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Graduating work-ready professionals: Research competency as a critical curriculum component

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Abstract

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Graduating Work-ready Professionals: Research Competency as a Critical Curriculum Component

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Abstract

Research skills are fundamental to the building of the evidence basis of professional practice, are at the core of lifelong professional learning and are the keys to discovery, innovation and knowledge transfer. Research competency is thus increasingly recognised as an important educational goal for graduates in many professions. This paper describes a flexible program, adaptable to any professional course of study that allows students to engage in meaningful, scholarly and authentic research. Students are supported to undertake a research activity that spans the research continuum from development of a research question through to dissemination of findings, and strategic points in-between.

Keywords: higher education; curriculum; research training; work readiness; professional practice

Introduction

Research training is widely recognised as an important component of many professional curricula, including the health and medical sciences, engineering, education and law (Laidlaw et al., 2009; Kim-Prieto, 2011; Wallen & Pandit, 2009; Barkan et al., 2009; Iliško et al., 2010). It is valued for its role both in learning and in the students' later professional practice (Laidlaw et al., 2012). In medicine, provision of

opportunities for participation in research during undergraduate education has been suggested as a means to encourage future engagement in academic medicine (Lawson McLean et al., 2013). It is also a professional accreditation standard in Australian medical school programs (Australian Medical Council, 2012). Within a 'learning healthcare system', understanding and participating in research allows the practising physician to combine clinical experience with innovation and evidence-based medicine to facilitate optimal patient care (Olsen et al., 2007). In other professions such as nursing, dentistry, allied health and social work, skills in critical thinking and in evidence-based practice are important to promote best-practice (Reising, 2003; Burke et al., 2005; Splieth et al., 2011; Rubin et al., 2010; Mitcham, 1986). Biomedical engineering graduates need to develop communication and collaboration skills with healthcare professionals to enhance health outcomes through application and development (Wallen & Pandit, 2009), and lawyers require fundamental skills in legal research (Barkan et al., 2009). Even athletic training educators have recognised the need to align their curriculum with the standards of other professional courses (Manspeaker & Van Lunen, 2011). In these and other professional areas, research skills are needed to ensure effective knowledge transfer and excellence in operational or professional activity.

Since research competency is a critical professional attribute and can enhance student employment prospects as well as provide an enduring skill set, it would seem logical for professional education curricula to include training in research skills. However, some undergraduate programs offer few opportunities for authentic research experiences, including instead isolated or fragmented learning experiences (Linn et al., 2015), or opportunities limited to providing teaching about how to undertake literature reviews, basic statistical analysis, or attendance at a conference (Danowitz et al., 2016; Fitz & Winkler, 1989). In other courses, such as medical degree programs, research training can take on various guises, including participation in coursework activities, elective research terms, established research programs, integrated medical and research degrees and community-based participatory research fellowships (Houlden et al., 2004; Schor et al., 2005; Grochowski et al., 2007; Rosenthal et al., 2009). Although it can be difficult to timetable research activities in a demanding curriculum, programs that facilitate independent learning are important in promoting a culture of research awareness and skills development in new graduates (Laidlaw et al., 2012). Critical components of scholarship include fostering intellectual curiosity, identifying areas of professional interest, and engagement (Brubaker, 2015). Thus, in addition to skills development for future practice, experience of research during under-

graduate education can influence the development of a professional identity as a researcher and scholar within a particular profession (Jackson, 2014; Daniels & Brooker, 2014).

A flexible program that allows students to engage in meaningful, scholarly and authentic research, which is adaptable to any professional course of study, is clearly of benefit to curriculum developers. We have recently reported evidence that such a program designed to promote research skills through experiential learning has improved medical students' capability in research (Mullan et al., 2014). In this report, we describe the key features of our program and its potential for application across a wide range of professional training courses.

Methods

An Australian medical school with a focus on addressing rural and regional medical workforce shortage provided a vehicle to introduce research and critical analysis as a core theme within a medical curriculum (Mullan et al., 2014). Course accreditation requirements by the Australian Medical Council (AMC) (2012) dictated that all students undertook some form of research activity and the course structure permitted the placement of the research component during the students' 12-month clinical placement. In this paper we will describe the features of the model with reference to our established medical student research activity and in the context of other professional disciplines.

Results

The Authentic Research model

The basis of the model described here is an activity designed to engage medical students in the continuum of research from designing their own research question through to dissemination of results. This authentic research activity is underpinned by evidence indicating that understanding and participating in research allows the physician to combine clinical experience with innovation and evidence-based medicine for optimal patient care (Olsen et al., 2007) and that research training should be valued for its role in both learning and the students' future professional practice (Laidlaw et al., 2012). Below are described the key features of our research activity and its potential for adaptation with the needs of varied users in mind.

1. Positioning the research activity in the curriculum

The challenge of providing a comprehensive opportunity to engage students in research was recognised in the curriculum development stage of our course, and the optimal positioning of the research component was considered to be in the senior years, during a 12-month community-based clinical placement. The placement location provided

students with experience in general practice, local hospital and other healthcare settings and the opportunity to identify and undertake relevant research topics in those settings, as well as within the general community. This has translated into student research projects covering a wide range of health and community issues, including rural access to health care, chronic disease management, public health, and specialist care.

While it is well-known that medical training includes one or more placement activities where students are provided with important 'hands-on' clinical experiences (Annear et al., 2016; Griffin et al., 2016), this is also often the case for other undergraduate students (Thompson, 2016). Incorporating a research activity within any placement or industry setting can provide opportunities to build professional skills alongside the development of research skills. Such active participation not only enhances research skills but the environment in the placement can help build teamwork and collaborative skills (Mitcham, 1986) and develop transferable and technical expertise (Vaezi-Nejad, 2008).

