

Does new media production actually engage students in authentic tasks in a work-integrated learning environment? The authors' experiences with students in science and science communication in both undergraduate and postgraduate classes support this contention. Our observations indicate that engagement is not universal, but it is effective with more than 90% of students. The publication of student work on the web, and counts of website hits and duration of visits, indicate that products are indeed garnering a 'real world' audience, even if the audience is not large. The organisational set up, production teams as well as task teams that rely on other task teams, that is required by students' assessment activities align with notions of 'authenticity' and 'work-integrated learning', as do tasks where students collect interviews or stories in the world outside the university. However, it is not clear that the engagement and authenticity that we have found for interview-based web stories and production of video is true for all modes of 'new media'. Nor is it necessarily the case that all implementations of interview or video assignments, or assignments employing other media, will engage students or will incorporate effective levels of authenticity.

Hypothesis 2. – Graduate attributes: Authentic tasks and work-integrated learning that new media production offers develop graduate attributes.

Is new media production authentic in a way that boosts development of graduate attributes? The authors' evidence that new media production bolster the graduate attributes of science students is supported by personal impressions of other lecturers employing these types of assignments (Kuchel, personal communication January 13, 2010; Ross, personal communication March 5, 2010). Crebert et al (2004) provide data supporting the notion that work-integrated learning boosts graduate attributes in the specific instance of work placements. That outcome has been echoed in the experiences of authors of this article, who have been supervising student placements in industry. One can thus argue that it is not only work placements but also other forms of authentic tasks that can enhance graduate attributes.

The question remains of whether the sorts of work-integrated learning and authentic tasks involved in the range of types of new media production develop these transferrable skills in an enduring way. Alternatively, can students leave their insights into teamwork and peer review at the door as they leave the classroom at the end of session? How realistic and how emotionally intense does student engagement need to be for such authentic tasks to support not only development but retention?

Hypothesis 3. – Science communication has benefits for learning science content

Can providing attention to science communication within a science class benefit the teaching of science content beyond merely adding contextual information? Or, does engagement with new media distract students from science content? Our investigations have revealed an example of an assignment in a science subject that, common sense would argue, suggests that learning of content knowledge is enhanced. Chemistry students were assigned to each create a wiki on an element in the periodic table. An intended outcome would be that their focus on one element, and their ability and desire to compare their work with that of others, will stimulate students to understand more deeply the characteristics of elements generally. Anecdotal evidence is readily available that science lecturers assign students to analyse and explain specialised scientific content for simulated consultancy reports, policy briefing documents, and media releases. In these cases, the accepted wisdom seems to be that students gain deeper content knowledge through such assignments.

Interestingly, the creation of videos by student teams in a first-year class in biology at the University of Queensland (Kuchel, personal communication, January 13, 2010) has not led to an increase, or a decrease, in the average score on the class's final exam. Some would argue that the absence of a rise in exam performance, however, may not reflect the impact on learning. It may be more an indictment of exams as a measure of learning than of the 'new media' strategy, as often end-of-session exams test recall and surface understanding.

One can conclude that deeper learning can be promised, but it cannot be measured by traditional measures of performance, such as exams, though no decrements in exam scores have been noted. On the plus side, despite the extra energies that students invest in their videos (cited by Kuchel to be up to twenty hours), this science communication-via-new-media element does not visibly detract from learning of science content.

Hypothesis 4. – Scalability: new media assignments can work in large classes.
Are new media assignments constrained by class size? The creation of podcasts, which has been employed in a class of two-dozen postgraduate students focusing on science communication, has been extended for use this past semester in a first-year chemistry class at the University of Western Australia with 350 students. Creation of videos in a first-year biology class has been occurring with a similar number of students at the University of Queensland, as referred to earlier. Similarly, written assignments for web publication have been done in classes of more than 180 students at the University of New South Wales. Experience suggests that new media assignments can scale up, though the upper limit in size has not been explored.

The range of 'new media' where such exercises can be employed has also not been determined. For example, does having a larger class of students, who are mainly novices with new media, contributing to wikis create more problems in policing content, or does the dynamic of a large base of public editors improve standards, the premise on which *Wikipedia* is founded, and does it improve learning? It is the authors' aim to experiment with scalability in large classes across a range of new media types and genres, either in classes that we run or contribute to or by identifying examples undertaken by others.

