From the International Desk

Opportunity, Diversity, and Integration in Undergraduate Research at the University of Queensland

Undergraduate research can be defined and experienced more broadly than the traditional model of a student research project situated in a single laboratory. The Boyer Commission Report (1998) set in motion an international educational movement placing a new emphasis on the role of undergraduate research within higher education. Today the education literature continues to report the variety of ways students engage with research (Beckman and Hensel 2009; Brew 2010a; Healey 2005; Robertson and Blackler 2006) and the potential benefits they gain (Goodlad 1998; Seymour et al. 2004; Hunter, Laursen, and Seymour 2007; Lopatto 2007; Myatt 2009). Here we describe undergraduate research within the context of an Australian research-intensive institution, reviewing the key findings from a study we conducted and providing some examples that characterize the nature of, and student benefits from, undergraduate research experiences across a broad range of disciplines. The diversity of models for these activities, both within and alongside the curriculum, may inspire other institutions to examine the diversity of such experiences that they offer. In addition to confirming our institution’s commitment to providing students with access to research experiences, this study allowed us to foster communication across the institution on the nature of the research-teaching nexus in practice.

National and Institutional Context

The Australian higher education system differs significantly in size and structure from the U.S. system. With a population of just over 21 million people, Australia has 39 universities, of which 37 are publicly funded and only two are private. All Australian universities offer graduate level, research-oriented degrees. The University of Queensland (UQ), a publicly funded university, offers a comprehensive education, from the undergraduate through the doctoral level within a research-intensive culture. UQ has a total undergraduate student enrollment of over 40,000 students, including 6,800 full time equivalent (FTE) graduate students. It consistently ranks in the top three Australian universities in terms of research funding.

The university offers a diverse range of undergraduate degree programs, the largest of which is a three-year bachelor of arts and a four-year bachelor of engineering. Those arts and engineering programs each enroll more than 1,000 first-year students each year. UQ employs more than 2,600 FTE academic staff, whose roles and responsibilities are categorized as performing teaching and research, research only, or teaching focused. Significantly, the teaching-focused academics have a specific educational research role—researching and publishing in the scholarship of teaching and learning. In addition to this obvious emphasis on teaching quality, UQ also commits a significant level of funding for strategic research in teaching and learning. Together, these initiatives provide the opportunity and support for faculty members to engage in teaching and learning initiatives across the institution.

Diverse Offerings for Undergraduate Research

In 2009, we undertook a large research project to characterize the diversity of research activities for undergraduates available across UQ, developing detailed descriptions of 77 such options and brief descriptions of an additional 58 possible research activities across 28 schools within the institution (representing 78 percent of the university’s schools). The options were offered in schools ranging from archaeology to dentistry, from science to social work, and from engineering to journalism (the full report by Farrand-Zimbardi, van der Burg, and Myatt is available at espace.library.uq.edu.au/view/UQ:212669).

The broad range of disciplines included in the study highlighted variations in the language used to describe academic research and also the research activities undertaken by undergraduates. For example, engineering and architecture used the phrase “creativity and design” when talking about undergraduate research because students were often involved in using research to design solutions for projects relevant to an industry context. In contrast, participants from psychology referred to many of their curricula-embedded research activities as
“methods courses” because the students’ activities often involved the critical analysis of various research methods. Therefore, during our literature searches and interviews we were careful to use a broad definition of undergraduate research to avoid unintentionally excluding activities in some disciplines that would not be recognized as research per se in other disciplines. Our definition of undergraduate research activities was informed by the work of Healey (2005), Jenkins and Healey (2010), and Beckman and Hensel (2009). However we found it necessary to focus this study on models that actively engaged undergraduates with the research of their discipline and to exclude models in which students were more passive (less engaged) in the research experiences. Indeed, several of our project participants indicated that including all undergraduate research models in which students experienced research passively or actively would have resulted in the inclusion of nearly every UQ course.

Importantly, this study engaged academic staff in explicit conversations about the nature of undergraduate research. It was clear during the group interviews we conducted as part of this study that some of the participants’ implicit understandings about undergraduate research were becoming clearer, leading to shared understandings of student learning. When Beckman and Hensel (2009) published their findings on the breadth of ways that undergraduate research may be defined across a nation, they called for institutions to engage in explicit conversations on the diversity of ways in which undergraduates could be involved in research within each institutional context. In line with this, our study has enabled individual academics to understand more clearly the diversity of possible ways to engage students in undergraduate research, as well as allowing us to develop a detailed resource of models—including their aims, characteristics and student benefits—across a large range of disciplines that we can disseminate more widely.