Incorporating a research activity within a placement setting need not be a burden (Mitcham, 1986). The key is to identify a location that will meet the curriculum needs and provide the accompanying industry experience. The 12-month clinical placement within our program provided the students with a suitable opportunity to undertake community-based research. It also ensured students had sufficient time to experience the research journey from development of an idea through to the dissemination of research findings. Shorter duration placements in other professional programs may be equally suitable if some of the preliminary research components are already in place. For instance, options for such projects may include the student undertaking analysis of data already collected, writing a journal-style article, and presenting a poster describing the findings; or students working in groups so that more time-consuming aspects such as data collection and analysis are shared; or omitting the writing component entirely, focussing only on communication with peers and industry representatives. If there is no placement activity normally timetabled within a particular program, a regular allocation of time over a semester and input from experienced industry representatives can allow opportunity for one or more components of the research activity to be completed.

Embedding a research activity requires a whole of curriculum approach; students need to be familiar with, and experience, a range of research concepts throughout the course, preferably with examples relevant to their chosen profession. In our medical program, students in junior years are taught skills in research (such as literature searching;

critical analysis; interpreting statistics; research methods and evidence-based medicine) integrated with the scientific and clinical content of the particular topic being taught (Mullan et al., 2014). The same activity could be adapted to any discipline. For instance, sports scientists can learn about research methods when discussing nutritional supplements; pharmacy students can learn about statistics when studying new therapies; and journal club and critical appraisal activities can be beneficial to all professional disciplines (Whiffin & Has-selder, 2013; Clark et al., 2014).

2. Academic management of the program

Dedicated administration is required for management of the student research activity, including ensuring on-going improvements to the program. The early management of our program focussed on administrative tasks such as allocating students to research-experienced academic supervisors, assisting with human research ethics applications, monitoring progress, ensuring students completed assessment tasks and organising marking and locations for peer presentations of research findings. The program has subsequently transformed into a sophisticated, comprehensive and scholarly activity, including the development of research resources for students and support for collaborations between students and external agencies. One of the keys to this transformation has been the exploitation of the varied skill sets and research interests of the academic staff responsible for program management. Our management team for the research activity currently comprises five experienced academic staff members who each contribute to the running of the research program alongside their other academic roles. The time allocated to managing the research activity is estimated at one full-time equivalent staff member for up to 85 students.

While our program is managed collaboratively among five staff, it is possible that one full-time academic staff member could manage the whole program depending on the number of students and the type of activity. We would recommend more than one academic be involved, however, as the multidisciplinary expertise of the team supports the efficient operation of the program. Each team member is an experienced research academic and has unique skills and interests in research areas including statistical analysis, qualitative research, report writing, curriculum development, research ethics and research capacity building. This expertise is specifically harnessed in the development of resources, provision of advice to students, and in ensuring student reports and presentations receive relevant and scholarly feedback.

3. *The need for academic, research-qualified student supervision*

The research activity implemented within the medical program discussed here is delivered to up to 85 individual medical students per year, located in ten off-campus, state-wide, geographical locations as part of the 12-month clinical placement. Placements may be up to 1,200 km from the main campus. While students are actively encouraged to develop research questions of relevance to their placement community, it became clear early on that each student would require research supervision from a qualified academic researcher located at the university, as many medical preceptors in the community settings lack research training or experience and have busy clinical and supervisory schedules (Tulinius et al., 2012; Abbott et al., 2014). To accommodate the need for research supervision, all research-qualified academic staff employed in the medical school are invited annually to participate as academic supervisors. There is an annual supervision load of approximately five students per full-time academic staff member, or pro-rata equivalent.

Academic supervision or mentoring of student research is recognised as key in students' engagement in research (Weller & May, 2013; Linn et al., 2015). Thus, engagement of faculty in the student research program within any professional educational curriculum is critical to its success. Academic supervisors play an integral role in translating the students' ideas into a suitable project that can be achieved within the time frame allocated. For instance, in our program, students are advised how to amend a survey to make it briefer, or how to restrict the period of a retrospective audit to avoid excessive data entry. Supervisors provide advice to their students about all aspects of research including project design, data collection and analysis, academic writing and dissemination of findings. They are also involved in marking the summative assessment tasks of other students, including the final journal-style, 2,500-word submission reports and conference-style poster presentations.

When the research program was first introduced, academic supervisors were randomly allocated to students, regardless of whether they were familiar with the research areas chosen by the students. However, some students identified research interests that were aligned with those of academic staff, which led to the current process of matching students with the particular research interests of their academic supervisors. For instance, students who wish to undertake research in areas such as health literacy, public health, or chronic disease are allocated to supervisors with those research interests. Such a strategy of exploiting the various research interests in any faculty or school is applicable across a range of professional disciplines. Our experience

has been that this innovation has increased engagement of academic staff with the student research projects, willingness to be involved in grading of the students' final reports, attendance at final presentations and the provision of assistance to those students seeking to publish their work.

The off-campus locations provide an additional challenge in terms of timely communication and provision of advice to the students. Opportunities for the usual 'water cooler' conversations about research are largely absent, which is why regular communication via email, telephone, videoconference and Skype™ is encouraged. To encourage peer interaction, a monthly all-hub video conference link-up session, facilitated by the research team co-ordinator allocates dedicated time for discussing the students' research projects.