Hypothesis 5. – Dissemination: What science communication academics and innovative science educators employ in their classes can be taken up successfully by other science academics, particularly when some of those science academics are engaged in the development and evaluation process.
Can one disseminate significantly new ways of teaching among science academics, and how can that be done? Principles of participatory design suggest that involving intended users in the development of a new 'technology' helps to gain buy in as well as identifying desirable features that the developers may not have considered. There is a substantial literature and tradition in the IT industry supporting this approach (Winograd & Flores, 1987 is an iconic example). The particular challenge here is that university academics tend to work in particularly 'atomistic' ways; so that one individual's hesitance, once overcome, is compounded by the length of time between discussions about teaching that might occur among colleagues. As a result, innovations in teaching can be seen to take a long time to spread.

Furthermore, even impressively widespread use of an innovation may result in only a small fraction of the intended or desirable uptake. For example, the online peer review platform of *Calibrated Peer*

Review has been employed at 650 institutions, but that represents only 5 to 10 percent of universities and colleges in the US, where it was developed. Within a single institution of higher learning, there may be only one or a handful of users, a small fraction of the number of academics in a school or department. On this basis, one can argue that what counts as 'successful' dissemination may not reach the vast majority of science academics or their students for years, if not decades, to come.

Spread of ICT-based innovations has not proven to improve pedagogy, per se, as noted in the literature on use of video in classrooms (see, for example, Forsslund, 1991 and Hobbs, 2006). That is evident in everyday observation of 'death by PowerPoint', a technology not used twenty years ago that is in ubiquitous use, though often not particularly effective use, in universities today.

The bottom line here is not merely that innovations in instruction may be slow to spread. It is that strategies for dissemination need to: (a) discriminate between more receptive and less receptive areas of the academic community; (b) involve potential adopters in the design process so that individual conditions can be addressed and buy-in can be built; (c) create more frequent conversations among academic staff about their teaching; and (d) relay not only how to use the technology-based approach but also relay the pedagogical improvements that it affords.

Hypothesis 6. – Pedagogical similarity

Are there pedagogical approaches in common among new media assignments across blogging, video production, wikis, podcasts, etc.? That is, can one use similar sets of conceptual tools whether one, for example, publishes a web page or creates a two-minute video?

The transfer of insights from one topic area to another is the basis of service teaching everywhere, where the statistical approaches taught by mathematicians are meant to be employed in exercises in psychology or biology. Here, we ask if the ability to compose and manipulate 'new media' is as transferrable as the ability to solve an equation. Such transferability in service teaching within and beyond the university context is sometimes called into question in the literature (e.g., Evans 1999) and often enough in the classroom, for example when a biochemistry lecturer teaching second-year students complains that they have not sufficiently learned first-year chemistry.

Some multimedia skills, such as the capacity to create an effective storyboard, are used in assignments for creating either a video or a podcast. Anecdotal evidence suggests that students can transfer these skills into new contexts. There is also evidence from the class of one of the authors that insights in visual composition in making a video can be transferred to the creation of still images in student brainstorming on butchers paper. Evidence supporting such arguments is still tenuous, and this transferability case is in clear need of further attention, both in our project and in further research.

Hypothesis 7. – Publication safety: If pedagogical benefits can be demonstrated, concerns about publication of student-produced science media can be overcome and red tape reduced.

Can student work be published for educational benefit? A canvassing of seventy science lecturers who can be seen to be more involved in, and committed to, teaching (suggested by their attendance at the UniServe Science Conference 2009) has revealed no instances of science classes that currently create wikis, animations, podcasts, or videos where student work is published on the web for a general audience. The lack of publication makes the exercise less authentic. There seems little compulsion expressed by the academics whom we have approached to seek publication, though some express interest in sharing one or two of the best examples from their classes.

It is not clear whether this hesitation is based on concerns about student confidentiality, potential for embarrassment for the institution by the publication of work of a non-professional standard, lack of time to create a web site for student publication, or university policies that frustrate attempts to publish student work on the web. Such barriers and how they may be dealt with by science academics will be explored in our project. They deserve more attention as the web enables student publication, generally, to undergo a transformation from printed matter scattered around a campus to items that are visible much more broadly.

