Real-World Assessment as an Integral Component of an Undergraduate Science Communication Program

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Abstract

This paper discusses Australia's oldest and largest undergraduate science communication program: that offered at the Centre for the Public Awareness of Science at the Australian National University. We outline the history of the program, and explain the pedagogy that drove its development. In particular, we address the assessment of student learning, which focuses on 'real-world' tasks. The four main assessment approaches discussed are 1) online blogs and opinion pieces; 2) a student conference, 3) research publication, and 4) work-integrated learning. These assessment approaches specifically target skills required by graduates to achieve both within the university and professionally. The different approaches require students to employ diverse communication techniques and strategies appropriate to their chosen audience. Students also gain practical experience outside of the university context, allowing them to recognise the relevance of their studies within an industry, private or government environment. Although these assessment practices are embedded in a specific science communication curriculum, we suggest that they can be incorporated within any science discipline major.

Introduction

Science communication as a practice is as old as science, but as an academic discipline it is relatively young (Rifkin, Longnecker, Leach, Davis & Orthia, 2010). Many science communication academics date its origins to 1985, with the publication of the Royal Society of London report *Public Understanding of Science* (London Royal Society, 1985). Others trace it to 1945, with Vannevar Bush's influential manifesto *Science: The Endless Frontier*, advocating that the US President institute a national science policy and public science funding (Bush, 1945). Whatever the origins of the field, tertiary education programs that teach students about communicating science with the public are a recent phenomenon. While postgraduate programs in science communication are relatively common, dedicated undergraduate programs are rare. Most universities that offer undergraduate science communication training only have one or two courses in the discipline.

In this paper we discuss the undergraduate science communication program that we believe is the biggest in the world, in terms of the number and diversity of course offerings: that of the Centre for the Public Understanding of Science (CPAS) at the Australian National University (ANU). In the first section, we trace our program's history, including the imperatives and constraints that shaped its development over 15 years. In line with Mellor's (2013) history of the MSc in Science Communication at Imperial College, we offer reflections on factors that have contributed to the program's longevity. In the second section, in keeping with this special edition's practical brief, we describe some assessment tasks currently used at various stages of our curriculum; these draw heavily on 'real-world' applications, and enable students to put their work in the public domain from first year onwards. Although the activities presented form large components of whole courses, we argue that elements of these tasks can be easily integrated into science subjects, in any discipline.

The CPAS undergraduate program

The CPAS undergraduate program was a spin-off of our longest-running program, the Master of Science Communication Outreach, an innovative degree that includes a hands-on apprenticeship in managing and delivering travelling science shows and science centre exhibits (Bryant, 2012). In 1998 the first undergraduate course in science communication was established to address concerns about scientific literacy, the image of science and the seeming inability of scientists to communicate effectively (pers comm Bryant, 2014). From 2015 the CPAS science communication program will offer 11 courses to undergraduates. These can be taken as electives, a Major, or a Minor either in conjunction with mainstream science or as a stand-alone discipline. The courses mix practical skills with science communication theory and research techniques. The program's overall aim is to equip graduates with the ability to critically evaluate, and clearly communicate, science-related information in the public domain, whether their aim is to reach any non-scientists, or specific 'publics' such as government, business, community groups, the media, or other defined demographic sectors.

CPAS ensures the skillset and teaching approach are relevant to students seeking professions in science communication and associated fields, to those embarking on careers as research scientists, and to those pursuing applied science professions that demand routine interaction with stakeholders, patients and clients. CPAS students are drawn from all areas of science and engineering, and many are enrolled in double degrees. We also attract students from advanced degrees such as the Bachelor of Philosophy (PhB) and from international exchange programs. CPAS courses are designed to accommodate this enriching disciplinary diversity, with considerable freedom in assessment items and case studies for students to focus on their areas of interest.