The issues and solutions described above are relevant across professions. Research is a scholarly and collegial activity, and academic supervision for novice researchers is critical in enhancing research activity and career development (Kjeldsen, 2006). The incorporation of a supervised research experience during undergraduate professional education needs to be well thought-out and have the support of all faculty. While it is clear there are workload implications for individual supervisors, we have found that the benefits can include additional publications and future collaborations at an individual level, as well as enhanced scholarship, including discovery and innovation, relevant at the school or faculty level (Boyer, 1990; Weston & Hudson, 2014).

4. Avoiding an ethics review bottleneck

Although human research ethics may not be a requirement for some professional research activities, we discuss it here as an example of addressing requirements to undertake a particular area of research. Obtaining human research ethics approval can be time-consuming and most ethics committees would be overwhelmed if required to assess up to 85 new human research ethics applications at one time. Moreover, novice researchers need guidance in this area as they are often unaware of the requirements for submitting a research proposal to an ethics committee and can find the application process daunting. To address this issue, consultation with members of the university Human Research Ethics Committee (HREC) was undertaken before the program commenced. This led to the development of an 'umbrella' human research ethics application, specifically to provide approval for the medical students' research projects. A senior academic researcher took the role of chief investigator on the umbrella application, which was approved only for low and negligible risk community-based student research. The umbrella ethics approval allows for quantitative and qual-

itative data collection methods with non-vulnerable groups and clinical audits, but excludes invasive clinical procedures or research involving vulnerable groups such as children or Indigenous patients.

To gain human ethics approval under the 'umbrella' approval, each student is required to submit a condensed version of a human ethics application, comprising a two-page proposal and supporting documents as required, including participant information sheets, consent forms, survey and interview questions and recruitment advertisements. The project proposal must include background literature, research objectives and methods, sample population, recruitment, stakeholder(s), and expected outcomes of the research. The HREC considers each project proposal individually within the context of the existing low and negligible risk 'umbrella' approval and assesses these proposals weekly via an expedited review process. The few students who wish to conduct projects not meeting the low and negligible risk criteria of the 'umbrella' ethics approval, such as investigations involving vulnerable persons, are required to submit a full human research ethics application and are supported by their academic supervisor in this more extensive process. Although this option is not common, it recognises the importance of allowing students to have ownership of their research and provides an avenue, albeit lengthy, to accommodate their interests.

This 'umbrella' ethics approach was dependent on the understanding and cooperation of the university's Research Services Office and the HREC. The impact of this strategy was significant. Not only did it reduce the burden on the university HREC, it sped up the process of approval so that students were advised quickly of approval or amendments as required to their proposals. A recent initiative is the development of an 'umbrella' ethics approval specifically for projects investigating health issues for Aboriginal and Torres Strait Islander persons, which is a step forward to enabling projects relating to Indigenous health issues to be initiated by students and completed in a timely manner.

The program evaluation after the first year revealed that the time taken for the novice student researchers to develop participant information sheets, consent forms, survey instruments and other important HREC paperwork was long and frustrating and reduced the time available for students to focus on and complete their research. Once again, in collaboration with the HREC, relevant templates for these items were developed (see Table 1). These template forms, which are reviewed and modified annually, help to ensure a consistent format of students' submissions to the HREC and allow students to move to the ethics review stage with a clear understanding of the ethics regulatory requirements and with the means to address them efficiently and effectively.

Table 1: Templates developed for preparing documents required for HREC submission and summative assessment

Template
Human Research Ethics documents
Participant Information sheet
Participant consent form
Wording for anonymous survey
Approval letter from participating clinical placement practice
Ethics agreement form detailing academic supervisor and other researcher experience, declarations and signatures
Ethics reporting form at completion of the project
Assessment tasks
Two-page proposal pro forma (headings: Introduction, Methods, Participants, Stakeholders, Ethical considerations, References)
Progress report
Final report as journal-style article
Conference-style poster presentation and abstract

5. Developing administrative and research resources as required

Some medical students in our program had previously been involved in research while others had little or no prior research experience. Feedback from academic supervisors and from students revealed there were some gaps in some students' research knowledge and identified frequently-asked questions raised by students in relation to their projects. For instance, it was clear that some students required instruction in entering data onto a Microsoft Excel™ spreadsheet and others required information about how to analyse data to obtain simple descriptive statistics, while others required information about how to develop a survey or to undertake thematic analysis of qualitative data. In response to these knowledge gaps, a process of identifying areas of need was implemented and research-specific resources were developed and made available both to students and their academic supervisors through their dedicated electronic learning portal. The resources developed to date cover a range of topics such as writing a literature review, designing a research question interpretation of results and exemplars of previous students' final reports and posters (see Table 2). Abstracts of all past student projects are also available for students to view and are valuable as examples of types of projects undertaken, methods employed and topics that have been successfully investigated.

Table 2: Electronic resources available to support medical student research

Module or resource
Project proposals – examples from previous cohorts
Searchable database of previous projects
Constructing your research question – article
Library support – PowerPoint™ presentation
Writing your literature review – PowerPoint™ presentation

Selecting your research method – PowerPoint™ presentation
Ethical considerations of research – frequently asked questions – short Q&A article
Constructing your research questionnaire – PowerPoint™ presentation
Analysing your data – PowerPoint™ presentation
Qualitative research – PowerPoint™ presentation
Qualitative research - Coding your data – PowerPoint™ presentation
Statistics for Medical Students - Getting Started (3 Parts) – video tutorial
Statistics for Medical Students - Data types – video tutorial
Statistics for Medical Students - Summarising continuous data – video tutorial
Statistics for Medical Students - Summarising categorical data – video tutorial
Statistics for Medical Students - Choosing the appropriate statistical test – video tutorial
Writing your report – PowerPoint™ presentation
Intellectual property and authorship– frequently asked questions

Responding to the resource needs of students is important in streamlining the research process to ensure efficiency and has the benefit of increasing research capacity of other stakeholders, by making resources available to industry partners and other collaborators, as well as junior faculty and graduate students.

