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Completing the Research Cycle: A Framework for Promoting Dissemination of Undergraduate Research and Inquiry

ABSTRACT

With the rise of undergraduate research and inquiry (UGRI) in higher education, it is important to provide students with opportunities to disseminate their research. This completes the research cycle and builds key communication skills. In this article we develop a framework for the dissemination of UGRI, linking exposure to the development of student autonomy. We illustrate the framework with case studies ranging from dissemination activities within the curriculum, such as poster presentations and journal clubs, through to UGRI journals, conferences and product launches. Finally we consider how institutions can promote and support the dissemination of UGRI. To avoid reliance on individuals, institutions should invest in appropriate infrastructure, such as an undergraduate research office, to ensure long-term support for UGRI and the promotion of dissemination activities.

KEYWORDS

communication, dissemination, undergraduate research, inquiry, research skills

INTRODUCTION

In *Scholarship Reconsidered* Ernest Boyer called for a move beyond the “tired old teaching versus research debate” (1990; p. xii) to a more productive conversation of how we integrate research, teaching and learning, as well as conceptualizing these integrated activities in the context of the Scholarship of Teaching and Learning (SoTL). One way to achieve such integration is by enabling students to engage in learning through research and inquiry. Indeed, following the 1998 Boyer Commission, which challenged universities to debate the nature of undergraduate education, there has been a global trend in higher education to engage students in research and inquiry. Undergraduate research and inquiry (UGRI) is recognised as a high impact educational practice (Kuh, 2008) which enhances student learning outcomes (e.g., Seymour, Hunter, Laursen, & DeAntoni, 2010; Spronken-Smith, Walker, Batchelor, O’Steen, & Angelo, 2012). Thus, many scholars of

teaching and learning promote UGRI practices and continue to investigate the impact of the different types of UGRI on student learning.

In this article we take an inclusive view of UGRI, from investigations grounded in coursework, through smaller-scale research projects that may be closed (i.e., the instructor sets the research question and knows “the answer”), to open projects in which the student generates the research question and develops the methods for study (Brew, 2006; Healey, 2005; Zimbardi & Myatt, 2012). Irrespective of whether it is closed or open, there is a cyclical nature to the activity involving identification of the problem, gathering information, analysing data and synthesising findings, communicating results, evaluating outcomes and generating new questions for future research.

Willison and O'Regan (2007) created a “research skills development framework” to provide guidance on the stages of the research cycle, one facet of which was communication. We focus on student UGRI dissemination activities in this article because we believe it has been insufficiently theorised; dissemination is a crucial part of the cycle and should be properly explored and characterised. The Boyer Commission (1998, p. 24) emphasised the need to make research public:

Every university graduate should understand that no idea is fully formed until it can be communicated, and that the organisation required for writing and speaking is part of the thought process that enables one to understand material fully. Dissemination of results is an essential and integral part of the research process, which means that training in research cannot be considered complete without training in effective communication [our emphasis].

However, dissemination can occur throughout the research cycle and is not limited to the results stage. Indeed, it is common practice to require students to make a formal presentation of their literature review or research proposal, allowing for feedback on emerging ideas as well as practice in communication skills. The close link between deep understanding and communication becomes apparent when students have to describe their research to others, for such activity engages them in the essential process of objectifying their knowledge (Popper, 1972). This is particularly so when they are required to express themselves in the concise and precise academic language of their discipline (Orsmond, Merry, & Reiling, 2004), but it will also happen when they are communicating with their peers, with teaching staff or with lay audiences.

Researchers who have investigated how UGRI can be disseminated to the public through journals and conferences (Hill & Walkington, 2012; Luck, 2009; Walkington et al., 2011; Walkington & Jenkins, 2008) report a variety of positive outcomes for student learning and personal development. Hill and Walkington (2012) found that students who presented their research beyond the curriculum learned how to communicate to diverse audiences and increased their oral presentation skills as well as their self-confidence. They also became more aware of their disciplinary culture and recognised potential benefits for employability. However, there remains a lack of research on different types of dissemination activities.

Alongside the desire to promote UGRI for its intrinsic value, effective communication skills are highly regarded as generic skills (de la Harpe & David, 2011). Communication is also a key part of understanding disciplinary “ways of thinking and practising”

(Hounsell & McCune, 2002). Thus, undergraduates need to learn and practice this skill. In making their research public, they have the potential to complete the research cycle and develop key skills in the process.