Modern challenges such as climate change, genetically modified crops, and predicted global food shortages have been identified as key reasons for scientists to "communicate like never before" (Gleadow & Nowak, 2013, p. 28). This is not new, with UNESCO making a similar call in 1999, stating:

> *relevant professional institutions should improve or develop programs for training scientific journalists, communicators and all other participants who are involved in increasing public awareness in relation to science (p. 55).*

The interdisciplinary nature of science communication has been identified as an important vehicle for developing science graduates' skills and attributes especially, but not only, communication skills (McInnis, Hartley, & Anderson, 2000). Most Australian universities aim to produce graduates who have abilities in key groups of attributes (Oliver, Whelan, Hunt, & Hammer, 2011), many of which align with what potential graduate employers are looking for (ANU, 2011). Although there is no definitive single list of attributes (Barrie, Hughes, & Smith, 2009) typically they include things like teamwork, thinking skills, civic engagement and tellingly "most lists include capabilities that cluster around communication"

(Oliver et al., 2011, p. 6). In a study defining the expected academic standards for degree programs, one of the five threshold learning outcomes identified for science students was that they will be effective communicators of science (Yates, Jones & Kelder, 2011).

Despite this recognised importance, a factor limiting CPAS's growth is the lack of institutional interest in making science communication courses compulsory for science students. CPAS enrolments have therefore stayed relatively low: most recently 60-65 students for first year courses, 18-35 for second year courses, 10-20 for third year courses, and 1-6 for internship or research project courses. The advantage of relatively small numbers is that it has been possible to offer innovative, real-world-based assessment items (discussed below), rather than falling back on large-class staples like exams. These assessment items and the close-knit community environment cultivated in our courses have gained us very high student evaluation scores. Students rank course experience on a five-point scale, with the ANU aspirational benchmark set at 4 out of 5. Our courses have averaged 4.25 out of 5 on this metric, ranging up to 4.7, compared to the science mean of 3.93 out of 5. Our courses have also almost always rated higher for this metric than non-science disciplinary groupings. We have examined student satisfaction in similarly-sized courses (fewer than 40 students) in the science disciplines; their average score is 4.1. This is slightly lower than our average score, which suggests student satisfaction with the nature of CPAS courses, including the assessment tasks.

As noted, a strength of our courses is innovative assessment in which students operate in the real public domain. This strength is a benefit of increasing specialisation, because real science communication is context-specific in terms of mediums, audiences, stakeholders, aims, and topics of interest, and this is easier to emulate within topic- or medium-specific courses. Accordingly, three assessment items we discuss are offered within specialist courses. It is more difficult to do 'real-world' science communication within a more generic course, but not impossible. Several of our courses use web-based platforms to put student science communication into the public domain, two of which we describe below. The literature emphasises the need for graduate attributes "to be taught within a discipline, integrated and embedded in a curriculum" (Bath, Smith, Stein, & Swann, 2004, p. 314). The assessment tasks presented here could be adapted to fit within wide-ranging science curricula, allowing more holistic integration of graduate attributes into courses.

Case studies in 'real-world' assessment

In applied fields such as science communication, educational experiences that mimic real-world practice are of great value (Docan-Morgan, 2009; Veil, 2010). Such experiences enhance students' sense that their classes are useful by giving them the opportunity to apply the theory they have learned to real projects. They also promote active learning, with students taking responsibility for creating knowledge themselves (Veil, 2010), and frequently enhance professional networking opportunities. Experiential learning tasks are also excellent sources of higher-order skills in graduates, which are perceived as valuable by both employers and students (Clark & White, 2010). Examples of experiential learning include practice-based learning (Barraket et al., 2009), internships (Clark & White, 2010), and client projects (Hamilton & Klebba, 2011). The experience in real-world settings also contributes to the development of professionalism in students (Nunamaker, 2007), a desirable trait for prospective employers.

Below, we provide four case studies of ‘real-world’ undergraduate assessment tasks, and include an evaluation of their reception by students and, where applicable, external partners and stakeholders. The case studies are drawn from five of our six longest-running courses. The sixth course, excluded from discussion here, is one we co-teach with another department. Our more recent course offerings also include ‘real-world’ assessment items, but space prohibits a discussion of them.

Publishing online: student blog posts and opinion pieces

Two of our undergraduate courses require students to write science-focused opinion pieces that are designed for sharing online. This kind of assessment item can be adapted to fit into a science course in any discipline, with marking rubrics adapted to course learning outcomes. Opinion pieces are directly relevant and useful to the future careers of science students, because they enable scientists to place their unmediated work into the public domain.

