ORIGINAL RESEARCH

Undergraduate research in nursing and health sciences: Curriculum design from first principles

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ABSTRACT

Background/Objective: Multidisciplinary learning within the framework of undergraduate education has recently been recognised as essential in developing an integrated and resilient healthcare system for the future. This inquiry seeks to derive common learning outcomes for a new multidisciplinary foundation research methods unit for undergraduate health sciences students.
Methods: An outcomes-based design was used to determine the learning outcomes from first principles. All academics across multiple health disciplines at a regional university in Australia were invited to a series of meetings to brainstorm a set of common graduate capabilities and the scaffolds required to achieve them. Meetings were carefully documented and agreed to by consensus after member checking. A thematic analysis was undertaken to identify emergent themes. The capabilities themes were checked for alignment with the institutional graduate attributes and the thresholds of learning outcomes (TLOs) set out by the Australian Government Office of Learning and Teaching.
Results: Three broad theoretical constructs emerged from the thematic analysis for the graduate capabilities: (i) health practitioners as evidence consumers (i.e. knowledge translation); (ii) health practitioners as evidence producers, (i.e. knowledge creation) and; (iii) ethical practice.
Conclusions: This study derived a set of learning outcomes from first principles, while applying an outcomes-based curriculum design methodology. This may be a useful approach for finding common learning outcomes within a multidisciplinary health educational framework. Such structures and processes may not only help to provide students with a solid foundation for learning content that they have in common with other disciplines, but may also to facilitate interprofessional communication in future practice.

Key Words: Nursing education, Undergraduate research, Curriculum design, Multidisciplinary healthcare, Interprofessional education

1. INTRODUCTION

Modern health care is becoming increasingly globalised. Many disease epidemics transcend national borders, such as diabetes, heart disease and dementia in the West and infectious diseases in underdeveloped countries. It has been predicted that the traditional independent, siloes model of health care will have limited capacity to deal with the local impacts of global health trends.[1] Future leaders in healthcare will require an awareness of global, multicultural and multidisciplinary perspectives. Moreover, the international trend towards patient-centred models of care and service integration will require much more interprofessional communication.[2] Indeed, communication between multidisciplinary healthcare professionals is emerging as a key competency

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requirement for interprofessional healthcare practice.[3]

A powerful way to prepare training health practitioners for collaborative interprofessional practice is through interdisciplinary and multidisciplinary education at the undergraduate level, even before students become defined by their professions.[4] An educational program that integrates students from multiple disciplines may help to foster improved interprofessional communication and lifelong collaborative approaches. In the health sciences, there are many undergraduate subjects that are common to most disciplines, such as a basic introduction to research methods. This inquiry seeks to determine a set of common (i.e. multi-disciplinary) learning outcomes for a new foundation-level research methods unit for undergraduate students from multiple health science disciplines at a regional university.

1.1 Theoretical framework

In his ground-breaking work on the scholarship of teaching and learning, Boyer[5] argued that academic teaching and learning was historically undervalued in academia and that if it is to achieve the same scholarly status as research, then the same degree of rigor that is applied to research should also be applied to the scholarship of teaching and learning. Since then, a plethora of scholarly approaches for the creation and dissemination of new knowledge relating to the scholarship of teaching and learning have been validated. In particular, design science relates to the scholarly methods used to design, validate and evaluate curricular.

A highly influential contribution to design science was Biggs's[6] concept of constructive alignment. Applying a constructivist approach to the scholarship of teaching and learning, Biggs asserted that learning must be constructed by the learner and that curricula should be designed such that the learning activities and assessments are aligned with the intended learning outcomes. This type of alignment within a unit is referred to as horizontal alignment and is best achieved using a backwards (i.e. outcomes-based) approach. That is, starting with setting the intended learning outcomes, then working backwards to set the learning activities and assessment tasks required to meet them.

In the National Graduate Attributes Project (GAP), Barrie, Hughes, and Smith[7] reported that, after applying constructive alignment to their units, academics became increasingly aware that graduate attributes also need to be aligned with learning outcomes, a concept referred to as vertical alignment. Graduate attributes are global statements that students ideally attain by graduation. For example, the institutional graduate attribute that most aligns with a first year research unit is; Life-long learning: the ability to be responsive to change, to be inquiring and reflective in practice, through information literacy and autonomous, self-managed learning. An ideal foundation research unit would familiarise students with diverse ways of thinking that would help them to develop a curious and inquiring mind with an interest in independent life-long learning.