Analysis of the characteristics of undergraduate research models based on the frameworks of Beckman and Hensel (2009) and Lopatto (2008) revealed similarities rather than differences across the disciplinary contexts. One of the tensions highlighted by Beckman and Hensel (2009) concerned student access to research activities, that is, whether they were provided to all students or only to honors students. Pleasingly, across the diverse range of activities we found at our institution, most undergraduate research opportunities were available to all students enrolled in a given program of study, rather than just to elite or specific cohorts of students. This supports the notion that, even across an extensive range of disciplinary contexts, there are many ways to incorporate undergraduate research for small and large cohorts of students. In most cases the activities we were able to identify were courses that students would take for credit toward their degrees, rather than co-curricular programs. The notable exception was in law, in which most of the undergraduate research opportunities were identified as co-curricular activities. Interestingly however, in this discipline co-curricular activities are seen not as an optional extra, but rather as an essential experience for students to gain a competitive advantage after graduation.

Given the diverse range of class sizes that allow students to engage in undergraduate research (the cohorts ranged from two students to 1,500 students) and the breadth of educational goals at a comprehensive university, it was surprising to find that the academics we interviewed reported student benefits closely aligned with those benefits reported from more traditional one-on-one apprenticeship models (Hunter, Laursen, and Seymour 2007; Lopatto 2009). Considering the literature supporting the student benefits of the traditional undergraduate model (see Seymour et al. 2004), it is particularly encouraging to see the same benefits reflected in a diversity of models, including skills in written communication, analysis of disciplinary literature, and research methodologies.

Not surprisingly, in many professional disciplines student outcomes from undergraduate research were described based on graduates’ eventual professional careers. For example, the disciplines of psychology and dentistry emphasized key outcomes related to skills in effective critique of—and therefore appropriate use of—research literature in professional practice. Interestingly however, many of the participants from what are considered “non-professional” programs also justified their use of undergraduate research-based curricula as essential for providing the skills that all students would need. This was true in a broad range of disciplinary contexts and was not limited to careers requiring advanced research degrees.

Below is a discussion of five undergraduate research models examined in the Farrand-Zimbardi, van der Burg,
and Myatt report (2010). These examples were specifically chosen to represent diversity in the activities that students undertake as part of an undergraduate research experience at UQ, especially in relation to the frameworks of Beckman and Hensel (2009). Table 1 summarizes the examples and highlights their differences.

### Undergraduate Research in 1st Year Chemistry

First-year chemistry at UQ is characterized by large classes (in excess of 1,000 students) and traditional practical experiences. An innovation in chemistry teaching at UQ has been the introduction of active student-learning experiences through a close collaboration with the Center for Authentic Science Practice in Education (CASPiE) at Purdue University. The CASPiE model provides students with an opportunity to design experiments and collect data that contribute to an ongoing investigation by a research scientist, either local or international.

Students who participate in CASPiE at UQ complete a six-week, two-phase block of research-focused practical work. In the first phase, students are introduced to the techniques, skills, and current literature relevant to the research project. During the second phase, students identify their own research question, conduct their experiments, and collect and analyze their data. Throughout the CASPiE block, students work in small groups under the supervision of a tutor, maintain a laboratory notebook, analyze data, and participate in online discussions. The exercise finishes with students writing a scientific abstract to communicate their project findings.

The benefits to students from this authentic research experience have been evaluated (Lawrie et al. 2009), producing clear evidence that they include students’ feeling they have become part of a community of scholars and that the students were more engaged than those taking traditional chemistry. The researchers also observed substantial gains in students’ understanding of scientific thinking, in their engagement, and in the students’ ability to identify and solve experimental problems. By linking their research work to the current work of a research scientist, students in the CASPiE program could see the relevance of their work to current research and gained confidence in their ability to contribute to the development of knowledge in their discipline.

### Undergraduate Science Students’ Experience in Research (USSER) Network

The USSER Network is a co-curricular program open to all undergraduate science students. It is designed to minimize time demands on students and to fit within an already-crowded curriculum. The USSER Network aims to welcome students into the research culture of UQ through a combination of informal lunches, tours, and laboratory placements.

“Meet the Researcher” lunches take a speed-dating format in which three to five students talk with a researcher for 10 minutes about research and career paths. When time is up, each researcher moves to the next table to meet a second group of students for the next conversation. The design fosters discussions among small groups and provides numerous personalized interactions between researchers and students. “Laboratories Unwrapped Tours” enable students to see inside real research laboratories; they provide a simple, yet surprisingly powerful, way to “demystify” the research laboratory. The third component of the USSER Network is the “Research Team Placements,” which provide students with opportunities to work alongside a research team as an unpaid volunteer. Placements often involve students actively participating in current research projects in the laboratory and in the field.
Evaluations of the USSER Network indicate that students gain an increased understanding of what a career in research entails, begin to realize the diversity of research being conducted at UQ, and make connections with UQ researchers (Farrand and Myatt 2009). In addition to increasing the frequency and quality of interactions between undergraduate science students and researchers, students have reported that USSER Network events provided valuable information about other undergraduate research opportunities and about future research-based career paths (Farrand and Myatt 2009).

Advanced Study Program in Science (ASPinS)
The Advanced Study Program in Science (ASPinS) is an enrichment program for science students at UQ targeting highly motivated, high-achieving students with an interest in research and a career in science. First-year science students with high university entry scores are invited to apply, and students must maintain a high level of academic achievement to remain in the program each year. ASPinS is an integrated series of three courses over a three-year science degree.