6. Keeping students engaged through formal assessment and recognition

Lack of experience, interest and time can negatively influence uptake of opportunities for research. Moreover, activities that are not assessable are often afforded little attention by students in a demanding course (Laidlaw et al., 2012). To promote engagement in the research program, formal assessment with timely feedback was implemented. Throughout the research activity, students are required to complete four formal summative assessment tasks; the submission of a two-page project proposal, a short progress report, a final 2,500-word written journal-style report, and a 5-minute presentation of their research with accompanying conference-style electronic poster. An integral formative part of the process of student learning is the feedback provided by academic supervisors during the preparation and development of these items. Students are encouraged to provide drafts to their supervisors and are mentored in the process of academic writing and dissemination strategies. Academic writing is an important communication skill (Mercer-Mapstone & Matthews, 2015), and can influence future research intentions (Cameron et al., 2015). Developing and incorporating mechanisms to provide academic support for students in developing competency in writing and dissemination is applicable to any area of undergraduate professional education.

Additional engagement with the research activity is promoted through an incentive program, with the awarding of prizes and academic recognition for outstanding medical student projects. Recognition of excellence is celebrated in several ways, including the public display of abstracts of student projects which received a mark of 'Ex-

cellent' in the main lobby of the school. Thus, students who are new to the course observe the importance placed on student research by the school and the university. This has had the effect of increasing student interest in research in earlier phases of the course, as evidenced by approaches from students to start their research projects soon after they enrol in the course. In addition, reports of student research activities are provided at every opportunity, for instance to the accreditation body for the medical school, various curriculum committees, in university newsletters and publications, and conference presentations.

Significantly, the example provided by the narrative above is not medicine-specific. The same resources developed for medical students can be used in their current format or adapted to suit a particular discipline context. Research using focus groups in any area of professional study requires the same approach to recruitment, discussion and thematic analysis of textual data and statistical analysis of data is no different whether it is a medical topic or results from, for instance, engineering or social science experiments. Moreover, engagement with relevant industry partners in rewarding excellence, for instance in donating prizes, may yield benefits across the board, including opportunities for student employment or industry-academic collaborations.

7. Supporting scholarly output and future research needs

Prior to the submission of their journal-style submission reports and the conference-style poster presentations, the students' assessment tasks are marked by research-experienced academics who provide feedback and scholarly advice. Students incorporate this feedback into their final reports and, if the individual is interested in seeking publication, the reports are suitable to use to prepare manuscripts for submission to peer-reviewed journals. For many students the interaction with their academic supervisor is their first experience of academic collaboration and some students continue the research collaboration with these supervisors after graduation. The growing number of peer-reviewed publications of past students (Mullan et al., 2014) provides evidence of the value of the program in development of research capacity, which is an important asset for newly graduated professionals embarking on their careers.

The continued contact between academic staff and graduates seeking to publish their student research post-graduation led to the recognition of the need to provide open-ended support for students beyond the research project. Students are actively encouraged to continue to use the online resources after graduation and these resources are also offered to clerkship preceptors, affiliated clinical staff, academic staff and other collaborators. In other disciplines, this type of extension of

scholarship from the university into industry can have a range of benefits, including improved processes and innovations (Madden et al., 2013; Okhio et al., 2015). The benefits reported by academic supervisors and community-based clinical preceptors from their engagement and collaboration with the students are substantial and are exemplified by the enhancement of skills in qualitative research among academic staff with limited prior experience in this area, co-authorship of journal articles and development of research ethics knowledge.

Discussion

A research component within a curriculum needs clearly-defined and reasonable expectations of outcomes possible within the time allocated and within the aims of the program. Once these have been established, the detail, resources, supervision and other requirements can be developed to match the curriculum requirements and capacity of a particular professional course, faculty or institution.

Research and critical analysis skills are relevant in all professions and should be considered core components of curricula. In medicine, they can influence the practice of evidence-based medicine and development of professional identity (Laidlaw et al., 2012). Similarly, in dietetics, curriculum initiatives that exploit experiential learning have been shown to develop dietitian students' competencies and to build self-efficacy in dietitians (Desbrow et al., 2014). In other professional areas, including dentistry, biomechanical engineering, social work, pharmacy, and nursing, building research capacity during undergraduate education can influence critical thinking, an interest in research and enquiry, and excellence in professional activity (Splieth et al., 2011; Wallen & Pandit 2009; Whipple et al., 2015; Takahashi et al., 2015; Boyd et al., 2012).

Allocating an experienced academic supervisor or mentor is well-recognised as a contributor to student research output (Weller & May, 2013; Linn et al., 2015) and the provision of this experienced individualised supervision and support allowed students in our program continued access to support and advice despite the physical distance between the placement and the university. It also proved effective in sharing the supervision load across the academic staff, the development of research collaborations and scholarly output, and growing the whole-of-school acceptance of, and commitment to, the research program. Increased engagement occurred when students' research interests were matched to those of their academic supervisors and effective personalised supervision over distance was facilitated by a range of communication technologies (Sussex, 2008). The mentoring by academic staff provides professional support and direction in the research

endeavour and can also play an important role in development of the student's identity as a scientist (Linn et al., 2015) as well as a future evidence-based practitioner. The continuous 12-month clinical placement is an advantage in this regard, as it provides the opportunity and time for the student to experience the continuum of research, as well as the supportive environment of clinical scholarship (Lawson McLean et al., 2013; Weston & Hudson, 2014).