Most universities incorporate graduate attributes or capabilities, although historically not all incorporated them directly into the curricula. This area is currently under serious reform in Australia after the advent of The Tertiary Education Quality and Standards Agency (TEQSA), which has been tasked to heighten transparency and evaluate the performance of universities across a number of criteria. TESQA's Higher Education Standards Framework will require universities to use their stated graduate attributes as a declared standard, against which evidence of teaching and learning performance can be assessed, monitored and used as benchmarks with other institutions.[8] Accordingly, Australian universities are in the process of reviewing their curricula for vertical alignment with their stated graduate attributes or capabilities.

It is important to acknowledge that the concept of graduate capability is less defined than that of graduate attribute. York[9] explains that an attribute denotes a skill level that has been previously been attained, where a capability implies a capacity for future performance. Stephenson[10] first articulated that capability encompassed an 'integration of knowledge, skills, and personal qualities and understandings used appropriately and effectively in new and changing circumstances'. Therefore, while attribute measurement is more readily tested and may thus have a strategic role in regulation and planning, it may be the more elusive concept of capability that will determine how prepared a graduating student is to meet the ongoing challenges of an ever-changing world, encompassing lifelong learning.

The evidence shows that embedding graduate capabilities within the curricula does facilitate their uptake by students and help to prepare them for the workplace.[11] A study on embedded graduate capabilities into a medical degree at the University of New South Wales found that students on placement were more satisfied with their learning experiences compared with earlier cohorts. The investigators attributed the embedding of capabilities in the earlier years to better prepared students, who were then able to make more of the opportunities that presented during placement, which in turn increased their satisfaction with the experience.[12]

Another form of vertical alignment used in the current inquiry is that of aligning national competency standards, called threshold learning outcomes (TLOs), with the intended learning outcomes for the new unit. In a first step towards

the standardisation of graduates ready to enter professional workplaces, the Australian Learning and Teaching Council (ALTC) has developed discipline-specific statements to encompass the entry-level TLOs for professional practice. The TLOs for Health, Medicine and Veterinary Science were designed to cover all the healthcare disciplines.[13]

The TLO that relates most strongly to research and evidence based practice is: "Upon completion of their program of study, healthcare graduates at professional entry-level will be able to: Retrieve, critically evaluate, and apply evidence in the performance of health-related activities". Discipline-specific interpretations for these TLOs are also provided with input from the corresponding professional associations. In the discipline of nutrition, for example, this TLO specifies graduate ability to: "Conducts research using appropriate research methods, ethical processes and procedures and statistical analysis." Thus, the discipline-specific TLOs are standards that can be used to check for vertical alignment with learning outcomes for a new unit.

While constructive alignment incorporates important elements of curricular, foundation year subjects must also align with learner needs and expectations. The widening of new enrolments under demand driven funding mechanisms has broadened socially inclusive accessibility to tertiary education and increased non-traditional student enrolments. There are now a higher participation rates by young people (17–21 year olds) and many diversity and equity groups, such as Indigenous students, students from low socio-economic and regional and remote areas.[14] Around half (51%) of all first year students in Australia are first in their family to attend university, which is just under the OECD mean of 53%.[15] Collectively, these factors suggest that current entry level university students may have more diverse academic[16] and psychosocial[17] preparedness than the traditionally competitive cohorts under previous capped systems.

With widely diverse starting capabilities in first year, additional scaffolds and practice environments are required to provide enhanced and adaptive student-directed learning opportunities. Scaffolds encompass those support structures that are created by the teacher (e.g. deconstructed tasks; providing models or templates) to influence how students think about a learning activity, particularly in the information-rich online environment.[18] This could take the form of an online capability test, for example, where students can self-assess and determine whether they need undertake specific learning activities. This type of scaffold would embed the institutional graduate attribute for self-managed learning by invoking intrinsic feedback and self-regulation,[19] while providing opportunities for interdependent, extrinsic feedback for those who choose to make use of the additional, optional scaffolded learning activities.

