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SCIENCE COMMUNICATION IN HIGHER EDUCATION: GLOBAL PERSPECTIVES ON THE TEACHING OF SCIENCE COMMUNICATION

Science communication as interdisciplinary training

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Abstract

Science communication education has come a long way thanks in part to broad recognition of the importance of communication skills and the capacity for science communication courses to address that need. Similarly, the current rise in demand for interdisciplinary competencies offers new opportunities for the advancement of science communication education, and for greater contribution to preparing graduates for a rapidly changing world.

Keywords

Professionalism, professional development and training in science communication

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Introduction and scope

This paper is concerned with science communication (SC) as a topic of study at university, and discusses a potential strategy for consolidation, growth, and deeper regard for university SC studies. Of course, new approaches to SC education also have implications for the nature and impact of science communication in practice, however the discussion here will focus on university studies and the role of SC courses in higher education (HE).

Additionally, university SC offerings are diverse in their aims, content, breadth, targeted students, and so on. It would be impossible to address the full complexity of offerings in any detail in a single discussion. Rather, this discussion will use a simple framework drawn from Turney's [1994] distinction of *skills* courses (training students in communication skills specific to future roles as researchers), *skills with theory* courses (skills courses that also include discussions on reasons and challenges for science communication, science/ society relationships and so on), and *big picture* courses (more comprehensive coverage of science communication as a field and the multiple disciplines that feed into it). At points in this discussion where it is necessary to distinguish between different types of SC courses, this framework will be used.

Growth in science communication studies

Science communication as a university subject has shaken off early perceptions as a niche 'add-on' to a science degree, and is now widely considered an integral component of science students' education. The skills introduced in SC courses are now seen as fundamental for science students to develop and apply in all aspects of their future work. In addition to benefiting careers, SC skills are considered by some to enable scientists to contribute to public trust in science and change in society [Bankston & McDowell, 2018]. This elevated perception of science communication has been a major advancement for SC studies. The development, evolution, and maturation of courses and teaching approaches have all surely contributed to the rise in stature of SC education. However, an argument can be made that new priorities for communication skills in learning outcomes and graduate attributes have also been beneficial, by creating a gap that SC studies were ideally positioned to fill.

It is likely that university prioritization of communication skills was in part driven by perceived shortcomings in the extent to which science degrees prepared graduates for employment. For example, a report on career pathways for Australian science graduates between 1990 and 2000 found that only around 40% of the graduates included in the review were employed in science-related jobs. While most graduates agreed that their science degree adequately prepared them with domain-relevant skills and knowledge, many felt they were underprepared in more general areas which were important in their work settings (written and oral communication, awareness of the social implications of science, understanding other points of view) [McInnis, Hartley & Anderson, 2000]. In other words, a majority of Australian science graduates were moving into work contexts that were not being addressed by the curricula of their degree programs. It is likely that this situation was not unique to Australia. In direct response to perceived requirements of employers, universities increased their focus on developing generic skills at both undergraduate and postgraduate level science programs, including skills development in leadership, information technology, teamwork, and communication [McInnis et al., 2000]. Communication skills became widely recognized as an important attribute for science graduates, and were recommended as threshold learning outcomes for science in Australian universities [Jones, Yates & Kelder, 2011]. They came to be commonly listed in learning outcomes for science programs in Australia, the U.K., the U.S.A., and Canada [Mercer-Mapstone & Kuchel, 2017] and targeted as general graduate attributes at many universities [Stevens, Mills & Kuchel, 2019]. Thus, it became important to develop the communication skills of science students — a significant shift in HE science pedagogy.

In practice, however, learning outcomes and graduate attributes in generic skills, including communication skills, can present formidable challenges. Program managers, curriculum designers, and instructors are not necessarily equipped to 'teach' these generic skills, which commonly fall outside the realm of their expertise [e.g. Herok, Chuck & Millar, 2013]. Fortunately in this case, SC courses were a ready vehicle for fostering science graduates with communication skills, and thereby addressing learning outcomes and graduate attributes in communication. Many universities now offer *skills* and *skills with theory* courses in science communication for science students, including compulsory courses for some science programs.[1] *Big picture* courses are also offered to science students, often as part of a larger science communication program. Some SC courses are discipline-specific with a tight focus on a specific range of skills, while others target a wider range of applications and are offered more broadly to students from both science and non-science degree programs.[2]

Employability concerns and a subsequent focus on generic skills was likely not the sole factor in the proliferation of SC courses. However it is reasonable to consider that they had some significant impact, particularly considering the sensitivity of modern HE to graduate employability. Furthermore, contribution to improving student employability has often been used to justify the establishment of new programs in science communication [Longnecker, 2022; Trench, 2012], and there is an array of SC courses that publicly claim to do just that.