The program of research should reflect the focus of the profession. Creating opportunities for student research within any professional course requires input from faculty and curriculum developers as well as industry partners and placement representatives (Xia et al., 2015; Khatwani & Desai, 2013; Madden et al., 2013). All stakeholders need to collaborate to ensure students' experiences are relevant and productive, as exemplified in academic-industry partnerships in plastics engineering (Lamontagne, 2015), and engineering (Chandrasekaran et al., 2015). In our case, encouraging medical students to develop their own placement-relevant projects removed pressure from faculty to identify and financially support multiple projects every year and avoided the possibility of staff taking on students as research technicians involved in isolated research tasks. In other professional disciplines, some of the financial imposts of research may be able to be overcome through partnerships or sponsorships with industry or business. One of the benefits of our research direction was that the community-based nature of our research program did not require the support of a large teaching centre or clinical facility to provide space, funding and other resources for students to undertake their project.

Boyer, in 1990, suggested four domains of academic scholarship: *discovery*, *integration*, *engagement* and the *scholarship of teaching* (Boyer, 1990). Our program reflects these domains in several ways, including student-driven research and collaboration with peers, industry and university-based academic supervisors. Outcomes are relevant to the learner's context and students embrace the scholarship of *discovery* during their research, and *engage* with their particular communities. Importantly, the research activity engages students in interpreting results rather than merely following a research protocol (Linn et al., 2015). Engagement with industry stakeholders through research has the benefit of strengthening the professions as well as industry-university links (Okhio et al., 2015) and active learning in this context can contribute to the development of relevant research competencies (Poole et al., 2009). Moreover, academic engagement with industry or business in developing an undergraduate research program can foster a wider culture of innovation and improvement (Madden et al., 2013). Students come to appreciate the value and relevance of research to

their profession and career progression, are able to understand the importance, implications and limitations of research and, importantly, develop the skills to apply research methods and findings in different contexts. Integrating their research experiences within their professional training and beliefs is an important step in the development of the student's identity as a scientist or researcher within their field (Linn et al., 2015).

Our approach has been predicated on a strong appreciation that, in addition to being research-ready, doctors need skills to filter, interpret and act upon up-to-date research findings and guidelines for evidence-based practice and to better serve their patients' queries and concerns in this "Dr Google" age. The same applies in other areas of professional education. For instance, a recent report describing the incorporation of undergraduate research as part of engineering technology education stated a range of student outcomes, including a deeper understanding of the field of engineering and engineering technology, and graduates who are better prepared for their future careers (Okhio et al., 2015).

The constraints of time and the potential bottlenecks such as the ethics review process (Glasziou & Chalmers, 2004) were recognised in the early stages of the curriculum design and effective collaboration with the HREC provided an acceptable solution to both students and the HREC. Novice health researchers are often daunted by the ethics application process (Greaney et al., 2012) and engagement with this aspect of research during medical school and recognition of its importance may influence the incorporation of ethical practice in the students' future research activity. Moreover, students observe that the same scrutiny of research ethics applied to academic staff research is applied to medical students' projects (Edwards, 2009), legitimising their own research experience and its importance.

Outcomes of our student research experiences are continually evaluated and the learner-centred feedback is acted upon (Rudland et al., 2013), with the result of strengthening both the program and the overall research curriculum within the medical course. Evidence of increased capacity in research and reports of peer-reviewed articles and conference proceedings as a result of individual projects has recently been published (Mullan et al., 2014). Our experience is that the university academic staff embrace the opportunity to be research supervisors. As a new and relatively small school there was a strong sense of community among the academic staff, as well as a commitment to the mission of the school to produce research-competent medical practitioners able to practice evidence-based medicine. An additional element that influenced the enthusiasm of academic staff to act as

supervisors was the promise and delivery of support from the research and critical analysis team members, particularly for those academics who were not experienced in social and/or community-based research. Information sessions were provided to staff and the resources, templates and other support provided to students were equally helpful to supervisors, particularly in saving time and upskilling in areas such as research ethics requirements.

The student research experience described here can be adapted to suit various tertiary education programs. Institutions wishing to incorporate a research activity within a specific course would need to identify key features including: where to position the activity with respect to pre-existing research skills of students and placement opportunities; whether sufficient academic supervision by qualified mentors is available or whether reasonable alternatives could be exploited, such as collaboration with a research institution to provide opportunities for students to experience research; whether there is a particular focus of the school or faculty that needs to be accommodated; assessment opportunities and requirements; and allocation of dedicated staff to manage the program.

It is possible that university programs wishing to engage students in research may not immediately have the capacity, opportunity or time available to implement all aspects of the research program described here. However, specific or selected components of our program could be incorporated to meet a particular focus of an institution or the specific needs of students and curricula. For instance, guidelines relating to development of surveys and participant information sheets could assist students to learn about the effectiveness of investigating a research question using a patient or community survey. Similarly, resources and mentoring in data analysis and reporting could address learning needs in this curriculum area.