Hypothesis 8. – Authenticity of science media: even student-produced new media that is not entirely refined will engage its target audiences, e.g., high school students.
Even if lecturers' hesitance to have their students' work published is overcome, will that work indeed attract a significant audience, thereby making it truly 'authentic'? The volume of viewings of poorly made videos on *You Tube* and visits to unsophisticated web entries on *Face Book* suggest that authenticity has a unique appeal to younger audiences. Does that attraction occur when content is orientated toward assessable matter in a university science class? Evidence to date on downloads from *iTunes University* indicates that science videos created by postgraduate students studying natural history filmmaking are among the most popular items created at their university, the University of Otago. On the other hand, profiles of scientists who were interviewed by UNSW science students for the *World-Wide Day in Science* (*WWDS*) project are gaining viewers, but they have not, as yet, 'gone viral'. The website has garnered one million web 'hits' in the past twelve months, but only two-percent of those hits (though still thousands per month) result in visits lasting more than thirty seconds. Voluntary uptake by high school students has not occurred (which is why high school lessons plans that incorporate *WWDS* materials are being developed, to shift the 'voluntary' element from student choice to teacher choice).

These results suggest that certain types of science-based new media that are created by students may indeed draw audiences when they replicate typical forms of entertainment (such as viewing *You Tube* videos). Other forms may garner attention only as enrichment material when referred to specifically in high school instruction, in revision for exams for a university class, or in other structured and compulsory ways. Questions about the impact on the ultimate audiences for students' work require further research.

Discussion and conclusion

This delineation of eight hypotheses illustrates a range of types of logical support for the educational benefits of science student publication in new media but also a set of questions in need of investigation. These questions revolve around the level of 'authenticity' that different types of new media creation and publication might provide, the positive or negative impact of such efforts on learning of science content, scalability from mid-sized classes (a few hundred) to larger classes (up to and beyond 1000 students), rate of uptake by science lecturers, transferability of skills and insights across new media, wariness about publication for outside audiences, and the impact of student-created content on such audiences. Despite these unanswered questions, our 'science in new media' project, described next, has passed peer review and been awarded funding.

Development of materials
We are in the midst of producing guidelines for student projects and assessment tasks, teaching strategies and lesson plans, case studies, and workshops. These materials are being evaluated by university science academics to assess the extent to which they can be of value in integrating student web publication and accompanying development of graduate attributes in the teaching of large science classes. The aim is to enable students to produce new media publications in four areas: (1) podcasts, (2) videos, (3) blogs, and (4) mixed media websites. A set of four teaching or assessment strategies per new media area is an initial target for testing.

Our evaluation and testing protocol for these materials will involve up to ten science academics in each of the four areas. They will be assessing a range of materials, such as guidelines for marking and student peer review, instruction for making 'pocket videos' with the cameras in mobile phones, iPods, and laptop computers, and assignment sheets for guiding, for example, first-year chemistry students in the creation of podcasts on class content.

Web platform

Our project requires creation of a venue for web publication of material produced by science students. This platform has two layers. One layer is for content specifically for peer reviewing within a subgroup of a class, a whole class, across classes, or across universities. *Calibrated Peer Review®* (*CPR*) provides one mechanism for student peer review. It enables assessing factors such as the suitability of content and presentation strategies for the intended audience and message. *CPR* is already employed by over 650 universities (as already noted) for text-based assignments. Developed with funding from the US National Science Foundation, it has demonstrated, in the experience of the authors and other users, an ability to boost constructive feedback to students while lightening the marking load of academics. The peer review process on *CPR* has also shown that it can improve students' critical thinking, as well as their composition abilities. That is evident in the quality of student writing and argumentation that we have seen in our classes as well as in students' reflective essays, class discussions, and end-of-session feedback.

The other layer of this project's web platform will contain content that is deemed by students and academic staff as worthy of showing to the wider community. This layer will accommodate publication of mixed media: text; images; audio; and video. There will also be links to existing online forums and publications: *iTunes University*; *World-Wide Day in Science*; *The Triple Helix* student science magazine/journal; and *YouTube* (university-based *YouTube* channels).

Both layers of the platform offer the potential for multi-university and international collaboration for students and staff. The range of audiences, from local to international, of these platforms enable gauging the extent to which various types of assignments can achieve the desired educational effect of being 'authentic' tasks.

Action research

To investigate both contextual factors and the educational effectiveness of web publication, we are employing an action-research strategy that involves science lecturers in evaluating and testing the new media publication materials that we have identified and are now refining. The action-research approach reflects what has been called '2nd generation innovation' (Southwell, Gannaway, Orrell, Chalmers, and Abraham 2005), where potential adopters of novel teaching approaches are engaged in their re-design. Participatory design is widely employed in the software and computer industries, as already noted. In this project, early engagement of science lecturers becomes a first step in dissemination of the teaching materials, where dissemination is warranted. It also assists in generating critical research questions about why such approaches do not work in various contexts and in demythologising why they should or should not be attempted.