Of course, the proliferation of communication training for science students is a very welcome development, and likely to contribute to graduates who are better equipped for a range of career paths including, but not limited to, science and research. We might also anticipate the broader social benefits that flow from more effective communication of science. However there is room for further growth in SC education. Many courses focus on communications within the narrow range of communicating scientific research findings within the same discipline [Stevens et al., 2019], reflecting what seems to be a widespread view that SC education (for science students) is primarily about developing communication skills for researchers [e.g. Brownell, Price & Steinman, 2013]. This does not have to be the case. Furthermore, there seems to be a hidden assumption that communication ability, whether narrowly or broadly focused, is all there is to gain from science communication training, when in fact SC education has a lot more to offer. Thus, the potential for SC studies to contribute to student development is still not fully recognized. One particular value that is consistently underexploited, is the potential for developing interdisciplinary thinking.

Demand for interdisciplinary competencies

It is widely acknowledged that our societies face a growing number of trans-science problems and issues that require interdisciplinary solutions, and that graduates are currently under-prepared to deal with them [Ashby & Exter, 2019; Power & Handley, 2019]. Climate change, biodiversity loss, and artificial intelligence are clear examples of current trans-science issues. However the management of a growing number of smaller, more local issues on environment, social welfare, public health, novel technologies and so on also require specialist knowledge and experiential perspectives from a range of disciplinary and non-disciplinary sources. While there is some diversity in the definition of interdisciplinarity [Lyall, Meagher, Bandola & Kettle, 2015], it is broadly considered to be the integration of knowledge and practices from one or more separate disciplines for advancement beyond the scope of any of the individual disciplines involved [Tripp & Shortlidge, 2019]. Interdisciplinarity is increasingly

[1] E.g. BSc (biology major) at the University of Tsukuba. BSc (selected majors) at the University of Western Australia. BSc (all majors) at the University of Waterloo.

[2] For example, the University of Queensland offers a course in communication and data visualization skills specific to quantitative biology. While at the Australian National University, a range of *skills with theory* and *big picture* courses are offered to students from most of the university's degree programs.

considered a vital skill set for future researchers, managers, and decision makers, and in turn, as an important employability marker [Lyall et al., 2015]. [3]

Although there is still debate over what interdisciplinarity is and how it can be taught at university [Klaassen, 2020] there is a broad consensus that universities should do more to foster it [Lyall et al., 2015; Power & Handley, 2019]. To prepare graduates for future challenges, universities are scrambling to develop interdisciplinary competencies in their students [e.g. Brassler & Dettmers, 2017; Lattuca, Knight & Bergom, 2012], and interdisciplinarity is increasingly seen as a core graduate attribute, along with the likes of critical thinking and digital literacy. This is an ongoing challenge, and exactly what qualities should be fostered in students, and how that can be achieved is still very much a topic of debate. To help with this, a number of authors have proposed lists and frameworks of interdisciplinary competencies [e.g. Mansilla & Duraising, 2007; Tripp & Shortlidge, 2019]. In particular, Lattuca and colleagues [2012] identified a useful list of specific and targetable skills and capabilities, a summary of which is presented in Table 1. So despite strong institutional will to develop interdisciplinarity among graduates, exactly how this will be accomplished is unclear. Furthermore, many academic staff are less enthusiastic about integrating interdisciplinary content in their courses, and this is likely fueled by a lack of support and training for interdisciplinary teaching [Lyall et al., 2015].

The current situation is very similar to that which contributed to the emergence of communication skills as a graduate attribute. Just as with communication skills, interdisciplinarity is increasingly considered to be vital to the future success of students, and their contributions to a functional society. Just as with communication skills, the importance of interdisciplinarity is being recognized in program learning outcomes and general graduate attributes. And just as with communication skills, the implementation of interdisciplinary pedagogy looms as effortful and challenging. However, while there was quick reliance on SC courses to develop communication skills, it has not yet been widely recognized that SC studies also have much to contribute to the development of interdisciplinary competencies.