Conclusion

Early exposure to research is recognised as instrumental in the development of professionals who are research-aware and active (O'Sullivan et al., 2009). Our aim has been to ensure all students experience, at least, a 'taste' of research, but with the clear expectation that this is an important learning activity in the development of a professional career and a future involved in research. The student projects undertaken to date have been modest in scale, reflecting evidence that individuals need to gradually develop experience and confidence in research (Farmer & Weston, 2002; Cooke, 2008) and ensuring completion within the time available. The small-scale restriction nevertheless allows the student to experience the continuum of research from design

to dissemination of results. Moreover, the provision of academic mentoring not only assists the student in completing their research project but can also foster the student's development of a scientific identity and their readiness for work. Our comprehensive research experience, applicable across professions, may thus help overcome issues that graduates express about a lack of suitable training in how to undertake research in the workforce (Linz & Hoban, 1992; Millar et al., 2009) and may assist in the development of life-long habits of professional enquiry (Irby, 2011; Jansen et al., 2015) and motivation to learn (Lopatto, 2007).

References

- Abbott, P., Reath, J., Rosenkranz, S., Usherwood, T. & Hu, W. (2014). Increasing GP supervisor research skills - Enhancing clinical practice and teaching. *Australian Family Physician*. 43(5), 327-330.
- Annear, M. J., Lea, E., Lo, A., Tierney, L. & Robinson, A. (2016). Encountering aged care: A mixed methods investigation of medical students' clinical placement experiences. *BMC Geriatrics*. 16(1), 38. <http://dx.doi.org/10.1186/s12877-016-0211-8>
- Australian Medical Council. (2012). Standards for assessment and accreditation of primary medical programs by the Australian Medical Council. Canberra: Australian Medical Council Limited.
- Barkan, S. M., Case, S. M., Kane, M. & Moeser, E. (2009). Testing for research competency on the bar exam: The next steps. *Legal Reference Services Quarterly*. 28(3-4), 281-289. <http://dx.doi.org/10.1080/02703190902961643>
- Boyd, M. R., Baliko, B., Herman, J. & Polyakova-Norwood, V. (2012). Redesigning a graduate research course for evidence-based competencies. *The Journal of Nursing Education*. 51(11), 652-655. <http://dx.doi.org/10.3928/01484834-20120927-01>
- Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ: Carnegie Foundation for the Advancement of Teaching.
- Brubaker, L. (2015). Making scholarship time: A handful of ingredients. *Female Pelvic Medicine & Reconstructive Surgery*. 21(2), 61-62. <http://dx.doi.org/10.1097/SPV.0000000000000141>
- Burke, L. E., Schlenk, E. A., Sereika, S. M., Cohen, S. M., Happ, M. B. & Dorman, J. S. (2005). Developing research competence to support evidence-based practice. *Journal of Professional Nursing*. 21(6), 358-363. <http://dx.doi.org/10.1016/j.profnurs.2005.10.011>
- Cameron, C., Lee, H. Y., Anderson, C., Byars-Winston, A., Baldwin, C. D. & Chang, S. (2015). The role of scientific communication skills in trainees' intention to pursue biomedical research careers: A social cognitive analysis. *CBE Life Sciences Education*. 14(4), ar46. <http://dx.doi.org/10.1187/cbe.14-09-0152>
- Chandrasekaran, S., Littlefair, G., Joordens, M. & Stojcevski, A. (2015). Students and staff perspectives on academic-industry partnerships in engineering, *Proceedings of 2014 International Conference on Interactive Collaborative Learning*, ICL 2014 7017782: 266-271.
- Clark, J. M., Rollins, A. W. & Smith, P. (2014). New methods for an undergraduate journal club. *Bioscene*. 40(1), 16-20.
- Cooke, J. (2008). A framework to evaluate research capacity building in health

- care. *BMC Family Practice*. 6(1), 1-11.
- Daniels, J. & Brooker, J. (2014). Student identity development in higher education: Implications for graduate attributes and work-readiness. *Educational Research*. 56(1), 65-76.
<http://dx.doi.org/10.1080/00131881.2013.874157>
- Danowitz, A. M., Brown, R. C., Jones, C. D., Diegelman-Parente, A. & Taylor, C. E. (2016). A combination course and lab-based approach to teaching research skills to undergraduates. *Journal of Chemical Education*. 93(3), 434-438.
<http://dx.doi.org/10.1021/acs.jchemed.5b00390>
- Desbrow, B., Leveritt, M., Palmer, M. & Hughes, R. (2014). Evaluation of a curriculum initiative designed to enhance the research training of dietetics graduates. *Nutrition & Dietetics: the Journal of the Dietitians Association of Australia*. 71(1), 57-63. <http://dx.doi.org/10.1111/1747-0080.12039>
- Edwards, S. J. L. (2009). Student projects in medicine: A lesson in science and ethics. *Accountability in Research*. 16(6), 285-306.
<http://dx.doi.org/10.1080/08989620903328451>
- Farmer, E. A. & Weston, K. M. (2002). A conceptual model for capacity building in Australian primary health care research. *Australian Family Physician*. 31(12), 1139-1142.
- Fitz, P. & Winkler, M. F. (1989). Education, research, and practice: Bridging the gap. *Journal of the American Dietetic Association*. 89(11), 1676-1679.
- Glasziou, P. & Chalmers, I. (2004). Ethics review roulette: what can we learn? That ethics review has costs and one size doesn't fit all. *British Medical Journal*. 328, 121-122. <http://dx.doi.org/10.1136/bmj.328.7432.121>
- Greaney, A-M. et al. (2012). Research ethics application: a guide for the novice researcher. *British Journal of Nursing (Mark Allen Publishing)*. 21(1), 38-43.
<http://dx.doi.org/10.12968/bjon.2012.21.1.38>
- Griffin, A., Jones, M. M., Khan, N., Park, S., Rosenthal, J. & Chrysikou, V. (2016). Exploring provision of innovative community education placements (ICEPs) for junior doctors in training: A qualitative study. *BMJ Open*. 6(2), e009931. <http://dx.doi.org/10.1136/bmjopen-2015-009931>
- Grochowski, C. O. C., Halperin, E. & Buckley, E. (2007). A curricular model for the training of physician scientists: The evolution of the Duke University School of Medicine curriculum. *Academic Medicine*. 82(4), 375-382.
<http://dx.doi.org/10.1097/ACM.0b013e3180333575>
- Houlden, R. L., Raja, J. B., Collier, C. P., Clark, A. F. & Waugh, J. M. (2004). Medical students' perceptions of an undergraduate research elective. *Medical Teacher*. 26(7), 659-661. <http://dx.doi.org/10.1080/01421590400019542>
- Iliško, D., Ignatjeva, S. & Mišić, I. (2010). Teachers as researchers: Bringing teachers' voice to the educational landscape. *Journal of Teacher Education for Sustainability*. 12(1), 51-65. <http://dx.doi.org/10.2478/v10099-009-0046-x>
- Irby, D. (2011). Educating physicians for the future: Carnegie's calls for reform. *Medical Teacher*. 33(7), 547-550.
<http://dx.doi.org/10.3109/0142159X.2011.578173>
- Jackson, D. (2014). Skill mastery and the formation of graduate identity in Bachelor graduates: evidence from Australia. *Studies in Higher Education*. 41(7), 1313-1332. <http://dx.doi.org/10.1080/03075079.2014.981515>
- Jansen, D. A. et al. (2015). embedding research in undergraduate learning opportunities. *Western Journal of Nursing Research*. 37(10), 1340-1358.
<http://dx.doi.org/10.1177/0193945915571136>