The research agenda for this project is designed around lecturers in science and science communication collaborating in development of teaching materials for web publication by students in mainstream science subjects. This collaboration is intended lead to formation of a community of practice (Lave and Wenger 1991) to address common concerns, such as development of student employability through more engagement of students in building their graduate attributes and a more accurate portrayal of science in public (Wellcome Trust 2000; Jasanof 1998).

Community of practice

A key outcome intended for this project is growth of such an international network, or community of practice. It would involve not only science academics but students who have a clearer understanding and greater capability to address opportunities and avoid pitfalls associated with web publication. The project's workshops at conferences and universities, along with follow-up by the project team, are conceived to build connections among academic staff interested in new media publication by their students, a strategy recommended by McKenzie, Alexander, Harper, and Anderson (2005).

A kernel of this community of practice is already evident in the project's core team, the authors and their project officers, along with early collaborators among science academics. The community can readily extend to members of an Australian and international network of science communication academics (ENSCOT Team 2003; Turney 1994). Staff from ten universities, members of the Science Communication Education and Research Network of the professional organisation, Australian Science Communicators, have already contributed to the planning of this project.

In sum, that is our approach – building on the authors' teaching experiences and data gathered from assessment tasks and student feedback, drawing on recent literature that resonates with that experience, and employing participatory design so that what we provide for lecturers makes sense against their touchstone, their classroom experience, and so that we can build a community of practice to examine and extend such approaches.

Current directions

We have gained positive attention from science academics. Over sixty participants across three sessions at the UniServe Science Conference 2009 were able to fill a whiteboard in five minutes with hurdles to implementation. However, they were also able to fill a board just as quickly with potential benefits of student web publication in their classes. Though these participants were self-selected as keenly interested in effective teaching of university science, they were not self-selected to attend our 'new media' sessions, as our project provided sponsorship in exchange for fifteen minutes with each of four special interest groups (biology, chemistry, physics, and teaching and learning). At a separate, unsponsored conference session on our project, half of the thirty participants were able to brainstorm possible new media assignments that they might like to undertake. It appears that new media are 'on the radar screen' for teaching and learning in university science. They thus deserve the careful scrutiny of circumspect development.

The train of logic in support of web publication as a boon to university science teaching is not entirely on firm foundations. It might indeed be seen to be a 'house of cards'. Should these shaky foundations be treated as rational deterrents, or are they a set of rational-sounding excuses that can be overcome with careful experimentation?

Such questions have not stopped a small group of science academics from experimenting with new media already, a larger group from volunteering to assist us in experimenting, and a greater number from offering to evaluate material that we gather and develop. House of cards or not, one can argue that the spirit of experimentation is alive, at least in some corners of university science teaching. We would thus argue for both ongoing experimentation as well as investigation of the individual hypotheses that we have listed above. We should do that not only with today's 'new media' but with that of tomorrow.

Acknowledgement

Support for the research described in this article has been provided by the Australian Learning and Teaching Council Ltd, an initiative of the Australian Government Department of Education, Employment and Workplace Relations. The views expressed in this article do not necessarily reflect the views of the Australian Learning and Teaching Council.

The authors wish to thank the two reviewers for constructive insights, encouragement, and editorial suggestions.

References

Australian Council of Deans of Science (2001) *What did you do with your science degree? A national study of employment outcomes for science degree holders 1990-2000*. Centre for the Study of Higher Education, University of Melbourne.

Crebert, G., Bates, M., Bell, B., Patrick, C-j, and Cragnolini, V. (2004) Developing generic skills at university, during work placement and in employment: graduates' perceptions, *Higher Education Research and Development*, 23(2), 147-165.

Davies, S. (2008). Learning to Engage; Engaging to Learn: The Purposes of Informal Science-Public Dialogue. In *Investigating Science Communication in the Information Age: Implications for public engagement and popular media*, eds. R. Holliman, E. Whitelegg, E. Scanlon, S. Smidt, and J. Thomas. Oxford University Press.

DEST, 2002. *Employability skills for the future*. Available from: http://www.dest.gov.au/sectors/training_skills/publications_resources/profiles/employability_skills_for_the_future.htm.

Dumlao, R. and Duke, S.(2003) The Web and E-Mail in Science Communication, *Science Communication*, 24: 283 - 308.

ENSCOT Team (2003) ENSCOT: The European network of science communication teachers, *Public Understanding of Science*, 12, 167 - 181.

Evans, J. (1999) Building Bridges: Reflections on the problem of transfer of learning in mathematics, *Educational Studies in Mathematics*, 39: 23-44.

