Vital and vulnerable: Science communication as a university subject

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Abstract Over nearly three decades, science communication has become established as a subject of teaching and research in universities across the world. Its standing as an academic discipline continues to be debated, but graduate degree programmes and doctoral research in the field are increasing. Partly reflecting its inherent multi- and interdisciplinary content, science communication is embedded in different institutions in different ways. These developments have been driven mainly by individual champions, but in some cases also by institutional and government policies. The diversity of science communication programmes reflects in part the various histories and institutional affiliations of the programmes. The diversity can be seen as a sign of the subject's vitality but it is also a condition of its vulnerability. Many science communication teaching programmes have given rise to consultancies, applied research, publishing and, perhaps most notably, doctoral research, but information from the promoters of science communication programmes indicates that some programmes are particularly exposed to the rationalisation affecting higher education institutions in many countries. Science communication's position between and across disciplines and departments may mean it is not always well equipped to defend itself just when its need is most apparent.

Keywords Science communication, institutional support, interdisciplinarity, master's programmes, PhD research, economic conditions.

Introduction

Over the past quarter of a century, a new subject has emerged in universities across the world. In many countries, on several continents, at widely differing institutions, science communication has become a recognised subject of individual courses in broader science programmes or of denominated degree programmes at bachelor's and (mainly) master's levels. The spread of these programmes since the mid-1980s parallels the staging of international conferences on the public communication of science and technology and the foundation and repurposing of academic journals to cover this field. Publication of handbooks, textbooks and other collected volumes, which has intensified since the late 2000s, both reflects the growth of taught programmes and promotes the field (see, for example, Bennett & Jennings 2011; Bucchi & Trench 2008; Brake & Weitkamp 2010; Cheng et al. 2008; Holliman et al. 2009a, 2009b; Kahlor & Stout 2009). The increasing research activity, reflected in the number of doctorates in this field—also spread across several continents and many countries—represents the consolidation of science communication as a university subject.

Several published reviews and discussions have addressed the status of science communication as a discipline or as a distinct field of study. Others have examined its underlying assumptions and models or explored its possible research agendas. Several reviews of taught university programmes in science communication have been published. All of this activity is also to a large extent a reflection of the growing and significant number of people and units in higher education who are engaged with science communication.

Mellor et al. (2008) defended the theoretical content and academic validity of science communication in the face of criticism from practitioners in the field. Miller (2008) also examined that divide through a survey of practitioners that indicated they were in large part unaware of the possible contributions of theoretical work to their professional activity. Priest (2010) reflected on science communication's 'coming of age' and particularly on its hybrid status as both interdisciplinary and multidisciplinary (that is, partly integrated between established disciplines and partly based on multiple inputs from various disciplines). Trench and Bucchi (2010) considered science communication 'an emerging discipline' that met some recognised criteria of a discipline but remained weak in terms of theoretical development and the clear definition of its boundaries with cognate areas. Gascoigne et al. (2010) argued that science communication deserves 'special attention' because it 'contributes powerfully to pressing questions the modern world faces' and can derive benefits from not being a full discipline 'because it allows science communicators to plunder all disciplines and fields of study to conduct their work most effectively'.

There have been many other examples of such discussions, including in closely related areas. The status of journalism as an academic subject remains contested but is ‘quintessentially cross-disciplinary’ (de Burgh 2003). After 40 years of publication of the journal of the same name, social studies of science could be seen as ‘still emerging’ and are classified as such by the US National Research Council; ‘the field has settled into a shape that is akin to that of a discipline, though still often prefaced with “inter” and “trans”’(Lynch 2011). The discussion of science communication in terms of the relationship between theory and practice and as a discipline and a field of study may be seen not as a weakness but as a sign of the subject’s vitality. Increasingly, however, the terms of the discussion refer to institutional policies and economic conditions, pointing more to the subject’s vulnerability.

Science communication has spread and diversified as a subject in a phase of economic growth and of general optimism about economic and social prospects and the contribution of science to those prospects. The world-wide discussion of and commitment to the knowledge economy gave strong emphasis to the role of scientific research in driving the economy and encouraged science communication initiatives in many countries. While very many social, cultural and other factors have also contributed to science communication’s growth, the international economic crisis, particularly as it affects third level education in developed countries, may now be a brake on its further expansion.