As Willison and O'Regan (2007) show, depending on their dissemination experience, students may also become more autonomous. We believe there is a relationship between the type of dissemination activity and the development of autonomy that has been under-explored in the SoTL literature. In this article we:

1. develop a framework relating research dissemination activities to student autonomy;
2. illustrate the framework using case studies across institutions; and,
3. consider ways that institutions can promote and sustain dissemination of UGRI.

RESEARCH DISSEMINATION FRAMEWORK

Willison and O'Regan's (2007) research skill development framework describes six "facets of inquiry" which students may develop by engaging in research. For each facet there are five levels of autonomy. Greater autonomy brings increased opportunities for students to take ownership of the research process by:

- choosing the communication genre and the language used to share knowledge and understanding;
- demonstrating their awareness of the constructed nature of knowledge by acknowledging increasingly diverse perspectives;
- understanding the extent of and the context of their own research contribution;
- exercising control over the choice of audience(s) for the research communication.

In our view, the level descriptors related to autonomy in communication do not take sufficient account of the impact achieved through particular methods of dissemination. We propose a revised framework specifically for research dissemination based upon the notion of **exposure**. This term expresses the nature of the audience in terms of its "publicness" (at the level of the individual class, department, or institution, to the local, national or international community), the extent to which the dissemination goes beyond the taught curriculum, and the potential sphere of influence that the research may have. The forms of exposure we include therefore extend from the confines of the curriculum, module or department to opportunities which have global reach and impact.

Willison and O'Regan (2007) suggest that, with an increased level of learner autonomy, there is a shift from the use of lay language to the language of the discipline. We contend that, as the level of exposure increases, the reverse is often the case. For example, for effective dissemination at national-level undergraduate conferences where audiences are multidisciplinary, academic and technical discourse has to be replaced by language accessible to a broader public. Learning to communicate complex ideas without recourse to discipline-centred terminology and jargon requires significant skill development.

Figure 1 shows a simple framework for mapping UGRI dissemination activities. The axis indicating exposure considers a range of audiences and contexts. The associated student autonomy is shown as a continuum, rather than being divided into stages. Importantly, the framework is intended to be descriptive rather than judgemental or necessarily aspirational: exposure and autonomy will be appropriate to the educational context (e.g., teacher-directed poster sessions within a module have limited exposure and autonomy,

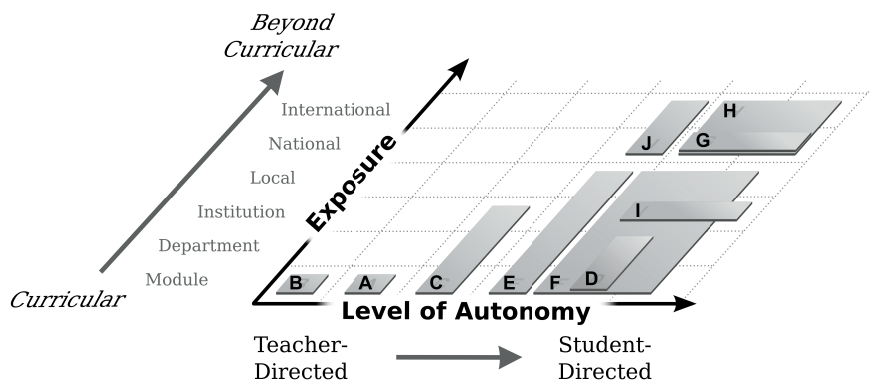


Figure 1: Framework for dissemination of UGRI showing relation between exposure and level of student autonomy. A journal club (endocrinology, Nottingham); B poster sessions (ecology, Otago); C poster sessions (psychology, Leuven), D poster sessions (pharmacy studies, Leuven); E Project work (iSci, McMaster); F local conferences (Queensland); G national conferences (NCUR, BCUR, ACUR); H national journals (Bioscience Horizons, GEOverse); I institution-based journals (BURN, Geoversity); and J product launch (Formula Hybrid Competition).

whilst student-directed conferences can have high levels of both). The framework is displayed horizontally to indicate this. Its purpose is to recognise and value the dissemination activity taking place, whether facilitated by the teacher or created by the student. Table 1 shows possible benefits to students associated with the different examples of dissemination given in the framework, derived from both the literature (e.g., Seymour et al., 2010) and the experience of the authors.