- Khatwani, P. A. & Desai, K. S. (2013). ERP modules for industry institute interaction, training and placement, and alumni management. *enterprise resource planning models for the education sector: Applications and methodologies*. Pennsylvania, USA: IGI Global.
- Kim-Prieto, D. (2011). The road not yet taken: How law student information literacy standards address identified issues in Legal Research Education and Training. *Law Library Journal*. 103(4), 605-630.
- Kjeldsen, K. (2006). A proficient mentor is a must when starting up with research. *Experimental and Clinical Cardiology*. 11(3), 243-245.
- Laidlaw, A., Aiton, L., Struthers, J. & Guild, S. (2012). Developing research skills in medical students: AMEE Guide No. 69. *Medical Teacher*. 34(9), 754-771. <http://dx.doi.org/10.3109/0142159X.2012.704438>
- Laidlaw, A., Guild, S. & Struthers, J. (2009). Graduate attributes in the disciplines of Medicine, Dentistry and Veterinary medicine: A survey of expert opinions. *BMC Medical Education*. 9(1), 28. <http://dx.doi.org/10.1186/1472-6920-9-28>
- Lamontagne, N. D. (2015). Academic-industry partnerships: Preparing tomorrow's plastics professionals. *Plastics Engineering*. 71(1), 14-17.
- Lawson McLean, A., Saunders, C., Velu, P. P., Iredale, J., Hor, K. & Russell, C. D. (2013). Twelve tips for teachers to encourage student engagement in academic medicine. *Medical Teacher*. 35(7), 549-554. <http://dx.doi.org/10.3109/0142159X.2013.775412>
- Linn, M. C., Palmer, E., Baranger, A., Gerard, E. & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*. 347(6222), 1261757. <http://dx.doi.org/10.1126/science.1261757>
- Linz, W. & Hoban, J. D. (1992). The need to foster students' research skills. *Academic Medicine*. 67(11), 763. <http://dx.doi.org/10.1097/00001888-199211000-00011>
- Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE Life Sciences Education*. 6(4), 297-306. <http://dx.doi.org/10.1187/cbe.07-06-0039>
- Madden, M. E. et al. (2013). Rethinking STEM education: An interdisciplinary STEAM curriculum. *Procedia Computer Science*. 20, 541-546. <http://dx.doi.org/10.1016/j.procs.2013.09.316>
- Manspeaker, S. & Van Lunen, B. (2011). Overcoming barriers to implementation of evidence-based practice concepts in athletic training education: Perceptions of select educators. *Journal of Athletic Training*. 46(5), 514-522. <http://dx.doi.org/10.4085/1062-6050-46.5.514>
- Mercer-Mapstone, L. D. & Matthews, K. E. (2015). Student perceptions of communication skills in undergraduate science at an Australian research-intensive university. *Assessment & Evaluation in Higher Education*. 42(1), 98-114. <http://dx.doi.org/10.1080/02602938.2015.1084492>
- Millar, E., Baker, M., Howden-Chapman, P., Wilson, N. & Dickson, N. (2009). Involving students in real-world research: a pilot study for teaching public health and research skills. *BMC Medical Education*. 9, 45-51. <http://dx.doi.org/10.1186/1472-6920-9-45>
- Mitcham, M. D. (1986). Integrating research competencies into basic professional education. *The American Journal of Occupational Therapy*. 40(11), 787-788. <http://dx.doi.org/10.5014/ajot.40.11.787>
- Mullan, J. R., Weston, K. M., Rich, W. C. & McLennan, P. L. (2014). Investigating the impact of a research-based integrated curriculum on self-