Universities across the developed world in particular face accountability pressures and viability audits, some of which have identified science communication as no longer sustainable. The relative novelty of the subject and its uncertain status as a discipline are factors in its possible vulnerability. The subject’s inherent interdisciplinarity is a primary source of intellectual stimulation but also a cause of institutional difficulties for those directly involved. In a curious dialectic, the indications of the subject’s vitality and of its vulnerability come from the same sources. From the evidence and examples adduced below we will see that science communication faces a challenging future as a university subject. However, just as its advance has been uneven, with surges of parallel growth but also lapses of many years between similar countries, its retreat—or consolidation, as it might be seen more optimistically—is also patchy and contradictory: openings and closures are happening side by side.

In this chapter, I review the short history of science communication programmes, consider their common and differentiating characteristics, outline their current challenges and opportunities, and reflect on the subject’s prospects. This chapter does not offer a formal comparative study but looks at an international topic in an international perspective, drawing on publications, websites and correspondents’ contributions from around the world.

The global spread of science communication programmes

Science communication programmes at universities did not spring fully formed from the imagination of their individual champions. From the mid-twentieth century, a couple of decades before these programmes emerged, science communication and related subjects have been taught to science students in institutions that required them to have some liberal arts instruction. Reflecting different higher education cultures, this element has accounted for a very minor and/or optional part of science degree programmes. Single modules or part-modules in science writing, presentation or other aspects of science communication have been taught either by scientists who have taken up this activity (and sometimes, as advocates, this cause) or, less frequently, by specialists in communication providing a tailored teaching service outside their own home departments.[1]

Two other trends are also part of the background to science communication’s emergence as a recognised university subject: the provision of short training courses for professional scientists and the inclusion of science writing or science journalism modules within broader communication and journalism programmes.

[1] The terminology varies from country to country, and from institution to institution within countries; I use ‘programme’ to refer to studies over one year or more leading to a degree or similar award; I use ‘module’ to refer to an element of a programme, typically lasting a semester. I use ‘subject’ to refer to the name and content of a programme. I have avoided ‘course’, as it can refer to either a single element or a combination of elements.

The factors influencing the growth within scientific communities of ‘science literacy’ or ‘public understanding of science’ initiatives have been widely discussed elsewhere. One of the manifestations of that interest, broadly shared across the leading industrialised countries and then spreading rapidly from there, was the demand from scientists for communication training. Professional societies were often the hosts of such short courses; university teachers were often the providers.

Science journalism established itself as a recognised specialism in the United States from the 1950s onwards and in Europe and elsewhere somewhat later. The accelerating growth of specialist newspaper sections and broadcast programmes from the 1970s onwards prompted the development of specialist modules within journalism bachelor’s and master’s programmes. Here too, the earliest initiatives were taken in the United States.

While these several contributory developments are all important, we date the start of science communication as a university subject to the late 1980s, when the first taught postgraduate programmes denominated as ‘science communication’ appeared in several countries. Those programmes are distinguished in several ways from what went before, not only by the breadth of the topics covered but also by their ambition to provide a professional qualification in an emerging area of work. The Australian National University (ANU) in Canberra was one of the first to establish such a programme in 1987; the programme was linked very directly to a professional outlet in informal science education, specifically a travelling science centre. The identification of this ‘science circus’ in the description of the university programme, which is supported by corporate sponsorship maintained for a quarter-century, underlines the highly applied character of the training.

Other science communication programmes started in the years immediately after the ANU innovation tended to be less specifically tied to particular professional outlets. Many were oriented to informal or formal education or to media, reflecting their origins, the backgrounds of their champions and their home departments. But some aimed to provide a general university education, equivalent to a degree in other humanities or social sciences subjects.

Over the decade after the ANU programme started, other postgraduate programmes in science communication—awarding either diplomas or master’s degrees—began in Australia, Britain, Spain, Italy, France and Ireland. From 1989, some of those involved were meeting through the biennial PCST (public communication of science and technology) conferences. In the same period, science communication sections were started (though not maintained) in the International Communication Association and the International Association of Mass Communication Research, both of which assemble university-based communication researchers in large annual gatherings. But the initiatives to start the taught programmes were more or less independent of each other. Their circumstances varied considerably: in some cases, the programmes were delivered by small teams also teaching and researching in natural sciences; in other cases, they were the outgrowth of longer established programmes in communication, journalism or social studies of science.