Once foundational scaffolded learning activities have been identified, they may be directly translated into learning outcomes through Bloom's taxonomy for learning, teaching and assessing framework.[20] The revised framework includes a second dimension that encompasses various depths of cognitive processes in addition to the original knowledge dimension.[21] The revised taxonomy places more emphasis on the action verbs that reflect the depth of cognitive processing appropriate for the level of learning. Framing the intended learning outcomes with the appropriate action verbs aligns the expectations of academics and students around learning performance.[22]

Design science has come a long way since its inception. It not only encompasses horizontal constructive alignment of learning outcomes to learning activities and assessment tasks, but also vertical alignment of both institutional graduate attributes and national threshold learning outcomes, which have also been aligned with professional accreditation bodies. Further, it encompasses learner expectations and levels of preparedness for study. Using the action verbs within the framework of Boom's revised taxonomy, the expectations of academics and students can be aligned with the intended learning outcomes. Design science now provides a rich theoretical framework, within which to design a curriculum.

Using a backward design to derive the learning outcomes, therefore, this inquiry aims to initially identify a set of school-level, shared (i.e. multidisciplinary) graduate capabilities. Then, working backwards the inquiry will (i) identify the scaffolds required throughout the undergraduate programs to achieve these capabilities, (ii) map the scaffolds to the capabilities in terms of level of learning, and finally (iii) use Bloom's revised taxonomy to derive the learning outcomes for a new shared unit for undergraduate health research. This is curriculum design from first principles.

1.2 Aims and objectives

The aim of this inquiry was to use an outcomes based approach to curriculum design (see Figure 1). The specific objectives were:

(1) To identify the shared, multidisciplinary, graduate capabilities for research and evidence based healthcare;
(2) To identify the scaffolds required to meet these capabilities;
(3) To delineate foundation (versus intermediate/advanced) level scaffolds;
(4) To derive a set of shared learning outcomes, suitable for foundation level learning.

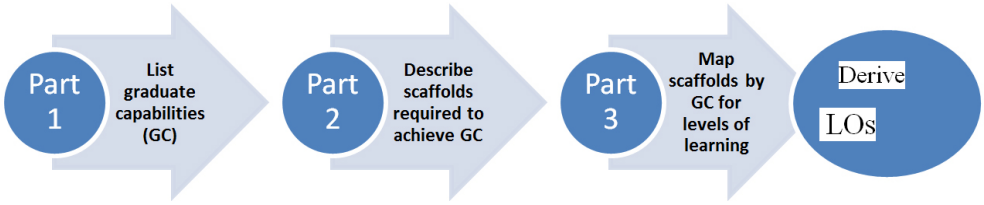

Figure 1. Overview of backwards design for deriving the shared learning outcomes (LO) for undergraduate research across health sciences

2. METHODS

2.1 Methodological design

A qualitative research design was developed with the aim to identify commonalities among academics' perceptions of the key learning outcomes required for undergraduate research methods training. A social constructivist approach to the construction and interpretation of meaning guided the analysis.[23]

2.2 Participants and recruitment

Data were collected through a series of meetings with academics from multiple health sciences disciplines (nursing, midwifery, sports and exercise science, clinical science, osteopathy, speech pathology, occupational therapy and podiatry). Recruitment emails were sent to all academic staff within the school inviting participation in a series of meetings to brainstorm and explore the commonalities around graduate capabilities and the scaffolds required to achieve these capabilities. Course co-ordinators for each of the disciplines were personally invited to attend and meeting times were scheduled to maximise their ability to participate and represent their disciplines as leaders. All meetings were conducted between October, 2015 and May, 2016. Each meeting was carefully documented by the investigator. The notes from each meeting were sent back to the participants for member checking after each meeting.

2.3 Data analysis

The final set of notes from all the meetings were then analysed through an inductive process of open coding to identify emerging themes.[24] These themes were validated by member checking with participants in further meetings and email feedback at each step of the process.

The notes from the first meeting documented the consensually agreed list of shared graduate capabilities. In meetings 2 and 3, the learning activities and scaffolds required to meet these graduate capabilities were similarly brainstormed and documented as dot points under each identified capability. The lists for both capabilities and scaffolds were transferred from the meeting notes to an Excel spreadsheet. Both lists were initially analysed for duplication and redundancy.

The respective capabilities and scaffolds lists were analysed by open coding by the investigator, which was verified in discussions with participating academics via emails. Once the main capability themes had been agreed to, they were listed in an Excel spreadsheet with their corresponding scaffolds. This was presented in a fourth meeting to the group where final adjustments to the emergent capability themes and corresponding scaffolds were agreed to by consensus. Then, each scaffold point was assigned a number representing levels of learning (1 'introductory/foundational, 2 'intermediary/advanced) by the author. A further meeting of all participants was held to calibrate and refine the levels of learning rankings that had been assigned to each scaffold point. The spreadsheet was again sent around to staff for final validation.