- perceived research capabilities of medical students in rural and regional placements: a pre- and post-test analysis of three student cohorts. *BMC Medical Education*. 14, 161. <http://dx.doi.org/10.1186/1472-6920-14-161>
- Okhio, C. B., Misoc, F. & Asgill, A. B. (2015). Incorporating training in research & research methods into the undergraduate curriculum in engineering and engineering technology-(E&ET). ASEE Annual Conference and Exposition, Conference Proceedings 122nd ASEE Annual Conference and Exposition: Making Value for Society.
- Olsen, L. A., Aisner, D. & McGuinnis, J. M. (2007). The learning healthcare system: Workshop summary. *Institute of Medicine (US) roundtable on evidence-based medicine*. Washington, DC: National Academies Press.
- O'Sullivan, P. S., Niehaus, B., Lockspeiser, T. M. & Irby, D. M. (2009). Becoming an academic doctor: Perceptions of scholarly careers. *Medical Education*. 43(4), 335-341. <http://dx.doi.org/10.1111/j.1365-2923.2008.03270.x>
- Poole, G., Egan, J. P. & Iqbal, I. (2009). Innovation in collaborative health research training: The role of active learning. *Journal of Interprofessional Care*. 23(2), 148-155. <http://dx.doi.org/10.1080/13561820802634894>
- Reising, D. L. (2003). Establishing student competency in qualitative research: Can undergraduate nursing students perform qualitative data analysis? *The Journal of Nursing Education*. 42(5), 216-219.
- Rosenthal, M. S. et al. (2009). Teaching community-based participatory research principles to physicians enrolled in a health services research fellowship. *Academic Medicine*. 84(4), 478-484. <http://dx.doi.org/10.1097/ACM.0b013e31819a89e8>
- Rubin, D., Valutis, S. & Robinson, B. (2010). Social work education and student research projects: A survey of program directors. *Journal of Social Work Education*. 46(1), 39-55. <http://dx.doi.org/10.5175/JSWE.2010.200800040>
- Rudland, J. et al. (2013). A student-centred feedback model for educators. *The Clinical Teacher*. 10(2), 99-102. <http://dx.doi.org/10.1111/j.1743-498X.2012.00634.x>
- Schor, N. F., Troen, P., Kanter, S. L. & Levine, A. S. (2005). The scholarly project initiative: Introducing scholarship in medicine through a longitudinal, mentored curricular program. *Academic Medicine*. 80(9), 824-831. <http://dx.doi.org/10.1097/00001888-200509000-00009>
- Splieth, C.H., Innes, N. & Söhnle, A. (2011). Evidence-based cariology in clinical and public health practice as part of the European Core Curriculum in Cariology. *European Journal of Dental Education*. 15(1)(suppl.1)45-51. <http://dx.doi.org/10.1111/j.1600-0579.2011.00714.x>
- Sussex, R. (2008). Technological options in supervising remote research students. *Higher Education*. 55(1), 121-137. <http://dx.doi.org/10.1007/s10734-006-9038-0>
- Takahashi, K. et al. (2015). Introduction of a clinical research experience program in hospital practical training for pharmacy students and its evaluation. *Yakugaku Zasshi*. 135(9), 1077-1082. <http://dx.doi.org/10.1248/yakushi.15-00083>
- Thompson, D. W. (2016). How valuable is 'short project' placement experience to higher education students? *Journal of Further and Higher Education*. 41(3), 413-424. <http://dx.doi.org/10.1080/0309877X.2015.1117601>
- Tulinius, C., Nielsen, A. B., Hansen, L. J., Hermann, C., Vlasova, L. & Dalsted, R. (2012). Increasing the general level of academic capacity in general practice: Introducing mandatory research training for general practitioner

- trainees through a participatory research process. *Quality in Primary Care*. 20(5), 57-67.
- Vaezi-Nejad, S. M. (2008). Benefits of industrial placement to students and industry. *Measurement and Control*. 41(2), 49-50.
<http://dx.doi.org/10.1177/002029400804100202>
- Wallen, M. & Pandit, A. (2009). Developing research competencies through a project-based tissue-engineering module in the biomedical engineering undergraduate curriculum. *Proceedings of the Institution of Mechanical Engineers. Part H, Journal of Engineering in Medicine*. 223(4), 443-448.
<http://dx.doi.org/10.1243/09544119JEIM539>
- Weller, R. & May, S. A. (2013). Factors influencing clinical students' perceptions of an embedded research project and associated publication output. *Journal of Veterinary Medical Education*. 40(2), 119-127.
<http://dx.doi.org/10.3138/jvme.1012-095R>
- Weston, K. M. & Hudson, J. N. (2014). Clinical scholarship amongst preceptors supervising longitudinal integrated medical clerkships in regional and rural communities of practice. *The Australian Journal of Rural Health*. 22(2), 80-85. <http://dx.doi.org/10.1111/ajr.12090>
- Whiffin, C. J. & Hasselder, A. (2013). Making the link between critical appraisal, thinking and analysis. *British Journal of Nursing (Mark Allen Publishing)*. 22(14), 831-835. <http://dx.doi.org/10.12968/bjon.2013.22.14.831>
- Whipple, E. E., Hughes, A. & Bowden, S. (2015). Evaluation of a BSW Research Experience: Improving Student Research Competency. *Journal of Teaching in Social Work*. 35(4), 397-409.
<http://dx.doi.org/10.1080/08841233.2015.1063568>
- Xia, J. C., Caulfield, C. & Ferns, S. (2015). Work-integrated learning: linking research and teaching for a win-win situation. *Studies in Higher Education*. 40(9), 1560-1572. <http://dx.doi.org/10.1080/03075079.2014.882302>