Turney (1994) reported on the growth of such programmes and courses in the United Kingdom and proposed a simple typology that distinguished programmes and courses focused on communications skills from those providing ‘skills with added theory’ or presenting ‘the big picture’. Whereas the first type referred to short courses and the second to individual courses within broader undergraduate programmes, only the third type fits with our present interest. Turney reflected on the difficulties of achieving balance between the theoretical and practical elements of such programmes.

Science communication programmes were started in Netherlands, Mexico and elsewhere over the following decade, and the diffusion of programmes across the globe continued in the present century. By the early 2000s, India had several postgraduate diploma and degree programmes in science communication, largely on the basis of active guidance and scholarship funding from government. In 2005, the Korea Foundation for the Advancement of Science and Creativity supported the establishment of a science communication master’s degree programme at Sogang University and in 2009 of a science journalism master’s degree course at the Korea Advanced Institute of Science and Technology. In Japan, Hokkaido University established a Master’s in Science Communication in 2006. In New Zealand, Otago University added a Master’s of Science Communication to its innovative postgraduate programme in science and natural history film-making. In Brazil, a Master’s in Scientific and Cultural Communication was added in 2007 to the existing offering in science journalism at the University of Campinas (Vogt et al. 2009). At the National Autonomous University of Mexico, the programme in

science popularisation, which started in 1996 through a close association with a science museum, was broadened from 2008 and linked to longer established studies in the philosophy of science (Haynes 2009).

Laurentian University, Ontario, Canada, describes its Graduate Diploma in Science Communication, a joint initiative with the Science North science centre, as 'North America's first and only comprehensive Science Communication program'. The relatively weak representation of North America in this story is notable. United States universities have often been to the fore in driving the professionalisation of new sectors of employment through career-oriented programmes, most notably, in the present context, journalism and public relations. Long established in graduate and undergraduate education in science writing and science, health and environmental journalism, US universities have not adopted the 'science communication' rubric for taught programmes as widely as have universities in many other countries.

The Directory of Science Communication Courses and Programs maintained at the University of Wisconsin–Madison covers many types of programme with a science communication dimension[2], but it offers very few examples of self-contained graduate or undergraduate degree programmes in science communication of the kind referred to above. Science communication tends to be represented more frequently as the subject of single modules within sciences or humanities degree programmes. Relatively rare exceptions are the Master of Science in Communication, with a specialization in science communication, at Drexel University, Philadelphia, and the Master's Track in Science/Health Communication at the University of Florida.

A discussion between representatives of science communication programmes at the 2006 international PCST conference led to a survey and report (Mulder et al. 2008). The survey covered science communication programmes in 19 universities in 10 countries. Based on the responses, the authors defined science communication programmes in terms of four 'areas of study'—science, education studies, social studies of science and communication studies. Supports for teaching science communication and content for such programmes come in various blends from those four sectors. In a more detailed examination of seven postgraduate programmes, however, Mulder et al. found more variation: direct engagement with science or education studies was not part of several of the programmes. The authors proposed the establishment of a core framework to which science communication programmes would subscribe.

More recently, Hong and Wehrmann (2010), in their review of 20 science communication programmes based on curriculum information available online, found that that a fifth included science content and a quarter covered education studies. They were seeking to establish whether the programmes prepared students to work as science communication professionals, and looked at the presence or absence of an internship and the fit of curriculum and programme objectives with the profiles of science communication professionals. They found the fit was generally poor and recommended that programmes 'provide clear objectives and profiles of science communicators' as well as indicating how modules in the four areas of study outlined by Mulder et al. (2008) fit into the professional profiles.

A series of articles published in the *Journal of Science Communication* (vol. 8, no. 1, 2009) offered an overview of master's programmes in science communication, with contributions from the coordinators of six of those programmes in six countries.[3] The coordinators had varying views of the scope of science communication as a subject for study and reflection. For de Semir (2009), it concerns 'the process of public transmission and diffusion of scientific knowledge'; for Trench (2009), it encompasses 'the relations between the organisations and institutions of science and those of society (including politics, education and media)'; and for Greco (2009), 'it is a complex dynamic system that functions on many intercommunicating levels and involves not only the mind, but also the body and the spirit.' However, the engagement between disciplines of natural sciences, social sciences and humanities is a common thread of these self-reviews, as is the engagement between the theory and practice of science communication.