Science communication as interdisciplinary training

Science communication skills are considered by some to be essential for collaborative interdisciplinary research [Bammer, 2020]. Clear communication is acknowledged to benefit mutual understanding, trust, negotiation, conflict resolution, and skill development — all important requirements for effective collaboration. The cross-disciplinary communication skills fostered in science communication are particularly suitable for interdisciplinary collaborations [Bammer, 2020]. In this view, people trained in science communication are valued for their ability to foster awareness, appreciation, and understanding of the

[3] In fact, the solutions to many of our current and future problems require a *transdisciplinary* approach — the integration of disciplinary knowledge with other non-disciplinary, non-academic sources such as lived experience, social systems, community values and so on. However, it is interdisciplinarity that is a current concern for HE (as will be discussed), and since this paper is a discussion of SC courses in HE, the scope of this discussion will be restricted to interdisciplinarity. In any case, if one considers disciplinarity, multidisciplinarity, interdisciplinarity, and transdisciplinarity to lie along a continuum of increasing inclusivity, complexity, and integration, then it is clear that many of the basic skills required for interdisciplinarity (awareness of other perspectives, open-mindedness and acceptance, flexibility and so on) are equally important for transdisciplinarity.

Table 1. Summary of interdisciplinary competencies as described by Lattuca, Knight and Bergom [2012].

Awareness of Disciplinarity A recognition that disciplines are socially constructed frameworks of assumptions, approaches, and means of validation to organize scholarly inquiry, and that members of the discipline have shared norms and values around valid forms of knowledge building.
Appreciation of Disciplinary Perspectives An understanding of how the characteristics of a discipline inform the nature of the knowledge and understandings that come out of it. A recognition of the strengths and weaknesses in disciplinary perspectives and an appreciation of the potential for different disciplines to make different contributions.
Appreciation of Non-disciplinary Perspectives An appreciation of the potential contribution from experience, knowledge, insight, and perspectives of non-disciplinary sources.
Recognition of Disciplinary Limitations An understanding and acceptance of the limits that arise as a result of disciplinary structure, and the limits of one's own discipline.
Interdisciplinary Evaluation An ability to evaluate interdisciplinary contributions based on an awareness of the knowledge, methods, perspectives, and limitations of one's own and other disciplines.
Ability to Find Common Ground An ability to identify commonalities in components of different disciplines, possibly through reinterpretation, in order to combine and integrate knowledge.
Reflexivity An ability to reflect on one's own values and biases and their potential to influence decision-making, understanding, and knowledge-building.
Integrative Skill An ability to integrate knowledge from more than one discipline to produce understanding or a solution to a problem that could not have been achieved within traditional disciplinary boundaries.

intricacies of interdisciplinary problems, and the assets and advantages offered by different disciplines. However, we can also take the view that people trained in science communication can do these things precisely because they have interdisciplinary competencies. In other words, communication is important for interdisciplinary collaboration, but that same communication *requires* interdisciplinary competencies. Vickery and colleagues [2023] hinted at this when they pointed out that inclusive models of SC training that introduce interdisciplinary perspectives can encourage students to become boundary spanners. The importance of developing interdisciplinary perspectives to be effective in science communication is well-known among SC practitioners, scholars, and educators. However, although the interdisciplinary nature of science communication is often discussed, the potential for SC education to foster interdisciplinary competencies is seldom explicitly acknowledged.

Science communication is an inherently interdisciplinary field [Bucchi & Trench, 2021; Longnecker & Gondwe, 2014; Trench, 2012], and in practice draws from communication studies, journalism, public health, marketing, education, psychology, social sciences and more [Longnecker & Gondwe, 2014]. It follows then, that SC courses and programs are also interdisciplinary by nature. Mulder and colleagues [2008] reported that university SC courses drew from the academic fields of science, education studies, social studies of science, and communication studies. In addition, depending on objectives and learning outcomes, SC courses (in particular *skills with theory* courses and *big picture* courses) can, and do, connect with cultural studies, politics, public policy, psychology, arts, literature, and more. Such multidisciplinary exposure can foster student awareness of and appreciation for frameworks and viewpoints outside of their own discipline, particularly if these differences, along with their merits, limitations, and implications are explicitly discussed with students. This exposure would be difficult to replicate in courses centered within a single discipline, but the potential for SC courses to foster interdisciplinarity does not end there.