Finally, the scaffold points were sorted by level of learning. A set of learning outcomes were then derived from the resultant list of those ranked as introductory/foundational. The corresponding learning outcomes were further refined by an educational specialist and sent around to the participating academics for a final round of member checking and validation.

3. RESULTS

3.1 Shared graduate capabilities for research

There were three distinct theoretical constructs that emerged from the list of capabilities, based on nine distinct graduate capabilities (see Table 1).

3.2 Aligning school-derived capabilities with TLOs

The nine graduate capabilities were then aligned with the TLOs proposed by each of the professional accreditation bodies for the purpose of standardising the health professions. Although, the wording of some of the TLOs proposed by the professional accreditation bodies were more polished than those of the school brainstormed graduate capabilities, this comparison confirmed that the school-derived list had not omitted a major TLO. The school-derived list was kept in its raw form so that staff could identify their inputs, which may help to foster a sense of shared ownership.

Table 1. The nine school-derived shared graduate capabilities associated with research

Theoretical construct		Capabilities
Consuming evidence	1	Independent consumers of literature/Confidence in appraising literature/Critical appraisal skills/Ability to assess the reliability, trustworthiness, and authenticity of evidence
	2	Understand the philosophical basis of different approaches (e.g. qualitative, quantitative, mixed-methods)
	3	Translational understanding - Use/translate/apply the literature/evidence to inform practice
Both consuming and producing evidence	4	Develop a investigable question – cultivate and develop an inquiring mind
Producing evidence	5	The ability to solve problems in innovative ways
	6	Ways of knowing, as an encompassing framework: Conceptualising a methodology
	7	Understand efficacy or methodologies of the discipline of practice and how that efficacy is measured
	8	Perform relevant data analysis: Statistical literacy/applied scientific method/interpretive analysis
Ethics	9	Ethical consumers/practitioners of research

Table 2. Matrix of capability by scaffolds for first year/foundation level of learning

Capabilities	Scaffolds notes
Ethical alignment	Awareness of cultural influences, values and beliefs
	Thinks through ethical implications of a proposition
	Awareness of ethical practice and research
	Understand what informed consent means
	Critique current news articles to discuss potential biased reporting in the media (and the ethical implications of this)
	Take an example paper or study –assess ethical aspects (e.g. reporting of informed consent)
Consumers of evidence/ Knowledge translation	Understand the philosophical basis of different approaches to research (e.g. qualitative, quantitative, mixed-methods)
	Integrated understanding of ontology, epistemology, and methodology underpinning various paradigmatic framework
	Understand efficacy and methodologies of the disciplines of practice and how that efficacy is best measured and methodology best applied
	Knowing your own understanding of the world
	How evidence hierarchy applies to different research questions and study designs
	Reliability versus validity
	Sources of evidence; how to find (i.e. search question and strategy)
	Sources of evidence; how to assess (i.e. primary, secondary and tertiary)
	What is a credible/trustworthy source of information (e.g. on the internet)
	Awareness of different approaches to what constitutes evidence across health sciences
	How to generalise from a paper; assessing which populations the findings apply to
Producers of evidence/ Knowledge creation	Can use scientific method as a way of thinking (i.e. proofs through experimentation)
	Inductive and deductive thinking and reasoning
	How to think creatively and innovatively
	Determines level of evidence for a hypothesis/proposition through a data-driven systematic approach (i.e. interprets a *p* value and CI)
	Reflection exercises
	Develops research questions and gets answers from data
	Can discern which research methodologies are appropriate for which questions
	Statistics and scientific method – learning by doing; experiential learning (e.g. computer labs) and learning practical skills
	Thematic analysis; conduct a thematic analysis
	Conduct statistical data analysis
	Develop numeracy skills
	Work on relevant practical examples

3.3 Scaffolds the graduate capabilities

There were six major scaffolds themes that could be used to structure the scaffolds notes. However, they were not as useful as the raw notes in identifying the specific scaffolds for a first year/foundation level unit. Thus the raw scaffolds notes were retained in the final matrix (see Table 2).