In our first-year course ‘Science Communication 1’, half the assessment involves ‘translating’ a scientific journal paper for different audiences and mediums. Students choose a research paper from any science journal, summarise it in plain language (200 words), then write a short essay (300 words) about why it might be difficult to communicate in the public domain. Each student then ‘translates’ their paper for two audiences/mediums, chosen from a list of five: a public lecture-style presentation; a news article for a quality news outlet; a tri-fold leaflet designed for a clinic or NGO; a mock grant application based on Australian Research Council Discovery Project forms; or a 300-500 word argumentative blog post. Students are encouraged to choose options that suit their career ambitions and the paper’s content.

The blog post option requires students to post their piece live on the science communication students’ blog, (Sandpaw - http://sandpaw.weblogs.anu.edu.au/). Their brief is to take a side on the issue the paper discusses, and persuade undecided readers to join them. Students learn the hallmarks of a quality academic blog post, such as the need to link to other content (including the journal paper itself), and to critically consider what styles of argument are most likely to persuade.

Beyond pedagogical benefits, students benefit from this option in terms of public reputation. Some posts have reached the first or second page of hits on Google for their chosen topic. At the time of writing, the ten most-visited posts had garnered 3,181,500 views (mean = 719), averaging 8 minutes per view. This is an impressive level of exposure for a first-year student.

In the third-year course ‘Science, Risk and Ethics’, the stakes are raised, and students are required to write four short opinion pieces (‘op-eds’ of 600-800 words) focussing on two potentially controversial, science-based issues current in the public arena. Throughout the course, students are exposed to scholarly, popular, and editorial articles that reflect upon and analyse science-relevant issues such as drug prohibition, research using animals, applications of nanotechnology, and calls for action on climate change. The complexities of representation of these issues are considered against a backdrop of scientific evidence, models of risk perception and communication, and, critically, ethics. In a typical analysis a student would collect representative texts from relevant media, conduct conceptual content analyses on these, and compare pertinent findings with existing scholarly literature.

Students are encouraged to choose topics about which they have strong opinions. They write two opinion pieces for each: one arguing in support of the issue, and one against.

Consideration is given both to scientific facts and the presentation of reasoned arguments based on pertinent values and ethical perspectives. Submissions require an annotated reference list, articulating why each reference was useful. Students indicate a target venue and provide a rationale for why their pieces are appropriate. Those who have written suitable pieces are offered the opportunity to publish them, or to co-publish with the lecturer.

Training includes advice and techniques for op-ed writing in lectures and course material; direction to the 'information for authors' areas of opinion sites (The Guardian, ABC Unleashed, The Conversation, The New York Times); and feedback on drafts from the lecturer, an experienced opinion writer. A student would typically spend 20-40 hours on this task, although this can vary, depending on students' aptitude and interest. Assessment criteria focus on elements such as: the cogency of arguments, the suitability of the language and structure for the target publication, the finesse with which facts and opinion are woven together, and the extent to which the pieces could be considered persuasive according to an array of recognised rhetorical and psychological techniques covered during the course (e.g., Fischhoff, Brewer, & Downs, 2011; Goldstein, Cialdini, & Griskevicius, 2008; Myers, n.d.).

For science communication students, blog posts and op-eds represent an increasingly important example of 'work-integrated learning' tasks (Crebert, Bates, Bell, Patrick, & Cragnolini, 2004). Such authentic activities are proven drivers of learning in science communication courses and they have myriad benefits as educational tools (Rifkin, et al., 2010). When students write in support of a position with which they agree they are obliged to consider the rationale for their perspective, rather than blindly asserting beliefs. When writing to support a case with which they disagree as in 'Science, Risk and Ethics', they are compelled to consider arguments with which they would not normally engage. These kinds of tasks enhance students' potential for using their science communication skills to more deeply engage in democratic discourse (Culver & Jacobson, 2012).

Blogs and op-eds are also often the only activities in which students enrolled in science-intensive degrees are asked to craft and present an argument that involves combining evidence with opinion and persuasive rhetorical writing techniques. This type of experience and skills practice is particularly relevant to students who are likely to go into careers that involve communicating science-based information for the purposes of changing people's behaviour, such as encouraging pro-climate or positive health behaviours.