It is common for SC programs and *big picture* courses to include critical reflection on the nature of science itself — its strengths, limitations, and underlying assumptions — and how this might be perceived from outside of the framework of scientific norms and culture, or in other words, from viewpoints that differ from the typical science student. It is also possible to include this type of reflection in *skills with theory* courses.[4] Our SC courses for biology students at the University of Tsukuba are of this style, commencing with a brief examination of the nature of science, and of science as a human endeavor. The courses also include a comparison with the features of other worldviews such as philosophy or indigenous knowledge systems. The aim is to disabuse students of any idealistic views of science and to prepare them first to acknowledge, and then to begin to understand views from outside of science. I have found that these courses encourage students to be more flexible in their views (by realizing that science is not the only lens used to view the world), more accepting of others' views (by attempting to understand their perspectives, priorities, and values), and more willing to listen to and objectively evaluate the ideas of others. All of this helps students to become better communicators, but it is also a foundation for developing capacity for interdisciplinarity.

Furthermore, SC courses which accept enrollments broadly from across campus (typically *big picture* courses or *skills with theory* courses) attract students who represent a range of both STEM and non-STEM disciplines and backgrounds [e.g. McKinnon, Orthia, Grant & Lamberts, 2014]. This intermingling of students presents an opportunity for exposure to the values and perspectives of each other's disciplines. Thought leaders in fostering interdisciplinarity recommend creating an environment to encourage the organic development of interdisciplinary thinking and awareness. They stress the significance of 'serendipitous encounters' for bridging epistemological divides, or opportunities for individuals from different disciplines to interact and share perspectives in natural unforced settings such as common meeting spaces [Klaassen, 2020]. Discussions and group work in SC courses involving students from different disciplines, or with different viewpoints, represent a valuable opportunity to encourage such serendipitous encounters.

Lattuca and colleagues' [2012] interdisciplinary competencies in Table 1 can be used as a mapping framework to examine how SC course content might contribute to interdisciplinarity. For example, when introducing topics or concepts from other

[4] Examples of such courses at the time of writing include *Communicating Science* at the University of Western Australia, and *Science Communication* at Imperial College London.

disciplines such as education, social sciences, cultural studies, psychology on so on, taking a moment to highlight key attributes of the discipline (e.g. norms, values, methodological approaches) can contribute to the interdisciplinary competencies of *Awareness of Disciplinarity*, and *Appreciation of Disciplinary Perspectives*. A discussion of the nature of science, including assumptions, values, strengths, and limitations (e.g. the central role of measurable evidence in science, how this lends objectivity but also limits the application of science) can contribute to *Awareness of Disciplinarity*, *Appreciation of Disciplinary Perspectives*, and *Recognition of Disciplinary Limitations*. If the discussion includes epistemological diversity and other ways of knowing (e.g. the norms, approaches, and handling of evidence in other disciplines) it can also contribute to *Interdisciplinary Evaluation*. Including views and contributions of non-science sectors of society (e.g. contrasting values and norms, or how evidence is valued differently) can contribute to *Appreciation of Non-disciplinary Perspectives*.[5] For courses with broad enrollments, student disciplinary diversity can be leveraged through peer discussions and small group activities designed to highlight and accentuate disciplinary perspectives, and thus further contribute to the interdisciplinary competencies already mentioned. A motivated educator might also find ways to address the remaining three competencies in Table 1, but contribution to five of these eight competencies can be achieved with only small changes to what is already being done to prepare students to communicate their science in *skills with theory* and *big picture* courses.[6] Such contribution would be difficult to achieve in many other subject fields without considerable redesign of courses.