In their first year, ASPinS students participate in voluntary, not-for-credit, activities such as a residential camp and a series of informal seminars. First year also includes a formal course for credit comprised of five modules, each centered on a key research theme and involving scientific presentations and panel discussions, followed by student group activities and student presentations. All activities are aimed at engaging students in different scientific and disciplinary perspectives. The second and third years focus on research projects undertaken within research groups, with a research mentor, and culminate in presentations at an undergraduate research conference (Blanchfield et al. 2007). ASPinS facilitates the entry of high-achieving students into the scientific community, offering students opportunities to become part of a scholarly community of like-minded peers from early in their science degrees. Through the seminars, research projects, and annual conference, students develop skills, a broad understanding of current scientific research, and a rich network of connections with research groups. Students are well informed as they make career decisions about whether to undertake research-oriented advanced degrees.

A Progression into Archaeological Research
The teaching of archaeology at UQ draws students into research through a scaffolded progression of courses. Students majoring in archaeology as part of a bachelor of arts at UQ can participate in research of gradually increasing complexity and authenticity. The first course in this sequence introduces students to current archaeological research and research processes (Discovering Archaeology). The second course (Doing Archaeology) builds on the first by introducing students to an archaeological site designed for the course, while the third-year course (Advanced Research in Archaeology) allows students to develop, conduct, and then communicate the findings of their own research project. This design is an excellent example that acknowledges the role of research within the professional practice of the discipline and matches this with an emphasis on research in teaching undergraduate archaeology.

Across the three courses, students are provided with the basis of knowledge needed to complete practically oriented research; they also gain practical experience in processing site materials and analyzing literature surrounding their discoveries. They develop research questions, undertake research, and in doing so, develop an advanced understanding of research and research processes. The communication of their results through archaeological reports, research papers, and seminars further emphasizes students’ immersion into the culture of archaeological research. With many archaeologists now working in roles related to the preservation of cultural heritage, the assessment tasks associated with each of these courses allow students to develop and demonstrate skills that are enriched by research and relevant to their professional destinations.

Summer Research Scholarships
The model for summer research scholarships for undergraduates at UQ is very similar to the North American one, in which students work with an established research group on their own project under the supervision of a more experienced researcher for eight to 12 weeks.
during the summer academic break. In addition to the unique opportunity to gain valuable research experience, students in some disciplines are also able to gain credit toward their degree. UQ summer research projects began in some science disciplines as early as 1994, but it was not until 2008 that a centrally organized, university-wide scholarship program was introduced in order to increase undergraduate participation in all disciplines and to provide more students with the opportunity to experience research. Scholarships are awarded based on academic merit; in some cases, scholarships are expanded to cover not only living expenses but also travel to UQ by overseas students of exceptional quality. In the most recent university summer break, UQ awarded more than 400 summer research scholarships across all faculties of the university.

The summer research experience is open to undergraduates and masters students from any Australian or international university. It provides students with the opportunity to develop key research skills and an appreciation of the procedures and protocols associated with research in the discipline in which they are interested. Students have valuable opportunities to develop networks and expertise. This serves the dual purposes of acting as an introduction to postgraduate research and assisting students to make informed choices about pursuing a research-based career.

Conclusion
The University of Queensland has a clear strategic focus on growth in research, growth in graduate education, and continued excellence in teaching and learning. However, there is always a desire to provide evidence of improved student learning (or engagement) to support every teaching innovation. This becomes more imperative if the teaching innovation (such as undergraduate research) appears to require additional resources. The recently announced Excellence in Research Australia (ERA) process, similar to the UK Higher Education Assessment (HEA) exercise, will provide national indicators of institutional quality, which in turn will be used to determine formulas for government funding. The ERA has produced a new focus on measuring research outcomes (through measuring publication quantity and journal quality) and has added increasing pressure for research productivity from all academics, with possible ramifications to their teaching productivity.

There is a growing tension between the evidence indicating the benefits to students from undergraduate research and the research reality of measuring academic productivity through indicators unrelated to providing a quality student experience. Understandably, the new ERA focus places increased pressure on the traditional research apprenticeship model, which is resource- and time-intensive, ensuring that this model will continue to provide only a fraction of the research experiences available to undergraduates. However, the diverse models for engaging students in research outlined in this article and discussed in the Farrand-Zimbardi, van der Burg, and Myatt report (2010), provide evidence that a research-intensive institution can develop and maintain a breadth of opportunities for providing students with access to research experiences and the associated benefits. The research apprentice is an effective model, but it is not the only model.

The integration of research and teaching demonstrated in the research-intensive context of UQ may not be typical of all Australian universities. Brew (2010b) identified a high number of co-curricular research programs for undergraduates across Australia, but commented that many were small and often implemented by a single academic. Further research is needed to understand the diversity of ways students are being engaged in research across a broader range of educational contexts. The challenge remains to increase student access to effective research experiences in a variety of forms, in all disciplines, and to continue to examine the evidence supporting that effectiveness in a range of educational settings.

References


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