Students report being challenged by these tasks, but also suggest they find them rewarding. Such responses broadly resonate with the findings of Carroll, Diaz, Meiklejohn, Newcomb, & Adkins (2013), who suggest that online assessment enhances a sense of greater participation in science and society by introducing the possibility that the public may read their work, and interact directly with them as a result. Some students have been sufficiently inspired by the experience to change their minds on issues they had not previously considered contestable, while others pursued blogging or opinion writing after the courses ended.

Large group activity organising a publicly-focused science communication event

Looking at the education of computer science students, Gruba and Søndergaard have argued that from a social-constructivist perspective of education, "learning is best achieved when students face complex, real-world problems in which there are no clear answers" (2001, p. 203; see also Merrill, 2002, p. 45). For them, getting students to collaborate in the organisation and delivery of a sizeable goal – a public conference – was an excellent way to achieve this. This thinking underpins the pedagogical approach embodied in our second-year course, ‘Practical Skills for Communicating Science’. In this course students work together to organise and deliver a publicly-focused science communication conference at which they and other science communication students present. The goal is to equip the students with the skills and knowledge necessary to successfully deliver such an event, and to understand the underlying processes of large-group-decision-making and organisation.

Throughout semester the students (typically about 20) participate in two strands of activities, in-class teaching time and assessment. Class teaching focuses on planning, organising, and delivering the conference. Students participate in guided group work to achieve this, typically deciding groups of roles early (often Advertising, Logistics, Scholarly Quality, and Budget), then choosing roles within them.

Students then work on key issues in their groups and in discussion with the whole class. Key discussions include the conference venue (in this case the Logistics group sources options and provides ideas, and then the class makes a collective decision) and the conference theme (here the Scholarly Quality group raises options and ideas, and then guides the class in making a decision).

Every week in class the students take steps towards the conference organisation, while also self-organising out-of-class activities, drawing on the ideas put forward by Collis and Moonen in their ‘contribution model’ of pedagogy (2006). In addition to sourcing venue and themes, activities typically include finding suitable keynote speakers; organising catering; conducting fundraising activities (raffles, trivia nights, bake and chocolate sales); and advertising via social media and physical forms, such as posters and advertisements in print media.

Throughout the course students are guided in their decision-making so that, as much as possible, they develop a sense of ownership of, and responsibility for, the conference, echoing the benefits argued by Gruba and Søndergaard (2001). This includes recognising the needs of the wide range of stakeholders, and constraints at hand. Considerations include (i) making sure the venue is accessible for their likely audience; (ii) providing appropriately diverse; (iii) accounting for the needs of other students presenting at the conference; and (iv) making sure the conference theme is marketable, while still being sufficiently open to allow students from different backgrounds to present (e.g., recent conference themes have included ‘Food’, ‘The Future’ and ‘Disasters’).

A sequence of formal assessment items focus, and allow the monitoring of, this work. In a pre-conference organisation report (worth 5%), students document their understanding of their role in organising the conference and explain whom their role impacts. After the conference, students submit a reflective organisation report (5%) detailing their opinion of their and their classmates’ work. Teaching staff take these reflections into account when providing their mark for students’ individual conference organisational role (10%).

The second strand of activities focuses on students’ own presentations at the conference. In class, they participate in guided discussions on aspects of good public speaking skills - including considering the audience, storytelling, pace, tone, body language, visuals and props - and practice these skills in tutorials each week. Practice sessions – drawing upon online discussion forum (10%) – have groups of between five and 10 students with the others providing feedback to their peers. In a ‘low stakes’ setting such as this, peer feedback has been shown to provide reliable assessment (Kakar, Catalanotti, Flory, Simmens, Lewis, Mintz, et al., 2013).

In developing their conference presentations, students are guided by class members (including via peer review) and assessment items. Once the conference theme is chosen, students choose an individual, related topic and write a short paper (worth 25%) covering background research. Recent examples include examinations of ‘The End of the Universe’ and ‘Threats to Humanity’ under the ‘Futures’ theme, and ‘Chocolate Cravings’ and ‘Genetically Modified Foods’ under the ‘Food’ theme. Students typically select topics that reflect their disciplinary backgrounds and interests.

