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Improving real-world impact from research-focused experiential learning in higher education: A call-to-arms and a case study from field ecology

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ABSTRACT

Research-focused experiential learning (RFEL), where students develop academic research skills by participating in research activities, is a valuable and widespread component of higher education that can be implemented in almost any subject area. It is key to student skills development and career currency and a potentially important source of research capacity for academic staff in teaching-focused universities, contributing to optimisation of the research-teaching nexus. Numerous initiatives facilitate this practice in an extra-curricular capacity, whilst its integration into curricula is less widespread, but gaining momentum. Nonetheless, real-world impact deriving from RFEL is not as visible as might be expected given the ubiquity of the paradigm. We argue that RFEL has yet to achieve its full potential and discuss how to overcome barriers to visibility and effective implementation of RFEL in terms of real-world outcomes, as illustrated using a case study from our own discipline – ecology. A capacity gap exists, particularly at the local level, in effective ecological site monitoring for biodiversity conservation and other forms of environmental management. We believe there is currently underused potential in integrating RFEL via student field experience (field trips, field work, field classes, or field programs) to fill this gap. We show how the parallel process of citizen science – where participating university students and others outside academia collect data as volunteers – lends insights and best practice recommendations to the RFEL model, for field, laboratory, desk-based and other studies. RFEL is critically important for upskilling students for competitive career markets. We outline five ways in which it can be galvanised to effectively yield visible real-world research and management outcomes in addition to positive pedagogic impacts, adding value within the sector.

Keywords: research focused experiential learning, work-integrated learning, ecological monitoring, field experiences, field programs

Introduction

Benefits of research-focused experiential learning (RFEL)

Student inclusion in academic research is an increasingly valuable form of active learning (Theobold et al., 2020) and an important and visible component of modern higher education (HE) particularly in the United States (US), United Kingdom (UK), and Australia (e.g., Morley & Golam Jamill, 2021). A myriad of extra-curricular initiatives exist that expose students to real-world problems, some of which make students central to solutions, and all of which give them 'hands-on' opportunities to develop their research ability

and acquire professional skills. Evidence of such Research-Focused Experiential Learning (RFEL) yielding pedagogic benefits is widespread in the literature, and in some instances impactful real-world outcomes are explicitly documented. Examples of the latter include undergraduate students as co-producers (Healey et al., 2016) in establishing and maintaining research laboratories in electrical and computer engineering (Ieta et al., 2011), developing digital apps for use in environmental science (Zipf et al., 2020), and undertaking research placements in politics (Sherrington et al., 2008). In the natural sciences in the US and UK, RFEL programs include the National Science Foundation's Research Experiences for Undergraduates program (National Science Foundation, 2021); the Harvard Forest Summer Research Program (Harvard Forest, 2021; McDevitt et al., 2020 and the Living Laboratories concept (Evans et al., 2015). Sage Hill (University of California Los Angeles, 2022), Mersey Island sediment recharge (University of Essex, 2022), Student-Environment Research Teams (Diaz et al., 2018) and the Cardiff University Otter Project (Kent et al., 2021) are further examples. Initiatives that go one-step further and integrate research experience into formal curricula, are also gaining momentum (e.g., Flaherty et al., 2017; Murren et al., 2019) and may be requisites for accreditation schemes (e.g., UK Professional Statutory and Regulatory bodies such as Royal Society of Biology (2019) and Chartered Institute for Ecology & Environmental Management (2022)). RFEL is particularly relevant in highly applied disciplines in keeping with Boyer's scholarship of application (Griffiths, 2004).

For academic staff/faculty, RFEL facilitates and strengthens networks with professional practitioners (e.g., in industry and non-governmental organisations) and is a means by which lecturers can maintain impactful research activity alongside teaching and learning activities (Bowne et al., 2011). RFEL provides added value to the marketability of degree programs, as a component of work-integrated learning (Jackson & Bridgstock, 2021) via developing student vocational skills, which has been shown to enhance graduate employability (Jackson & Dean, 2022; Mauchline et al., 2013). The incentive for both staff and students to publish research findings from RFEL in academic journals or associated publications (e.g., reports or management plans) is an important currency of such upskilling of students for either the workplace or (further) graduate study. Finally, RFEL facilitates positive outreach to communities, promoting institutional brands whilst allowing networking opportunities with professionals and ultimately increasing student satisfaction (Hix, 2015).