This paper does not intend to trivialize the task of fostering students' interdisciplinarity. This is a mammoth challenge requiring large changes in faculty mindsets, program curricula, and if done properly, the structures of universities themselves [Swora & Morrison, 1974]. SC courses are not an easy fix or a panacea, and to suggest so is not the intent here. However, SC courses do have the capacity to make an important contribution to opening students' minds to broader perspectives, and commencing the journey toward developing interdisciplinary competencies. It is also important to point out that the suggestions above for incorporating a focus on interdisciplinary competencies into SC courses are based on my own perspectives and experience teaching SC in my particular university context. While I believe my experiences are in common with many SC educators, the examples here might not be applicable for all contexts, but neither are they an exhaustive list of all possibilities. The suggestion here is that we begin to look for and capitalize on opportunities to develop interdisciplinarity through our SC courses.

Scholars have already noted that developing communication skills among science students can lead to a diverse range of broader applications and benefits, including influencing public attitudes and government policy, becoming a better scientist, and facilitating the progress of science itself [e.g. Bankston & McDowell, 2018] — flattering praise for the value of SC courses. However, consideration of benefits

[5] This competency is essentially a first step into transdisciplinarity, and further highlights the point made earlier that both interdisciplinarity and transdisciplinarity require some of the same basic competencies.

[6] *Skills* courses which target development of practical, discipline-specific communication skills, and do not include the kind of theory or discussions mentioned would require larger scale changes. However, these courses have very specific aims, and interdisciplinarity competencies may not be a concern.

to student learning and development beyond communication skills, to include interdisciplinary competencies, opens up an opportunity for a much richer, more fundamental role for university SC education.

Re-envisaging science communication studies

Despite the successful development and growth of university SC education until now, it should not be assumed that it will continue to be valued and supported. SC courses are somewhat precarious, in part precisely because they span disciplines and departments and do not fit neatly into institutional frameworks [Trench, 2012]. SC courses and even whole programs can and do close down [Gascoigne & Metcalfe, 2017; Mellor, 2013; Trench, 2012]. At a time when our societies increasingly face problems requiring solutions to which the skills and perspectives developed through SC education can contribute, it is important to stay alert for opportunities to consolidate and strengthen the position of science communication in higher education.

Just as recognition of the importance of communication skills advanced SC education in the past, the current demand for interdisciplinary development is another opportunity to grow the field. The promotion of interdisciplinarity through SC studies can be achieved through the development or reinforcement of what in many cases is already being done, or could be implemented without major restructuring — course content draws from a range of disciplines, the norms and cultures that structure disciplines (and science) can be highlighted and discussed, disciplinary contributions can be critiqued and valued, and students can be exposed to a range of new perspectives. To reimagine science communication as an asset for interdisciplinary training, these features need only be fostered and made more salient.

The interdisciplinary nature of science communication may be self-evident to SC educators and academics, but this may not be obvious to all, and certainly not to those outside of our field, including HE administrators. Many SC courses do not explicitly highlight their potential for interdisciplinary gains, even when those courses likely include development of interdisciplinary competencies. More could be done to highlight the multidisciplinary nature of SC studies and their contribution to students' interdisciplinary development in course descriptions and introductions, and to explicitly target the development of interdisciplinary awareness and attitudes in learning outcomes. Foregrounding interdisciplinarity in this way could focus the attention of students, instructors, and administrators on the opportunity for developing these competencies, and initiate an evolution in the perceived role of SC studies at university.

In sum

In the past, SC education has benefited from its ability contribute to program learning outcomes and university graduate attributes. We currently face a similar opportunity, this time by contributing to interdisciplinary competencies. An expanded pedagogical focus to target interdisciplinary competencies in SC courses offers potential for growth and renewed appreciation for SC studies, and positions the field to better equip graduates to face the complex problems ahead. None of the measures discussed here constitute a major revision of what is already being done in SC education. Neither does a heightened focus on interdisciplinarity necessarily detract from the current communication objectives of SC courses. In fact, interdisciplinarity and communication skills are recognized as going hand in hand [Power & Handley, 2019; Vickery et al., 2023], so a combined focus could potentially enhance both. But re-casting SC studies as contributing to the development of multiple core graduate attributes could further entrench the field into degree programs at a more fundamental level, helping to secure a permanent and valued position in HE for SC education. In addition, this broader focus could help dispel the view of SC education solely as the development of scientific or technical communication skills, and establish a more accurate view that includes the development of epistemological awareness and communicative maturity.

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