Later in semester students turn these research papers into plans for final presentation. This takes the form of either a documented list of what points will be made when, what props will be used, or a set of PowerPoint/Keynote slides. This is submitted to the lecturer for formal assessment (10%), and classmates for peer review and critique (Søndergaard & Mulder, 2012). This peer review is itself formally assessed (following Carson & Glaser, 2010) and contributes 10% of the final grade. Review and critique of students’ plans is based on the characteristics of good public speaking skills covered in class. Finally, students give their presentations during the conference (worth 25% of the grade), formally evaluated by tutors/lecturers and informally evaluated by Science Communication 1 students.

On the whole, students relish the challenge and appreciate the skills fostered in this course. Students often describe the course as not only enjoyable, but “really valuable”. A student’s comment illustrates the overall sentiment of student evaluations, noting this was a:

> *very good course on communication (and not just science communication). I learnt A LOT about how to present and how to make it a good presentation for the audience. The conference was an amazing experience and I learnt so much from other people about food [the topic of that year’s conference] too. I got to work with amazing students and the lecturer was really passionate as well.*

Publication-oriented student research projects

The second year course ‘Science in Popular Fiction’ teaches science communication research skills. The major assessment item is a research project worth 50% (in two parts: project proposal and final report), in which students devise their own research question and methods, find and critically review relevant literature, collect data via a focus group they organise, and analyse their results. Research questions typically investigate how participants respond to an aspect of science in a film or television episode, for example whether *Gattaca* (1997) shapes people’s views about designer babies.

Students choose from two options for this assignment. Option A is an ordinary assignment (completed solo for assessment), which teaches students qualitative and social science research methods. Option B involves a group project aimed at the possibility of publication in a peer-reviewed journal. Students devise their project as a group under the lecturer’s supervision. They develop a focus group protocol that must receive university ethics approval before implementation. Their proposal and ethics application is given a single mark, moderated for individual contributions. They then proceed as for Option A - each student facilitates, transcribes and analyses one focus group using the group-devised protocol, for an individually completed report. Option B thus collects data from multiple replicate focus groups, building a large sample size that opens the publication possibility. After the course, the group and lecturer decide whether the data are strong enough to warrant attempting publication.

This course has run four times, always with 6-10 of 22-35 students choosing Option B. Every project was based on a television episode (2010 *The Simpsons*, 2011 *Bones*, 2012 *House*, 2013 *NCIS*), with mixed success in publication attempts. The 2010 cohort's project was published in the *International Journal of Science Education Part B*, with the lecturer as lead author (Orthia, Dobos, Guy, Kan, Keys, Nekvapil, & Ngu, 2012). The 2011 cohort made publication attempts, and while weak data prevented success, the manuscript was posted online with a student as lead author and lecturer second (Coonan, Orthia, Bloomfield, Horst, Pascoe, Schiffl & Axelsen, 2013). Inspired by this student's dedication, the 2012 cohort wrote up their results without the lecturer's co-authorship (but under supervision), to attempt an all-student-authored publication. That process is still underway. The 2013 cohort is still deciding how to proceed.

Irrespective of publication success, feedback indicates that Option B enhances the learning experience of students in terms of disciplinary knowledge, career-plan clarity, and general academic skills, as reported for other undergraduate research projects (Alamodi et al, 2014; Pacifici & Thomson, 2011). Students enjoy engaging in real collaborative research, being treated like adults, and learning what journal paper submission and peer-review entail. They have found it "*fun and challenging*", that it "*[made] the whole idea of doing postgraduate research less scary*", "*honed professional academic skills*", that they "*learnt to work better in a team*" and "*learnt a lot about science communication and its relation to our chosen medium of entertainment*". In the words of one student, the project:

> *improved my confidence, assisted with the development of my writing style, and above all, enabled me to visualise my future applying the knowledge I gained in the field of science communication.*

It is unusual for students to publish research completed as coursework rather than in a designated 'undergraduate research' course, but raising the possibility in second-year fosters student interest in research. So far half the Option B students have completed a third-year research project and/or honours. Naturally, published students appreciate what publishing adds to their professional reputation. While many universities publish a peer-reviewed undergraduate journal, students consider publishing in a professionally-recognised journal to be an achievement worth striving for.