As a science film-maker and science communication lecturer, Davis (2010) takes a different view, arguing that science communication practice and theory (or research) should be separated. In his view:

> [W]e should be treating the *practice of science communication* as a separate and recognizable academic entity that draws its theoretical and research wing from those studying narrative, writing, filmmaking, design and digital communication …

[2] Posted at http://dsc.journalism.wisc.edu/index.html.

[3] Posted at http://jcom.sissa.it/archive/08/01.

> [R]esearch and theory that currently falls under the auspices of science communication … is a perfectly valid and valuable area of study but, for the sake of clarity, we should be distinguishing it as a separate academic area from those aspects of science communication to do with its practice.

The several published listings of science communication programmes tend to reinforce this image of diversity, and specifically this unresolved tension between mainly professional and mainly academic orientations. In 2007, the European Commission commissioned a guide to science journalism training, updated most recently in 2010 (EC 2010), that also includes more broadly based science communication programmes not specifically geared to journalism. An expert group advising the British Government on issues in science and the media included a listing of three undergraduate and eight postgraduate programmes in science communication as part of the relevant training provision (Science and the Media Expert Group 2010). The EU listing for the United Kingdom and the expert group listing do not completely overlap, although the information was gathered for both at roughly the same time.

The expansion of science communication as a university subject has been uneven in substance and in space and time. There have been programme closures as there have been openings. In two of the countries with the earliest and strongest presence in the field, Britain and Australia, some programmes have stopped. In Britain, undergraduate programmes at Sheffield Hallam University, the University of Bristol and the University of Western England were discontinued, as was the Master's in Communicating Science at the University of Glamorgan. Imperial College London added a Master's in Science Media Production to its pioneering Master's in Science Communication, while it suspended the associated Master's in Creative Non-Fiction Writing after two years of operation. At the University of New South Wales in Australia, a bachelor's science communication programme with two degree tracks that included significant science content as well as communication and other humanities and social sciences subjects closed in 2010 after a decade of operation. By the end of the 2000s, indeed, there were several signs that the tide was turning or, at least, that expansion had slowed and existing programmes faced more demanding requirements.

Increasing challenges, remaining opportunities

This was confirmed, though by no means uniformly, in email correspondence (plus one direct interview) with senior lecturing staff responsible for the coordination of science communication programmes. Many expressed concerns arising from the generally difficult financial conditions facing universities in many countries. Their comments included references to the impact of increased student fees and the difficulties of replacing staff who leave. There were also reassurances from some correspondents, however, that staffing was adequate and that vacancies had been filled. The correspondents also identified challenges and opportunities that are more particularly linked to the character of science communication programmes.

Fourteen responses were received from 11 countries. In order to illustrate some of the common or related features, selected points from the responses are presented below. They are identified by country; where there was more than one response from an individual country and the responses differed in substance, the responses are given discrete numbers.

- Challenges
  - Suspension of programmes due to recruits falling below viability thresholds (Germany, Thailand, Australia 1)
  - Increased pressure to meet financial reporting targets (UK 1, Netherlands 1)
  - Not seen as core business and therefore vulnerable to cutbacks (Netherlands 1, Italy)
  - Insufficient academic staff to handle increased project and thus restraint on taking in additional students (UK 2)
  - Small specialist teams running programmes politically weaker than department-size units (Australia)
  - Research effort affected by overload of education and coordination duties (Netherlands 1)

  - Different affiliations within the university and different evaluation frameworks for teaching and for research (UK 2, Netherlands 1)
  - Strategy adopted of 'hiding' in a larger structure that recruits larger numbers of students (France 2)
  - Change in programme's character through relocation to another department (Mexico)
  - Continuing need to explain or justify science communication and science communication research in a natural sciences institutional setting (UK 2, Netherlands 1)
  - Imbalance of professional education openings and professional positions (Finland, Spain).
- Opportunities
  - Start of a new programme with strands in journalism and museums (Hungary)
  - Start of a new programme in Latin America based on an existing, long-established programme (Spain/Argentina)
  - New master's programme in science communication developed in association with existing programmes in related fields (Australia 2)
  - Recognition of science communication team's distinctive contribution to the university's public profile (Spain, UK 1, UK 2, Italy)
  - Encouragement to expand programme and strengthen its international dimension (Italy)
  - Protection of programme through good reputation and association with university's strategic aims in science and society (France 2)
  - External support from institutions promoting science-and-society initiatives (Spain)
  - Satisfactory recruitment levels without major promotional effort (Spain, UK, Finland, France 1, France 2)
  - Satisfactory institutional support, staffing and prospects for growth (Finland, Netherlands 2)
  - Improved protection through relocation from a natural sciences to a humanities department (France 1, Mexico)
  - Addition of a programme and short courses providing continuing professional development for those in relevant employment (UK 2)
  - Increased recruitment of PhD students in recent years (UK 2)
  - Demand for delivery of courses in science communication for other programmes' students (Spain, UK 1, UK 2).