CASE STUDIES OF UGRI DISSEMINATION

Here we present four cases of UGRI dissemination: curriculum-based activities, conferences, journals, and product launches. Each offers a range of possible dissemination strategies. The cases are mainly derived from the institutions of the authors, rather than providing a comprehensive catalogue of possibilities. Readers are referred to Healey and Jenkins (2009) and Healey, Lannin, Stibbe, and Derounian (2013) for further examples. Our cases focus on conventional academic activities, but dissemination can also occur through other avenues such as letters to the editor, newspapers, magazines, blogs and social media networks.

Curriculum-based Activities

Activities within the curriculum serve as a starting point for dissemination of UGRI, allowing students to develop a deeper understanding of subject matter and the inquiry/research process.

Journal Clubs

For many years, a University of Nottingham second-level module in Endocrinology has used the journal club format as a combined formative and summative coursework exercise. It introduces students to investigative thinking and requires them to face the challenge of exposing research to critical questioning. Pairs of students select research articles and prepare to present them to the rest of the class. Each pair chooses an article

Table 1: Possible benefits to students associated with different forms of dissemination activities for UGRI. Dissemination activity letters refer to Figure 1.

DISSEMINATION ACTIVITY	POSSIBLE BENEFITS TO STUDENTS
Journal club (A)	Autonomy and confidence Critical thinking
Poster sessions (B-D)	Autonomy and confidence Ability to explain difficult concepts in lay terms Creativity Oral presentation skills Technical skills in poster design and creation
Conferences (F-G)	Autonomy and confidence Ability to explain difficult concepts in lay terms Oral presentation skills Skill in writing abstracts Networking skills
Journals (H-I)	Autonomy and confidence Ability to write using the language of the discipline in a succinct way to a prescribed format Ability to review and appraise academic papers Ability to respond to reviewer's comments
Product launch (J)	Autonomy and confidence Ability to explain difficult concepts in lay terms Oral presentation skills Technical skills of building the product Networking skills

of interest to them, but must submit it for approval so that the lecturer can ensure variety. The lecturer assesses performance against criteria for understanding, presentation, and contributions to discussion. Although they are presenting the work of others, students develop autonomy and investigative awareness in a safe class setting (A in Fig. 1). Feedback gained by one of the authors (Luck) consistently describes this as a transformative and confidence-building educational experience.

Poster Sessions

Poster sessions provide a means for students to communicate their research and gain feedback on their work. Posters may be presented within the module or to a wider audience.

In a second-year Ecology module at the University of Otago, students work in groups to prepare a poster. The exercise is teacher-directed, focussing on particular ecosystem components, but students have to inquire into relationships between the components and create posters to explain them. Each poster is presented and discussed with the class (B in Fig. 1; Spronken-Smith et al., 2011).

In a fourth-year educational psychology module at the University of Leuven, small groups of students have to develop a research proposal. Students present their work in a poster session and discuss it with peers and members of the research centre (C in Fig. 1).

At the same institution, third-year Pharmacy students work in groups on a small but authentic research topic of their choice. After developing and implementing an experimental protocol, they write a research article and present a poster. The posters are presented to their peers, lecturers and researchers, and to the second-year students of the programme (D in Fig. 1). Feedback on this dissemination activity shows that students

appreciate the opportunity to present their work in this way, and second-year students describe the poster session as an appetizer for future study (Elen, Schouteden, Verburgh, & François, 2011).

Project Work with Multiple Forms of Dissemination

McMaster University's Honours Integrated Science (iSci) Program uses interdisciplinary research projects throughout the curriculum to produce graduates with strong investigative and dissemination skills. Third-year students complete four full-credit projects which provide a transition from previous problem-based learning to independent fourth-year thesis research. They have a choice of topics and use a range of methodologies, working independently as well as in groups. They communicate their results to audiences at different academic levels, including peers, academics, and invited external experts. They use a variety of modes of communication, including: an extended technical abstract; a presentation of findings to the class and invited guests; and an audio podcast, produced for a lay audience using non-specialist language (E in Fig. 1).

All of these outcomes are made publicly available through the University's website. Students, therefore, reach a large audience, highlighting the importance of choosing accessible language and appropriate levels of detail. This poses significant challenges to the students but promotes their autonomy by deepening their understanding of the topic and reinforcing their involvement in the inquiry process.

Research Conferences

Academic research conferences typically include postgraduate sessions, and some also have sessions for undergraduates. Less common, but gaining popularity in recent years, are dedicated undergraduate research conferences. Whilst they may offer differing levels of exposure (from sessions held within a module to external, public events), all promote a high level of student autonomy. They create a professionally realistic but educationally safe environment in which students can expose their work to scrutiny. Disciplinary and interdisciplinary conferences can be found at institutions around the world, whilst nationally-based conferences are becoming increasingly popular.