This assessment strategy shows that it is possible for second-year students to develop real, publishable research projects. In part this is because science communication-oriented research in the popular fiction area is relatively sparse, so there are many questions unanswered and gaps in the literature. However, the only other report of a similar program that we are aware of was in biochemistry (Pu, 2010), an extremely well-studied subject, so the approach need not be unique to science communication.

From the lecturer's perspective, time spent mentoring Option B during the course is offset by time saved marking a group assignment instead of multiple individual assignments. The publication attempt activities after the course are more time consuming, but it is essentially publication-oriented work, so potentially worth the investment for a teaching-oriented academic. This approach is more time-efficient than one-on-one supervision of undergraduate research projects.

Work-integrated learning: students as 'consultants' for industry

The third-year 'Science in the Media' course involves assessment tasks grounded in journalistic writing, media analysis and the development of communication plans. The major assessment task (worth 50%) is a group project undertaking a communication consultancy for an external organisation, marked on interim (10%) and final (30%) reports and a presentation (10%). Interim reports are included to encourage group collaboration (Noonan, 2013). Each group member's evaluations of their and their colleagues' performance moderates the mark, highlighting the importance of contributing to the group (Noonan, 2013), and passing some assessment 'power' to students, which Sedgwich (2010) suggests enhances learning.

This assessment type provides students with an appreciation of how science communication 'works' beyond universities, and gives them tangible examples of applying theory in practice and evidence of their abilities, which they can use in seeking employment. Providing science students with varied writing tasks better prepares them for the workplace - preparation that Australian employers have identified as lacking (Gray, Emerson & MacKay, 2005). This assessment program has run once thus far, so evidence is somewhat limited. However initial results are promising.

The first iteration saw 16 undergraduates (two groups of five, one of six) complete consultancy projects for different clients: a medical-related professional body; a peak scientific body; and a federal government program. Each had a different range of tasks for the students, including producing materials such as web presences, social media strategies, brochures, banners, posters, articles, media releases and YouTube video scripts, and conducting stakeholder research. In each organisation a contact officer acted as the students' supervisor and mentor in collaboration with the lecturer.

The students produced materials and planned communication strategies that would actually be used by organisations, and this, rather than producing work only for assessment, created a different mind-set. Anecdotal feedback throughout the semester showed the students were very concerned with the quality of their work. They also developed their interpersonal skills as they managed routine interpersonal communication difficulties with other team members and stakeholders, a key skill employers would like graduates to have, but often find lacking (McInnis, Hartley, & Anderson, 2000; Yorke & Harvey, 2005). Students largely self-managed their group performance, demonstrating a skill that is both crucial in workplace settings and broadly considered as an important aspect of lifelong learning (Noonan, 2013). Challenges specific to projects varied: the group working with the medical-related organisation experienced communicating about a contentious issue; the government group learnt much about government process and requirements; and the peak science body group gained insight into stakeholder negotiation.

The lecturer liaised with mentors to ensure there were no problems. Most groups did not have any, but one had a communication breakdown with their mentor, when someone else was brought in to oversee them without being briefed. The initial assignment brief had been intentionally vague, to allow students some choice in their tasks; this contributed to the lack of clarity and direction. The lecturer facilitated a meeting with the new mentor and students and they re-established a set of deliverables and deadlines. Consequently, future mentors will be required to clearly document their expectations of the project and its outcomes in the beginning. For example what exactly do they want the students to produce? What are the deadlines? How often do they expect to communicate with the students? As a guide, mentors need to devote about an hour per week to supporting students.