These summarised responses illustrate the uncertain status of a still-emerging university subject. The balances of challenges and opportunities reported were broadly similar across the countries sampled. However, some demands seen as a challenge or difficulty in one case were seen in another as an opportunity. This may be taken as reflecting different institutional and economic conditions, independent of the particular subject of science communication.

My own direct experience of founding and leading a science communication master's programme over 15 years also gives evidence of similar challenges and opportunities and illustrates some of the issues facing programmes of this kind. The Master's in Science Communication established in 1996 at Dublin City University has been seen as contributing to the university's reputation for innovation and the university's international reach, both in attracting students from several countries and in functioning as a base for participation in international projects. The programme has been maintained and a retiring lecturer/coordinator replaced, although its student recruitment has come close to the (shifting) viability thresholds. However, the programme has probably fallen short of its original ambitions for interdisciplinary collaboration. It started in a collaboration between two departments in different disciplines in two institutions in two jurisdictions. For the first seven years of its life, the programme was delivered jointly by Dublin City University (Ireland) and Queen's University Belfast (Northern Ireland, United Kingdom). Its coordinators were based in the School of Communications in the first university and the Department of Physics in the second. The lecturers who contributed to the programme included medical scientists, archaeologists, historians of science, a psychologist, journalists, a philosopher, chemists, biologists, media analysts, communication theorists and others. However, there has been limited interaction between the lecturers in natural sciences on the one hand and humanities and social sciences on the other.

Queen's University Belfast withdrew from the programme in 2003 for strategic reasons of the kind already touched on in the correspondents' comments summarised above: the programme was not a core activity of any department and it did not fit well with the increasing emphasis on quantitatively measured research output in natural sciences departments. The withdrawal of Queen's reduced somewhat the diversity of the inputs to the programme; a single module among six that are specific to the programme (there are six further modules, some optional, shared with other programmes) has significant natural-sciences content and is delivered from the Faculty of Science and Health.

In other ways, however, the interdisciplinary aspect is prominent. The discourses and systems of natural sciences and social sciences are both examined critically. Most students have backgrounds in natural sciences, though each annual cohort includes some with qualifications in media studies, literature, languages or other humanities or social sciences subjects. The cross-disciplinary experience of the classroom has been a major feature of the programme. The inclusion of students from various backgrounds is not universal in science communication programmes. Some master's programmes specify that entrants must have science degrees; in this way, they are set up as conversion courses. The lecturers include individuals with primary degrees in biological sciences and higher degrees (master's and PhDs) in communication or business. Natural scientists have often reported that they found teaching in a more reflective manner and broader context especially stimulating, and the social scientists and humanists reported that they relished the challenge of engaging students with backgrounds in the natural sciences with the methods and logics of the humanities and social sciences.

Having lecturers who have moved from natural sciences to communication either through additional qualification or research is one of the most usual expressions of interdisciplinarity in the delivery of science communication programmes. An unusual expression of interdisciplinarity is found in SISSA (the International School for Advanced Studies), Italy, where classes in science content (mainly neuroscience and physics, reflecting the special interests of the home institution) are delivered by research scientists with a communication specialist alongside to explore the media and other social dimensions.