Local-level Conferences

Since 2004, the University of Queensland's Advanced Study Program in Science has used a research conference as the pinnacle event of a three-year elite program. First-year students organize and chair the conference, which includes an opening plenary speaker and awards, as well as a program of oral and poster presentations by 40 second and third-year undergraduate researchers. It is held in a large auditorium, with posters being displayed in a wide foyer. A book of abstracts is produced and the conference has the look and feel of an authentic, professional meeting. It attracts students, supervisors, senior faculty, family and friends and, therefore, offers exposure at module, department, University and local community levels (F in Fig. 1).

This research conference "is a very important means of communication within the science community, and the development of skills in writing abstracts, scientific papers, giving presentations and answering questions are all vital in producing successful research scientists for the future" (Blanchfield et al., 2007, p. 137). It is integral to the educational program: students coordinate the event in their first year knowing that they will be the presenting researchers in future years. Its success led the University to introduce

an institution-wide cross-disciplinary event. In 2012 this attracted more than 200 presentations (as posters, oral presentations, and “three minute thesis” competitions) running as three concurrent sessions over two days.

National-level Conferences

The opportunity for students to present their research findings at a national level offers wide, public exposure for their research (G in Fig. 1). The National Conference on Undergraduate Research (NCUR), established in the US in 1987, attracts delegates from the US, Canada, and beyond. The 2012 conference had 3300 participants and featured 2759 individual presentations, posters, performances and visual art displays (Cavitt, 2012). In the UK, the first British Conference of Undergraduate Research (BCUR) was held in 2011, attracting more than 150 students from 50 universities. Selected papers were published in a special edition of the *Reinvention* undergraduate research journal.

The first Australasian Conference on Undergraduate Research (ACUR) in 2012 brought together over 220 students, supervisors and supporters, with 130 oral presentations and posters across many disciplines. The best papers, selected through a rigorous review process, were published in Macquarie University’s UGRI journal *Macquarie Matrix*. Student organisers of the conference used social media (Facebook and Twitter) to encourage discussions before, during and after the conference, further increasing the impact of the event (Anonymous, 2012).

Research Journals

Worldwide, the number of undergraduate research journals has increased substantially in recent years. Katkin (2003) found that almost one-third of U.S. institutions ran at least one of these journals on their campus, and the number is evidently much higher today (Hart, 2012). There is great diversity amongst journals in their intended audiences and objectives. There is also variation in the extent to which different groups of students have access to them (Taraban & Blanton, 2008). Nevertheless, publication in this form can represent the highest level of attainment for dissemination (Council on Undergraduate Research, 2012).

The following discipline- and institution-based examples show how journals can become part of a written dissemination strategy for UGRI.

Subject-specific and Expert-reviewed Journals

Bioscience Horizons (BH), established in 2008, publishes outstanding research by UK undergraduates in the form of full research papers and reviews (H in Fig. 1). All have been subject to expert review and contribute to the world corpus of citable scientific literature. *BH* is owned by a consortium of UK universities and published online as a free-access journal by Oxford University Press. Students submitting manuscripts to *BH* need to engage directly with the procedures and constraints of professional research publication. In doing so, they are forced to move their work from the educational context in which it was performed to the domain of public appraisal and criticism. The scientific quality of articles in *BH* is high (evidenced by rates of citation; www.biohorizons.oup.com) and publication represents a remarkable accomplishment by students who achieve it.

The journal insists that the student is the lead author, to ensure that they assume ownership of the work. This requires them to take full responsibility for fulfilling publication requirements, including writing, submitting and responding to review. Evidence from

authors attests to the transformative effect that engagement with professional publication has on their personal development and career prospects (Luck, 2009).

GEOverse is a national-level Geography undergraduate research journal, developed by a consortium of UK universities led by Oxford Brookes University (Walkington, 2008). It uses a team of postgraduate reviewers from a range of universities, thereby extending the pedagogic benefits of the publication process beyond the undergraduate authors. Pairs of postgraduate reviewers collaborate through a wiki; this provides a supportive, dialogic learning space in which they can hone their reviewing skills and ensures that undergraduate authors do not receive conflicting opinions (Walkington, 2012). The journal recently responded to demand from outside the UK by publishing its first international article.