Mentor evaluations were positive overall, indicating they would be willing to participate again. Typical comments included:

> *…what a pleasure the group was to work with, and how impressed we have been with their dedication, creativity and hard work (Science organisation)*

> *I was very impressed with the standard of their work. As non-PR/-Comms students they really brought their writing and communication skills to the project… This took very little of my time but has presented me with some great ideas for future campaigns (Medical-related organisation)*

> *I really enjoyed it. I appreciated all the support through the process, particularly as I came in at the halfway mark. While the project was not a particularly efficient means of developing the relevant communication material, we were very pleased to be involved in helping develop the students' skills (Government program – emphasis respondent's)*

Students were able to give feedback throughout the semester, either anonymously online or at a final debriefing. Student evaluations conducted at a faculty level are better predictors of satisfaction than institutional surveys (Denson, Loveday & Dalton, 2010) so the comments are useful to illuminate students' perceptions of the assessments. Part way through some admitted feeling daunted or 'a bit lost', especially in the group with the poorly-defined project. Although some sense of feeling 'daunted' at having to problem-solve and identify alternative options can stimulate critical thinking (Mackay & Tymon, 2013), having too much uncertainty was unsurprisingly counterproductive. Pushing the students to take ownership of the project and identify potential solutions to problems within clearly-defined objectives appeared, however, to have a positive influence on learning. Students were better able to appreciate the value of what they had done, as illustrated by their comments (examples are shown below):

> *The major assessment task - that was interesting and useful for real life experience. It was a really great thing to go through. (from formal course evaluation).*

> *I just wanted to let you know that I got that volunteer position that I applied for… I want to say thanks for the opportunity to get some real life comms experience last year in Science in the Media, because the social media skills from that really convinced them to get me in to help them out (unsolicited email).*

Conclusion

This paper describes the 'real-world' assessment used in an undergraduate program in science communication born from a single course developed to teach science students effective written and oral communication. The initial purpose of this program was to serve the existing science student population, which is drawn from all science and engineering disciplines. The curriculum needed to be relevant to students irrespective of whether they were planning on pursuing research or applied careers. The types of 'real-world' assessment described in this paper are both the product of a maturing undergraduate science communication program and a reason for its continuing growth and success. More broadly, the increasing importance placed on science communication skills outside universities has sustained student numbers and institutional affirmation of our activities.

Communication, interpersonal, and research skills are transferable between disciplines, as evidenced by their inclusion in the majority of graduate attributes listed by Australian Universities (Oliver et al., 2011). In particular the ability to communicate science is identified as a specific threshold learning outcome for science graduates (Yates et al., 2011). These skills are all developed through the subjects and assessment tasks described in this paper. The use of opinion writing and blog posts helps science students to engage more deeply in democratic discourse (Culver & Jacobson, 2012) and creates a sense of greater participation in science and society (as per Carroll et al., 2013). Creating complex situations requiring complex problem solving and group work enhances student learning (Gruba & Søndergaard, 2001) and equips students with skills vital to both the workplace and lifelong learning (Noonan, 2013). Publishing student research is not common, but nor is it restricted to science communication as other examples are seen in biochemistry courses (Pu, 2010).

Not all universities offer science communication courses, however we believe that incorporating assessment tasks like those described is achievable within existing science curricula with some adaptation to course contexts. We also believe that incorporating formal learning of communication is ultimately invaluable to the science teaching and learning process. There, however, is a workload associated with incorporating assessment tasks such as these, which may negatively impact lecturers' ability to balance teaching with research and other academic activities. Currently all authors of this paper spend at least 50% of their time teaching, irrespective of their designation as researcher or lecturer. Institutions may wish to consider injecting funds to provide teaching relief or other means of support. However, this injection of funds necessitates what Mellor (2013) described as the need for institutional recognition that the benefit of the program outweighs any financial shortfall. Unfortunately university pressures means such recognition is rare, both internationally (Mellor, 2013) and in Australia. This is possibly compounded by a lack of a comprehensive body of strong evidence demonstrating the value of science communication subjects and the 'worth' of these kinds of assessment activities within that educational context.

The assessment activities described here are excellent opportunities for students to develop higher-order skills that are valued by industry and employers (Clark & White, 2011). Arguably the skills developed through these types of tasks could enhance attainment of graduate attributes (McInnis et al., 2000) and potentially improve student performance in other subjects. This is an area requiring further exploration at both an individual and institution-wide level. We acknowledge, as others have before us (de la Harpe & David, 2012; Hodgson, Varsavsky & Matthews, 2014), the complexity of evaluating these gains but believe that this is a necessary and underexplored area of research. Clear demonstration of the positive impacts of science communication courses on student learning overall can only help to validate the discipline's worth and foster institutional recognition.

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