Barriers to real-world impact and visibility

Nonetheless, in our view, RFEL has not reached its full potential insofar as real-world outcomes are less impactful in terms of both reach and extent than might be expected given the ubiquity of the paradigm. This lack of impact could be real (true) or perceived; in the latter case outcomes may be far-reaching and extensive but inadequately reported on, which we can refer to as a visibility issue. Visibility issues can arise from limited transparency in RFEL reporting via academic publications and associated literature. This is reflected in and potentially caused by an absence of clear rules guiding the acknowledgement students should receive. University student participation in scientific research projects is frequently considered a form of citizen science (e.g., Philippoff & Baumgartner, 2016) yet even in citizen science, clearly defined and universally accepted standards do not currently exist for attribution of credit to volunteer participants (Dickinson et al., 2012). Journal author guidelines, for example, do not generally instruct contributors one way or another and the publication of research conducted by undergraduate students tends to be disseminated within a separate arena of undergraduate research journals as listed by Tatalovic (2008). Whilst postgraduate students normally first-author their contributions in professional (non-undergraduate)

journals as guided by their supervisors, and co-authorship of scientific articles in professional journals by undergraduate students occurs, it is not always explicit and may replace transparency regarding student participation in methods sections (i.e., an either/or approach). For example, a project on tools for quantifying biodiversity and assessing management outcomes in a South-African savannah ecosystem yielded three publications that included undergraduate students as co-authors but did not explicitly refer to this anywhere in the manuscript (Goodenough et al., 2017, 2020; Hart et al., 2020). It also yielded two publications that clearly described the inclusion of 50 undergraduate students in the methods section but did not include any of them as co-authors and did not list their names in the acknowledgements (Goodenough et al., 2018a, 2018b). The project is an exemplar of RFEL yet is inconsistent in attributing credit to participants. In other examples where university student participation is explicit and apparently essential to a research output (i.e., the data would not have been collected without student involvement), the authors go no further than acknowledging a body of students in general (e.g., Dörler et al., 2018; Mutz et al., 2006). Similarly, management prescriptions are often informed by RFEL via unaudited communication to stakeholders, which therefore bypasses the grey literature, hampering the visibility of the impact. This may occur where findings are otherwise formalised; for example, a published study of avian phenology in the UK by Goodenough et al. (2015) with undergraduate students as co-authors, has markedly influenced Portland Bill Observatory management action but was not formally included in management plans. These gaps in adequate reporting remain the case despite the growth of the concept of partnership, and related ideas of students as research co-creators and co-producers alongside faculty/academics (Healey et al., 2014) as a viable alternative to consumerist HE paradigms (Healey et al., 2016). Bell (2016) states that undergraduate engagement in subject-based research is the most frequent way in which students experience co-inquiry as part of partnership, whilst the 'students as researchers' pedagogy is listed as one of ten high-impact HE activities by Kuh (2008). Nonetheless, visibility issues and true lack of real-world impact persist.

True RFEL real-world lack of impact (i.e., not simply low visibility of impact due to uneven reporting) pertains in-part to expectations of both staff and students within HE communities. Expectations of real-world impact arising from subject-based research produced by students as the primary investigators (albeit under guidance) tend to be relatively low. This is not surprising because RFEL is primarily seen as a means of enhancing student skills, knowledge, and employability, with subject-based research outcomes (including real-world impact) having secondary emphasis, as reflected in the focus of literature reporting on RFEL, which is predominantly pedagogic (e.g., Lopatto, 2007; Mauchline et al., 2013; Sherrington et al., 2008). Research outcomes of studies where students were primary investigators may be reported under the radar due to visibility issues already described, but this only serves to strengthen our argument that a key function of students in HE, i.e., as producers of meaningful research, is being missed. Therefore, to improve real-world impact, we need to additionally, and explicitly, showcase research excellence from RFEL.

Another dimension of the effect of expectation on impact relates to differing interpretations of and value attached to the research-teaching nexus at different types of HE institutions and related tensions within the academic staff body. UK and US HE providers are commonly classed as either research or teaching-focused, with the latter also termed 'post 1992 institutions' (UK; Cartwright, 2007) and predominantly undergraduate institutions (PUIs) (US; Bowne et al., 2011). Staff at research-focused institutions are typically expected to produce substantial quantities of high impact research outputs and are normally recipients of greater amounts of both research funding and dedicated time for research relative to their teaching-focused counterparts. Griffiths (2004) suggests that the belief of high-quality teaching and learning being inherently improved when delivered by research-active lecturers is a myth proffered by

research-focused institutions in defence of receiving concentrated research funding. The currently prevailing attitude that research and teaching must be integrated in a meaningful way to benefit each other is evident in numerous initiatives and centres of academic development from both types of institution. These explore the efficacy of various forms of research-based (including RFEL), research-orientated, research-informed, and research-led teaching (Griffiths, 2004) and include the Connected Curriculum Framework (CCF) (Fung, 2015) at University College London (UCL) and the McMaster Institute for Innovation and Excellence in Teaching and Learning (MIIETL) (Healey et al., 2016). With any strategy for optimising research-teaching integration however, subject-specificity is an important consideration (Griffiths, 2004) and some subject areas tend to embed meaningful integration of teaching and research (including via RFEL) more readily or easily than others. Correspondingly, modes to maximise RFEL efficacy vary according to subject, as affected by variation in, for example, stakeholder expectations and practical implementation.