Institution-based Showcases

Geoversity, also developed at Oxford Brookes, is a pedagogic tool to showcase student work within a department (I in Fig. 1). It aims to promote student learning rather than merely mirroring academic publication (Walkington, 2012). Its postgraduate reviewers come from within the department, and here too a wiki is used to support their first steps in this process. Author guidelines and referencing requirements are the same as those for *GEOverse*, allowing articles to be published in the more appropriate of the two journals. The process is supported by curriculum-based training in writing for publication (Walkington & Jenkins, 2008; Walkington et al., 2011; Dellinger & Walkington, 2012).

Bioscience Undergraduate Research at Nottingham (BURN) is a department-based repository for valuable undergraduate research which would not otherwise reach the public domain (I in Fig. 1). Students are invited to write for *BURN* on the recommendation of academic staff following the annual assessment of final-year projects, so it provides a snapshot of some of the best projects completed each year. It is used as a vehicle for publicity as well as being a showcase for excellence. Articles are not expert-reviewed (other than during degree assessment) and are not citable publications, but they do enable students to engage with the process of reporting and publicising their research.

The opportunity for publication in *BH*, *GEOverse*, *Geoversity*, *BURN* and similar vehicles (Hart, 2012) is available to all students, but in practice achieved by relatively few. Review and selection of submissions present a quality filter and it would be naive to pretend that more than a small proportion of undergraduate research meets the standard necessary for public exposure or research citation. Nevertheless, the possibility of publication at this level and the existence of high quality examples should be encouraging to students embarking on research for the first time. They show that undergraduate research can be more than an educational exercise and that completion of the full research cycle by publication is a realistic possibility.

Product Launch

Project-based work aimed at product development is a highly regarded pedagogic model within engineering education (Dym, Agogino, Eris, Frey, & Leifer, 2005) and other areas with direct industrial or business application (Luck, 2008). We consider product development to be a type of UGRI, since the process of developing the product is very much an inquiry/research process.

A well-known example within the collegiate North American engineering community is the Formula Hybrid Competition (<http://www.formula-hybrid.org/competition.php>),

one of several worldwide competitions in the Society of Automotive Engineers (SAE) Collegiate Design Series. This competition brings together teams of undergraduate and graduate students from different disciplines to design, build and present an innovative vehicle according to a set of competition rules. The vehicle must meet performance specifications, as well as being cost-effective and marketable. This ensures that teams include individuals from multiple disciplines, ranging from engineering to business. The competition is generally co-curricular in nature, so one of the first challenges the students face is to raise funds to support the costs of building their vehicle and attending the competition.

Evaluation includes a formal business case and sustainability presentations, as well as tests of the vehicle's design and performance. Expert judges assess the ability of individual team members to articulate the rationale and techniques used in the design and development processes, ensuring that all have contributed. This maintains the academic integrity of the competition whilst ensuring that teams can communicate their ideas effectively to an audience of expert engineers (J in Fig. 1).

INSTITUTIONAL SUPPORT FOR DISSEMINATION OF UGRI

With increasing levels of exposure of UGRI, beyond the module and department (Fig. 1), there is an enhanced need for central institutional support. For national and international initiatives, multi-institutional support is required.

Central institutional support can take a number of forms, including: raising institutional awareness and alignment with institutional missions; defining the required policies; developing suitable pedagogy and curricula; and creating conducive staff and university structures, which include tenure and promotion (Jenkins & Healey, 2005). Many campuses, especially in North America, have Offices of Undergraduate Research (UGR Offices). While these have diverse roles (including coordinating campus activities, maintaining databases of research opportunities for students on and off campus, distributing stipends to students and grants to academic staff, and supporting departmental/program curricular efforts), they can give direct support for the dissemination of the outcomes of student investigations (Katkin, 2003). In particular, UGR Offices may help realise the types of institutional and local events shown in Figure 1.

In 2003, the University of Alberta created an initiative called *Research Makes Sense for Students*. This aimed to raise awareness of UGRI by working across campus to embed research experiences in courses and programs, as well as exploring the role of UGRI in the learning environment (Turner, Wuetherick, & Healey, 2008; Wuetherick & McLaughlin, 2011). It developed into the Undergraduate Research Initiative (www.ualberta.ca/uri), dedicated to embedding research throughout the undergraduate learning environment. Activities of the Initiative include:

- encouragement and visibility for undergraduate journals (the institution has five, both disciplinary and interdisciplinary);
- marketing and resource support for an annual student-organised, campus-wide UGRI symposium, complementing numerous course- and discipline-based events across campus each year;
- training for students to enhance their dissemination skills through workshops on writing and publishing, developing posters and presenting conference papers; and,

- funding for students to attend national and international UGRI events, ensuring that they have access to forums beyond the institution.