3.4 Derived learning outcomes for a first year/ foundation level unit

With a maximum of six learning outcomes permitted (institutional policy), it was evident that the two evidence/knowledge constructs (see capabilities column in Table 2) would require two separate sets of learning outcomes. For the purposes of designing a research methods training unit, the knowledge creation construct was primarily drawn upon.

Based on a synthesis of the summary of capabilities by scaffolds for foundation-level learning with Bloom's revised taxonomy action verbs, draft foundation-level unit learning outcomes were derived and are presented in Table 3.

4. DISCUSSION

The major finding from this inquiry was that a shared foundation unit in research for students across multiple disciplines in the health sciences would require a broad approach. Learning outcomes would need to address the development of capabilities in three broad conceptual areas: (i) knowledge consumers, how to find and apply knowledge; (ii) knowledge producers, how knowledge is created, and; (iii) ethical awareness, particularly how to evaluate the ethical implications of research and evidence.

Table 3. Derived learning outcomes for shared first year research unit

Learning Outcomes (LO).	On completion of this Unit students should be able to:
LO 1	Describe different philosophical approaches to knowledge creation
LO 2	Differentiate the strengths and limitations of various study designs
LO 3	Identify a question and plan an appropriate methodology to address it
LO 4	Evaluate ethical implications of a research proposition
LO 5	Demonstrate an ability to conduct basic data analysis
LO 6	Demonstrate an ability to interpret and report findings

The concept of knowledge consumers includes the ability to locate, evaluate, translate and apply evidence in practice. This depends upon having the capability to formulate an answerable question, conduct systematic searches, locate and appraise various types of evidence in relation to certain clinical populations of interest. This is generally referred to as evidence based practice.[25] However, Graham et al.[26,27] have proposed the term knowledge-to-action (KTA) to describe the processes involved in consuming and applying knowledge, arguing that the term knowledge to practice is too narrow and that there are too many other terms in use, such as knowledge translation, implementation, and utilization. They describe a seven-part knowledge-to-action cycle, which maps the whole process of applying knowledge and incorporates knowledge creation.[27]

There is an argument that this aspect of the evidence cycle may be best taught in the traditional discipline-specific silos, as different health professionals utilize evidence in different ways in practice. A recent qualitative study exploring barriers for research utilization in nursing practice, for instance, found that lecturers and tutors at university need to provide relevant clinical scenarios that the students are likely to encounter in practice and relate that to knowledge generated from research in order to enhance student engagement with the material.[28] More recent work from the United States suggests that a much more comprehensive, integrated curriculum that builds upon the learning from a foundation evidence-based practice research course is required to prepare nursing and health sciences students to utilize research in practice.[29]

It has been argued that prior familiarisation with the processes involved in knowledge creation via the research process could motivate health practitioners to translate research into practice.[30] The research process includes developing the capacity to ask investigative questions, apply an appropriate methodology and disseminate findings to a wider student, scientific, clinical or patient population.[31] Innovative curriculum for engaging first year health science students have involved active learning and team-based approaches to increase student satisfaction with learning research methodologies.[30,32] Working in teams and collaborating could also increase first year sense of belonging and inclusiveness, in addition to fostering collaborative working across multiple disciplines.

The ethical principles that govern the conduct of research on human participants is one aspect of the ethical orientation for students of health sciences. Indeed, an ethical code of

conduct is an essential quality in a health practitioner, reflected by its inclusion as an institutional graduate attribute and threshold learning outcomes. There is evidence that some undergraduate courses require students to undertake ethical training, although projects are rarely subjected to the prior approval of institutional ethics committees.[30]

These three areas are all-encompassing areas in and of themselves. For first year students, who require additional learning supports (i.e. learning scaffolds), the two theoretically distinct knowledge constructs would best be learned separately. While ethical principles should be pervasive in both, learning should perhaps commence with the role of ethical awareness in knowledge creation through understanding the research process. Perhaps prior familiarisation with the processes involved in knowledge creation would lay the foundation for learning how to apply knowledge using the knowledge-to-action cycle. This would be a logical, symbolic order of learning; knowledge must be created before it can be applied.