More critically, being interdisciplinary tends to mean looking two or more ways simultaneously and being rooted in neither one recognised institutional setting nor the other. The difficulties of negotiating these relations with representatives of various disciplines and with institutional leaders representing various approaches are reflected in some of the observations above on the current situation and are expanded in the comments of several programme coordinators:

> Science communication is in the tricky position of having to set itself up as an academic subject, while at the same time attending to its relationship with the scientific establishment. Science communication has a base in the universities, but in the bulk it's an 'out-of-doors' activity. History and Philosophy of Science can turn all its attention to the academic corridors in a way that science communication academics may not feel completely sure about. It's possible that the problems science communication faces in the academy could be turned into virtues—its intellectual agenda, its courses—and its 'impact' on society.
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> —Stephen Webster, Imperial College London, pers. comm., January 2011

> I'm not sure the scientists understand completely what we do and they could have some problems with some of it. We are in a strange balance. They understand that we are useful. It depends on different boundary conditions: we could become a kind of outreach department or a research department, though this is less likely. Mostly, the scientists in our institute have in mind a popularisation model for science communication.
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> —Nico Pitrelli, SISSA, Italy, pers. comm., November 2010

> We would not be able to survive very long on our own because we are too small. The programme's good reputation and, especially, the fact that the university has structures dedicated to science communication protect us. The university established a vice-presidency for science and society two years ago.
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> —Elsa Poupardin, University of Strasbourg, pers. comm., January 2011

> The status of science communication programmes is likely to reflect the political insight of the director, the programme's ties to influential actors in the university and outside, and the educational context (which faculty the programme sits in, whether students are willing to pay for postgraduate study, the competition from other programmes, cost etc.). Having powerful allies is essential as is having redundancy in place, where possible, for when key allies leave. That said, when budgets are cut, the interdisciplinary programme seems more likely to go first.
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> —Will Rifkin, University of New South Wales, Australia, pers. comm., March 2011

> We were very fragile when we depended directly on science departments but our relocation to Letters seems to protect us. Our Masters is really a professional Masters and the departments in Letters don't have professionally oriented programmes.

> The literary people want to keep us because of the professional dimension to our education and we are able to participate actively in the life of the department.
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> —Baudouin Jurdant, University of Paris 7, pers. comm., January 2011

Conditions for sustainability

From the survey of existing programmes, the correspondence and comments of programme coordinators, and personal experience in the field, we can identify several key criteria for differentiating science communication programmes. Using those criteria, it may be possible to extract factors for the success and sustainability of some programmes, although political and economic factors in individual countries and their higher education sectors need to be included to provide a full picture.

As the clear majority of the programmes surveyed are postgraduate (master's and diplomas) and the rate of attrition of undergraduate programmes has been significantly higher, these key criteria apply mainly to postgraduate programmes:

- Breadth of student recruitment—open to science graduates only or open to all graduates with interest in science?
- Institutional setting—based in natural sciences faculty or in humanities or social sciences?
- Mode of delivery—full-time, part-time, or both?
- Target markets—new graduates, those already in related employment, or both?
- Balance of content—mainly science content, social and communication studies or professional skills?
- Disciplinary connections—linked mainly to natural sciences, science education, media/communication, other humanities or social sciences?
- Institutional strategies—support for interdisciplinary collaborations, for science-and-society initiatives, for innovative programmes?
- Programme team—programme delivered mainly by dedicated staff or staff with main responsibilities elsewhere?

Satisfactorily assessing individual programmes against these criteria is itself a challenge. In some cases, institutional support can be more apparent than real. Professorial appointments have been made in some British universities to chairs in the public understanding of science or science and society that appear to address the same or related agenda but have not contributed to the development of science communication as a subject of education and research (Miller 2008). The appointments have, it seems, been motivated mainly by concern for the university's prestige; the holders of such posts tend to be chosen for their high profile as science popularisers rather than for their interest in pedagogic or theoretical issues in science communication. These appointments, it has been argued, 'embodied a split within universities over the perceived role of academics with respect to public science' (Mellor et al. 2008).

One criterion that is difficult to articulate but that appears important is that of enthusiasm: the individuals and (mostly very small) teams coordinating these science communication programmes have often taken on the role of champions of this new subject, in many cases being the first champions or immediate associates of the first champions of the subject in their institutions. They have had thrust upon them the task of advocating, justifying or defending—as the circumstances demand—the case for science communication.

Hong and Wehrmann (2010) have emphasised the criterion of professional education, observing on the basis of their survey of programme content that 'it is still doubtful to what extent the science communication programmes equip students to become professionals.' They argue that the objectives and content of these programmes should centrally 'reflect on the real world of science communicators'. With colleagues at Technische Universiteit Delft, the Netherlands, they have taken initiatives to raise science communication students' awareness of career opportunities and science communication teachers' awareness of professionalization issues. While some programme coordinators might choose to emphasise equally the dimension of intellectual curiosity, it is generally true that science communication programmes have spread more or less in line with the spread of relevant professional employment opportunities.