Forsslund, T. (1991) Factors that influence the use and impact of educational television in school, *Journal of Educational Television*, 17(1), 15–30.

Gosper, M., Green, D., McNeill, M., Phillips, R., Preston, G., Woo, K. (2008) *The Impact of Web-Based Lecture Technologies on Current and Future Practices in Learning and Teaching*, http://www.cpd.mq.edu.au/teaching/wblt/overview.htm, Australian Learning and Teaching Council, Sydney.

Hobbs, R. (2006) Non-optimal uses of video in the classroom, *Learning, Media and Technology*, 31(1): 35-50.

Hutton, P. and Pluske, J. (2005) *University units specialising in scientific communication are valuable for teaching generic skills*. Report for UWA Teaching Intern project. CATL. U of Western Australia.

Jasanoff, S. (1998) Coming of Age in Science and Technology Studies, *Science Communication*, 20, 91-98.

Kennedy, G., Dalgarno, B., Gray, K., Judd, T., Waycott, J., Bennett, S., Maton, K., Krause, K.L., Bishop, A., Chang, R. & Churchwood, A. (2007) The net generation are not big users of Web 2.0 technologies: Preliminary findings. In *ICT: Providing choices for learners and learning*. Proceedings ASCILITE Singapore 2007 (pp. 517-525). Accessed from: http://netgen.unimelb.edu.au/publications/published.html 25 April, 2009.

Kennedy, G., Dalgarno, B., Bennett, S., Judd, T., Gray, K., & Chang, R. (2008) Immigrants and Natives: Investigating differences between staff and students' use of technology. In Hello! Where are you in the landscape of educational technology? Proceedings ascilite Melbourne 2008. Accessed from: http://netgen.unimelb.edu.au/publications/published.html 25 April, 2009.

Lave, J. and Wenger, E. (1991) *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press.

McKenzie, J., Alexander, S., Harper, C., and Anderson, S. (2005) *Dissemination, adoption and adaptation of project innovation in higher education.* Carrick Institute of Learning and Teaching in Higher Education. http://www.carrickinstitute.edu.au/carrick/webdav/site/carricksite/users/siteadmin/public/Dissemination,%20Adoption%20and%20Adaption.pdf

Mulder, H., Longnecker, N., and Davis, L. (2008) The State of Science Communication Programs at Universities Around the World, *Science Communication* 30(2): 277- 287.

Raison, M. (2006*). Macquarie University: Science, Engineering and Technology Study*. Macquarie University.

Southwell, D., Gannaway, D., Orrell, J., Chalmers, D., and Abraham, C. (2005) *Strategies for effective dissemination of project outcomes: A report for the Carrick Institute for Learning and Teaching in Higher Education*. The U of Queensland and Flinders University.

Rifkin, W. (2007) Beyond Words. In *Designing Information and Organizations with a Positive Lens: Advances in Appreciative Inquiry, Vol. 2,* eds. M. Avital, R. Boland, and D. Cooperrider, Elsevier, 189-204.

Rifkin, W. (2004) World-Wide Day in Science, *Learning and Teaching Support Network Bioscience Bulletin*, UK Higher Education Academy, Spring.

Tatalovic, M. (2008) Student science publishing: an exploratory study of undergraduate science research journals and popular science magazines in the US and Europe, *Journal of Science Communication*, 7(3), http://jcom.sissa.it/.

The Carrick Institute for Learning and Teaching in Higher Education (2007) *What's Happening in Science?* Sydney.

Trench, B. (2008) Science reporting in the internet's electronic embrace. In *Investigating Science Communication in the Information Age: Implications for public engagement and popular media*, eds. R. Holliman, E. Whitelegg, E.

Scanlon, S. Smidt, and J. Thomas. Oxford University Press.

Turney, J. (1994) Teaching science communication: Courses, curricula, theory and practice, *Public Understanding of Science*, *3*, 435 - 443.

UNESCO (2003) Science for the 21st century: a vision and basis for action; World Conference Declaration on Science and the Use of Scientific Knowledge, scientific agenda, action plan, Budapest and Santo Domingo, 1999. -- Brasília: UNESCO, Available from: http://unesdoc.unesco.org/images/0013/001315/131550e.pdf

Wellcome Trust / MORI (2000) *The role of scientists in public debate*. London: Wellcome Trust.

Winograd, T. and Flores, F. (1987) *Understanding Computers and Cognition: A New Foundation for Design*. Norwood, New Jersey: Ablex Publishing.