With the exponential growth of information and digital technologies, undergraduate pedagogical ideals have shifted away from instilling a body of discipline-specific knowledge with students, towards a need to prepare students to become creative problem solvers in continuously changing, evolving environments.[31]

Gray et al.[31] report on an institution policy to shift students from knowledge consumers to knowledge producers throughout their curriculum by instilling students with a 'inquire-research-publish' cycle of learning. The scaffolds required to prepare students for this cycle was extensive and embedded within the whole course curricula. It includes an introductory module aimed at familiarising students with the conventions of descriptive summarising of research, followed by a unit focussing on presenting an argument using evidence which incorporates skills on how to find, critically assess, interpret and discuss research. This was then followed by a unit focussing on discipline-specific research conventions.

Thus, foundation-level scaffolds prepared students for the 'junior' seminar series, which focussed on discipline-specific processes of independent inquiry, and which bridged the gap between foundation-level learning the capstone 'senior' unit that encompassed an independent research project.[31] This is consistent with the Boyer Commission[33] recommendations that seminars were an effective scaffold for inquiry-based learning.

The idea of providing consistent and extensive scaffolds to prepare students as independent researchers by the time they graduate is consistent with current trends and views. The Boyer Commission Report[33] called for research-based learning (i.e. learning as inquiry) to become the standard way of learning in all research universities. They recommended engaging first year undergraduate students in the research process, increasing involvement throughout their degrees to the point where the research capability in their final year is almost equivalent with a first year post graduate level of research independence. The Boyer Commission urge that the cross into post-graduate research should be seamless and that those who enter the workforce do so as capable, independent researching practitioners of their respective disciplines.

The construct of research has undergone a transformation in the curriculum literature. Research skill development has been described as 'an underlying principle of all education'.[34] It is no longer an elitist activity for universities and scientists. It no longer depends upon being an outstanding student, discretely invited to stay on after graduation to do research. The advent of the internet is empowering widespread research activity for the masses and in all areas of life. Given that research has become such a pervasive part of everyday life, undergraduate research must be recognised as integral for success at university, in the modern workforce and in the development of an inquiring mind with an interest in life-long learning.

While research is a worthwhile and often necessary pursuit for researching academics, the problem of engaging first year students in the research process is challenging. Traditional first year psychology and health science programs may include a statistics unit, which students typically approach strategically (i.e. in order to "get through"), while noting in their evaluations they see no relevance to their chosen professional practice or career path. A pilot study in India[35] that attempted to engage first year students in authentic research found that it was too much to expect that first year students could see a future for themselves as researchers by the end of an introductory, active learning program. Rather, first year units should aim to increase awareness of a potential for research to play a role in their career. That is, to broaden the horizons of first year health sciences students to include research.

Limitations of the study

Students were not directly consulted as part of this process of the first year curriculum design. However, student evaluation reports and formative feedback at mid-semester over the two previous years were taken into account at the brainstorming scaffolding meetings. For example, one comment from a first year student (anonymous student feedback form) in a statistics unit observed that a more basic unit was required in order to prepare students to more effectively learn statistics.

This was an enlightened observation and validates from the perspective of the students that having statistics as a foundation learning for research methods may actually be putting students off perusing research in their later years. A gentler, more 'accessible' introduction to research methods and training as a foundation might inspire students to want to know more about research and prepare them for a statistics unit at an intermediate or advanced level of learning.

5. Conclusions and recommendations

Through first identifying a set of shared, school-level multidisciplinary graduate capabilities then working backwards to determine the corresponding learning outcomes for first year undergraduate learning in research, three broad areas were identified; knowledge production, knowledge translation, and awareness of ethical principles and practice.

The set of shared learning outcomes derived for the knowledge production/creation unit were as follows: On completion of this Unit students should be able to: (i) Describe different philosophical approaches to knowledge creation, (ii) Differentiate the strengths and limitations of various study designs, (iii) Identify a question and plan an appropriate methodology to address it, (iv) Evaluate ethical implications of a research proposition, (v) Demonstrate an ability to conduct basic data analysis, (vi) Demonstrate an ability to interpret and report findings.

In conclusion, this inquiry recommends that undergraduate research learning should commence with a basic introductory unit for all first year students entering the health sciences. This would aim to familiarise students with the research cycle; ask a question, conceptualise a methodology and disseminate the findings. It should then be followed by an evidence based practice (EBP) unit where students learn how to find, evaluate and translate discipline-appropriate research evidence to inform practice. Such a solid foundation in research training must be reinforced by the consistent embedding of inquiry-based learning in higher levels in order to develop the desired graduate capabilities for independent inquiry and life-long learning.

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Conflicts of Interest Disclosure

The author declares that there is no conflict of interest.

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