As mentioned above, the first postgraduate programme in Australia was explicitly linked to a practical activity and employment outlet. An internal survey in 2011 of graduates of the Dublin City University Masters in Science Communication, with responses from approximately one-third of all the 200-plus graduates, showed that 60% were working full-time or part-time in science communication.[4] Their main areas of work were journalism, informal education, public information, research in science communication and teaching or training in roughly equal proportions. A demand-oriented survey of science communication education and training would likely show a diffusion of new opportunities in science museums, science centres, science outreach, science information, science writing, science websites and so on, in a similar pattern to the diffusion of science communication programmes. This linkage can be a support for the sustainability of science communication programmes as long as the employment trend is upwards; it could be a handicap if the trend is reversed.

Some programmes have strengthened their position through more formal links with the world of work. At the University of Western England, the Science Communication Unit provides consultancy services that include exhibit design, campaign design and evaluation. The unit also provides short communication courses for clients working in scientific institutions and science-based companies. Several science communication programmes are linked with science centres, among them the Master's in Science, Media and Communication at the University of Cardiff, Wales, which is presented in collaboration with a science centre, Techniquest. Among other programmes that have received financial support from companies, foundations or government to support professionalisation in the sector, the master's programme at Universitat Pompeu Fabra in Barcelona, Spain, has had long-term financial support from the pharmaceutical company Novartis and from the philanthropic arm of a regional savings bank, Fundacion La Caixa.

Further supports for science communication as a university subject have come through international networking of science communication teachers in conferences, research projects and other collaborations. Of the 220 registrants for the 2010 international PCST conference in New Delhi, India, who responded to an evaluation survey (44% response rate), 21% said their main involvement in science communication was in teaching or training and 23% said it was in research.[5] Several collaborations between university-based science communication specialists, including the present volume, have grown from the biennial PCST conferences, and university lecturers in science communication are strongly represented among the PCST scientific committee that organises the conferences.

There are also national conferences and workshops in the field, often also the initiatives of university-based science communication teams. A meeting of science communication teachers from British and Irish universities took place in London in 1997. The science communication team at Imperial College London initiated an annual conference, Science and the Public, the second of which led to a collected volume, *Science and its publics* (Bell et al. 2008). The editors' introduction to that volume reflected the contested status of science communication as a subject for formal academic study; the exchanges between science communication practitioners and academics that formed part of the conference's background 'were a sharp reminder of the tension that lies at the heart of the field of science communication: how should the relationship between theory and practice be managed?' (Mellor et al. 2008).

Another initiative of science communication specialists in universities was the formation in the early 2000s of the European Network of Science Communication Teachers (ENSCOT) as a project funded through the European Commission's Raising Public Awareness of Science and Technology programme. This group of university-based lecturers in science communication and science journalism from Britain, France, Germany, Ireland and Spain developed teaching materials in various aspects of science communication (ENSCOT Team 2003). They were joined by others from several more countries and from outside universities in subsequent projects, European Science Communication Workshops and ESConet, developing and delivering short communication courses for research scientists.

The growth of research, publishing and conference activities promoted by science communication specialists in universities is a significant mark of the embedding of science communication as a university subject. Several

[4] This survey was undertaken by the author to mark 15 years of the master's programme. There were no reliable means to reach all of the approximately 225 graduates of the programme; 77 responses were received. A report on the survey is posted at http://www4.dcu.ie/communications/resources/pdf/Results_of_survey_of%20graduates_of_MSc_in_Science_Communication.pdf.

[5] This survey was undertaken by the author for the guidance of the organisers of future PCST conferences; it is not published.

regular publications have been initiated directly by individuals and teams associated with taught science communication programmes. They include:

- *Quark*, published quarterly for over a decade from the mid-1990s by the Science Communication Observatory at Universitat Pompeu Fabra, Barcelona
- *Com Ciencia*, an online science journalism magazine published by the Labjor unit at the State University of Campinas, Brazil, which published its 100th edition in 2010
- the *Japanese Journal of Science Communication*, an open-access journal published twice a year since 2007 by Hokkaido University
- *JCom* (Journal of Science Communication), an open-access journal published quarterly since 2002 by SISSA, Trieste, Italy, where Italy's longest established master's degree in science communication is based.