Case study: RFEL via ecological monitoring from field experience

One example of a discipline in HE where RFEL can be easily implemented practically but may require further development and clarity of stakeholder expectations to reach its potential, is field experience in ecology. Field experience, including 'field-work', 'field programs' or 'field classes' is defined here as any activity where supervised groups of students undertake scientific sampling in situ on organised outings. Field experience has numerous pedagogic benefits, triggering positive associations in the affective domain (Boyle et al., 2007; Jacobson et al., 2015) with associated cognitive benefits (Richards et al., 2012). Learning by doing allows students to make critical connections in their understanding of scientific content (Berland et al., 2016), giving context to information taught in a classroom setting (Larsen et al., 2017) and is integral to the development of practical skills in ecology (Andrews et al., 2003). Additionally, field experience is one of the means to bridge the student-faculty divide in HE by facilitating positive interactions in a relatively informal setting (Hart et al., 2011). Lastly, there is a need to prevent field skills, such as identification skills from 'dying out' in future generations (Fleischner et al., 2017; Millenbah & Millspaugh, 2003; Millspaugh & Millenbah, 2004) due to the risk of field studies being undermined by cost-cutting measures (Cooke et al., 2020). Overall, field experience provides an invaluable platform for optimising the research-teaching nexus (Fuller et al., 2014).

Ecological monitoring is a key component of problem solving in biodiversity conservation, with longitudinal data necessary for detecting ecological patterns over time (Hobbie et al., 2003; Vanderbilt & Gaizer 2017). Nevertheless, most site monitoring, particularly at the local level, is low profile and poorly funded, despite its value for informing conservation planning. Local monitoring programs do not always involve innovative scientific enquiry, instead answering research questions only pertinent to effective local site management. This limits their capacity to generate research funding from traditional sources such as research councils. Coordinated collaborative networks across universities can facilitate the scaling up of RFEL field experiences at greater temporal and spatial scales (Bowne et al., 2011), yielding greater research impact for staff and students at PUIs/post-1992 institutions and broader, more effective management outcomes.

Notable aspects of field experience that promote its integration into conservation and environmental planning are as follows: 1) data are normally collected in groups, allowing mitigation of observer bias and inter-observer skills differences (e.g. Callaghan et al., 2019) and collection of multiple and granular datasets over short periods; 2) data are collected at the same sites on repeated occasions over extended timescales, allowing accumulation of longitudinal datasets; 3) oversight of data collection by academics, practitioners,

or student mentors (e.g. Philippoff & Baumgartner, 2016) allows mitigation of errors in data collection and can overcome observer variability; 4) RFEL is a cost-effective method to provide field experiences as often only basic equipment and travel costs are required, which can normally be absorbed by HE teaching budgets; 5) environmental costs incurred by transport are reduced by students visiting sites en masse e.g. in coaches or minibuses rather than private cars, making local site visits more sustainable.