Similarly, the University of Queensland's Office of Undergraduate Education (www.uq.edu.au/undergraduate/) has been established to promote the "UQ Advantage" student engagement initiative, which includes UGRI opportunities. The Office funds, coordinates and promotes summer research scholarships. The number of participating students has grown from fewer than 200 (in 2010) to over 400 (in 2012). More importantly, the undergraduate research model has expanded into disciplines which did not previously support UGRI.

Central offices such as these can have a stabilizing influence on UGRI for a relatively small institutional investment. They help to mitigate the inevitable transience of undergraduate students involved in supporting journals and conferences as they move through their programs and graduate. They also promote sustainability by reducing overreliance on individual members of staff for their success.

When dissemination extends beyond the institution, such as national or international journals and conferences, cross-institutional collaborations should be encouraged to build the capacity and sustainability of such initiatives.

CONCLUSIONS

In this article we have suggested a framework for research dissemination, identifying the many and varied relations between exposure and student autonomy. Its use has been illustrated with case studies from different stages of undergraduate study. We have also considered how dissemination can be supported at an institutional level.

Our framework can be used by academic staff as well as students. It offers a planning tool for recognising and mapping dissemination opportunities across a degree programme. Opportunities which extend or go beyond the taught curriculum, such as research conferences and journals, can also be mapped. They point students to valuable ways of building their learning and developing their skills and confidence.

Program-level planning helps to avoid piecemeal, unlinked or repetitive dissemination opportunities, and mapping can help to build a spiral curriculum (Bruner, 1999). In this sense, the framework encourages a structured approach to increasing the exposure of research work. Students can use the framework to record their own achievements and expose gaps they might wish to fill, including making use of opportunities beyond the curriculum. This approach will also enhance personal development planning.

Amongst the case studies, curriculum-based activities such as journal clubs and poster or oral presentations to peers provide a gentle and risk-free introduction to dissemination. They help to build student confidence and set an appropriate environment for subsequent personal development. Such activities are common throughout higher education, though sadly, they may be the only opportunities for dissemination in many institutions. The McMaster iSci program shows how a range of activities can be embedded in the curriculum. The array of outputs to a variety of audiences, set within a scaffold of dissemination experiences, directly fosters student autonomy within the program.

We have discussed some examples of formal UGRI publication, ranging from teacher-directed activities associated with the curriculum (*Geoversity*, *BURN*) through to national journals (*BH*, *GEOverse*). The former offer valuable learning opportunities, while the latter provide exposure at the frontiers of research and facilitate exceptional levels of student

autonomy. Similarly, national research conferences provide high levels of exposure and potential for autonomy. At an institutional level, the University of Queensland conference shows how first-year students can take on leadership and organisational roles. This builds highly desirable graduate attributes while reducing the resource implications for staff.

The product launch example illustrates a scenario for research dissemination which is of direct, practical relevance to vocational and career-focussed students. The Formula Hybrid Competition gives students wide exposure and develops high levels of professionally-relevant autonomy. Of course other possibilities for dissemination exist, such as contributions to newspapers and magazines, blogs and social media. Future research could usefully analyse some of these possibilities, as well as more conventional ones, and their associated learning outcomes.

To avoid overreliance on champions, institutions serious about UGRI have invested in an appropriate infrastructure to support it. Many institutions have created UGR Offices to ensure long-term support for curriculum-based initiatives and to promote UGRI dissemination events. The pedagogic return on this investment is high. As the exposure of UGRI dissemination moves beyond the institution, cross-institutional collaborations should be forged to ensure the sustainability of such initiatives.

In summary, we have raised awareness of the range of dissemination possibilities for UGRI and proposed a heuristic framework to prompt consideration of their value. For some students, presenting within a module will be challenging enough, and indeed some research projects are most suited to this kind of exposure. Other students undertake research worthy of institutional, local, national or international recognition and will derive significant benefit from communication in appropriate forums. All of the dissemination opportunities we describe promote research skills and a range of personal, graduate-defining attributes. In certain areas, evidence of these student benefits can still be anecdotal rather than extensively objectified, and we suggest this as a productive avenue for future SoTL research.

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