University academics associated with the development of science communication programmes have also been key figures on the editorial boards and in contributions to the internationally distributed peer-reviewed journals in the field: *Public Understanding of Science*, launched in 1992 with John Durant, a founder of Imperial College London's science communication master's, as first editor, and *Science Communication*, which acquired its present name (it was formerly *Knowledge*) in the 1990s, reflecting the emergence of science communication as an academic subject.

The growth of PhD research in science communication may be the single most substantial mark of science communication's full emergence as a university subject. Several of the programme coordinators whose correspondence is summarised above referred to the small groups of PhD researchers in their teams as a significant gain; the taught master's programmes surveyed here have provided many of the recruits to PhD projects. Since 2000, more than 100 PhD theses in science communication have been completed internationally, and the indications are that there may be at least as many currently underway. Outline details of 57 PhD theses collected for analysis came from 14 countries on five continents (van der Sanden & Trench 2010). The subject areas included media and journalism (14 of the 57 theses), means of communication (10), engagement and dialogue (7), scientists' role and image (7), and roles of stakeholders (6). The diversity of the field is also represented in the broad spread of research aims, among which it was not possible to identify common categories. In a tentative general commentary, it was noted that 'science communication [as reflected in the PhD theses] is much more "science" than "communication"' (van der Sanden & Trench 2010).

Here again we see that the diversity and uncertainty that characterise science communication as a field of education and research are conditions both of the subject's vitality and of its vulnerability. In PhD studies, international developments mean that the individual relationship between apprentice PhD student and master PhD supervisor is giving way to programmes of research that include required taught elements and collective supervision. In science communication, there have been new starts in organising such programmes between departments and even between universities but there have also been programme closures, reflecting the difficulties of managing those relationships. For example, a joint PhD programme in science communication between SISSA and the University of Milan closed after several years in operation.

However, the PhD scholars who have emerged from the system over the past decade in particular represent an undeniable achievement for science communication as a university subject. They also represent a second generation of science communication specialists with, in general, higher levels of formal qualification in science communication than many of the founding figures in the field, who took up teaching and research in science communication on the basis of personal interest and backgrounds in scientific research, science education, media practice or other sectors.

In terms of personnel and capacities, science communication has become ever more deeply rooted in the university system over two decades. It is no longer solely the province of scattered individual champions. But it remains marginal, often trapped uncomfortably between the major shifting blocs of natural sciences and humanities or social sciences. Despite the many inspiring initiatives aimed at dissolving the boundaries between the 'two cultures', and even to develop a 'third culture', the binary division is still strongly entrenched in higher education. The widespread trend to reorganise universities around a few major subcentres rather than myriad departments has, if anything, reinforced the two-cultures divide. So too has the research funding environment, which gives increasing weight to the large-scale and highly visible activities that are characteristic of the natural

sciences and engineering and very rarely found appropriate in the humanities or social sciences. In a circular motion, these large-scale activities become defined as 'core' to the institutions, while other activities are regarded as non-core and thus as priorities for pruning when rationalisation is deemed necessary. Thus, on top of inherited tribal structures and different research paradigms, financial factors and conventional wisdom on the rationalisation of university structures are militating against interdisciplinary collaboration across the great divide.

In the view of E.O. Wilson (1999), 'the greatest enterprise of the mind has always been and always will be the attempted linkage of the sciences and humanities.' He has argued for the possible 'unification of knowledge', but even more modest projects can illuminate the 'big picture' of the human condition through collaborations of sciences and humanities. There have been many of those, and there will continue to be many despite the uncongenial trends. It may be that science communication can defend its position most easily in functional terms, as providing the means for transmission of scientific information to non-specialist audiences, but that limits the scope and potential of the subject. Precisely because of its position in the gaps between the sciences and the humanities, science communication has much more to offer: it can be a place of intellectual inquiry into the convergences and divergences of different disciplines; it can be an engine of institutional reflexivity, helping modern universities to examine how they manage their internal diversity and how they articulate with the wider world.

After two decades in which science communication has faced many challenges to survive and thrive in universities, it may be time to ask whether universities can face the challenge of having science communication in their midst.

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