Challenges to the effective integration of RFEL and real-world outcomes in the context of field experience include: 1) student skills deficits; particularly for foundation and first year undergraduate students learning concepts and techniques for the first time; 2) lack of student motivation/engagement; 3) the seasonal nature of data collection, i.e. normally conducted at the same time of year (spring/summer) (Hobbie et al., 2003); 4) the brevity of field experience – most residential field classes last between one and two weeks, and day trips may be repeated only once per year; 5) academics remain responsible for analysing data and preparing manuscripts for publication, which delays outputs due to inherent time pressures. Nonetheless, solutions to these challenges exist and are implementable. Negative impacts on data reliability and accuracy via student skills deficits in a RFEL field experience context are resolvable with best practice guidelines for structured citizen science projects (Callaghan et al., 2019). These include a training and evaluation phase, and data validation to prevent bias from inter-observer differences, e.g., inclusion of identical data points from two independent observers only included in analyses (Frigerio et al., 2018). Standard data checking and post hoc validation practices include immediate post-fieldwork data review, and technological tools to constrain possible data values, either from the outset (e.g., via mobile data gathering platforms such as Epicollect (Centre for Genomic Pathogen Surveillance, 2023) by drop-down menus in Excel spreadsheets. These practices reduce 'sloppiness' and falsified data (Philippoff & Baumgartner, 2016), which may reflect a lack of student skills and/engagement. Although lack of engagement may be reduced for extracurricular or otherwise self-selecting RFEL activities (as for citizen science: Aceves-Bueno et al., 2017; Philippoff & Baumgartner, 2016) it can also be ameliorated by targeted communication to promote understanding and foster agency and trust (Frigerio et al., 2018). Threshold levels of engagement for acceptance onto modules within curricula may be introduced to promote responsibility and agency with knock-on effects on data quality. Close oversight by staff and/or 'mentors' (e.g., postgraduate students as helpers and demonstrators) can additionally mitigate skills and engagement issues (as for citizen science, Aceves-Bueno et al., 2017). Connectivity of RFEL in collaborative networks (Bowne et al., 2011) has potential for mitigating the impacts of both field experience brevity and seasonality on data quality, i.e., if data are combined from field experiences at different institutions conducted during different seasons at the same sites, or simultaneously at different sites, using standardised protocols. Finally, staff responsibility for dissemination of findings from RFEL via research publications and grey literature can be shared with students where the latter are given agency in the process and a clear pathway for implementation. For example, undergraduate students might be expected to write draft manuscripts reporting field experience findings as part of subject-based or skills modules within curricula. These manuscripts would then be edited and prepared for publication by academics in a similar manner to supervisor support for outputs from postgraduate study. This would yield benefits to both parties, providing that visibility issues concerning reporting are addressed.

Six-point plan for implementation of RFEL with dual pedagogic and real-world outcomes

We therefore believe that dual pedagogic and real-world outcomes from RFEL are possible with a shift in outlook and an increase in reporting guidelines, exposure and expectations across stakeholders and the

systems that facilitate them within both post-1992 (PUI) and research-focused institutions. Having showcased the potential for real-world impact from RFEL and outlined best-practice based solutions for our field (ecology) we offer a six-point plan for enhancing the efficacy of RFEL across disciplines as follows:

1. Introduce clear, feasible instructions for authors concerning student credit attribution/authorship in academic journals and associated literature (e.g., reports/management plans);
2. Equally emphasise pedagogic and real-world (applied) outcomes in RFEL reporting;
3. Increase awareness and expectations concerning the value and availability of RFEL amongst practitioner networks;
4. Increase awareness of RFEL within the student body and amongst applicants (including potential co-authorship of academic publications);
5. Increase awareness amongst academic staff/faculty of RFEL as a means of facilitating research outputs in the broader context of the research-teaching nexus and related tensions; and
6. Promote and provide opportunities for RFEL within curricula, with participation contingent on threshold levels of engagement to contribute to maintaining quality standards in research outputs.

Conclusion

Research-focused experiential learning (RFEL) is an appropriately lauded mainstay of higher education. Our subject area and application – field ecology for ecological monitoring – is particularly suited to integration within the RFEL paradigm. However, across disciplines, research, and real-world outcomes of RFEL are often overlooked or overshadowed by pedagogic goals. This represents a missed opportunity for generation of high-quality research and real-world impact by staff and students who equally benefit from it. Further, the current climate of squeezed research funding and increased teaching commitments at universities makes it a particularly attractive option for research active academic staff/faculty. Our suggestions for solutions to this issue centre on a combination of increasing both expectations and visibility amongst stakeholders (staff, students, practitioners). We recommend further work involving mixed methods assessments of staff and students at both teaching and research focused HE institutions to build an evidence base by gauging opinions on the extent to which RFEL is a) desirable; b) has adequate impact; and c) is adequately reported on.

Biographies

Bryony Tolhurst is a Principal Lecturer in Behavioural Ecology at the University of Brighton whose research focusses on mammal ecology, urban ecology, citizen science and human-wildlife conflict. She advocates students as active scientists and researchers during their university education.

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Maureen Berg is a Principal Lecturer in Ecology and Conservation at the University of Brighton. Her research focusses on plant communities with an interest in wetland and grassland habitats. She is a strong advocate of experiential and research informed teaching.

Angelo Pernetta is Associate Dean (Education and Student Experience) at the University of Brighton and a conservation ecologist with a research focus on anthropogenic impacts on animal communities from various taxa. He is invested in students being active participants in conservation science as part of their higher education experience.

Neil Crooks is a Principal Lecturer in Ecology at the University of Brighton. His research focuses primarily on the effects of pollutants on fish physiology, morphology, and behaviour. He is an enthusiastic proponent of research-focused experiential learning as a way of enhancing the student experience whilst achieving conservation goals.

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