

Challenges and barriers to implementing research-based experiences for undergraduates at Macquarie University

Report

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Executive Summary

In a university that aspires to offer transformative experiences that change the lives of students, and that desires to promote enquiry-driven learning (*Framing of Futures*), it is important that attention be given to factors that facilitate and factors that hinder development of research-based experiences for students.

Twenty semi-structured interviews were conducted with Macquarie University academics from all Faculties and a range of academic levels who had an interest in, and/or a formal role, to develop undergraduate research.

Academics were asked about perceived constraints and enablements in implementing research and inquiry based learning, the actions taken, academics research practice in their department and its influence on the curriculum. They were also asked to define undergraduate research and to provide examples.

Key perceived constraints were a number of institutional policies and structures, academics' mindsets and lack of skills, and questions of time and money. Participants also mentioned issues of communication, general points about academic working conditions and some also mentioned issues of student attitudes and competence.

Key perceived enablements were the existence of facilitative institutional structures, professional learning to change mindsets and develop relevant skills, integrating undergraduate research with one's own research, supportive people and engaged students.

Academics defined undergraduate research in different ways. Different definitions appeared to lead to different practices and opportunities for further development. Some ways of defining undergraduate research precluded development.

Forms of engagement in undergraduate research were identified from the definitions and examples given in the interviews. These range from basic undergraduate learning/competency to atomistic undergraduate research development (moving from individuate uncoordinated skills development, to coordinated skills development and research-based scholarly experience/tasters); to wholistic undergraduate research development (scholarly practice within courses and integration into the scholarly community).

Recommendations

1. Provide and support facilitative structures for encouraging undergraduate research, such as: a whole of program approach, inquiry included as part of induction, facilitative maps and structures for scaffolding research within units provided.
2. Require new course proposals to include research experiences and outcomes.
3. Consider appointing research-led teaching associate deans in faculties so that they can integrate research and teaching strategy.
4. Continue to simplify ethics requirements for coursework
5. Develop a coordinated system for undergraduate research internship programs including a formal structure for applying for grants for UGR and a coordinated approach for the allocation of undergraduate scholars
6. Provide exemplars for undergraduate research where students can gain academic credit.
7. Create multiple opportunities for professional learning for academics and sessional staff including sharing good practice, encouraging discussion and debate and providing resources to support this.
8. Provide resources for academics to fit undergraduate research into their own research programs.
9. Develop a system of rewards for academics who integrate research into their courses. These might be financial, or workload related.
- 10.** Develop a culture where undergraduate research and evidence-based practice is seen as normal.
- 11.** Utilise the course review process to encourage and support research-based learning.
- 12.** Provide support for student societies that encourage research and for student participation in scholarly conferences, e.g. ACUR

Introduction

This paper reports on the findings of a study conducted to explore Macquarie University staff perceptions of the challenges and barriers to implementing undergraduate research and inquiry. The report aims to assist the implementation of Macquarie University's Learning and Teaching White paper.

The study was begun in 2013 as part of the Macquarie University Competitive grant funded project "*Stimulating strategic teaching and learning initiatives through enhanced familiarity with undergraduate research and inquiry*". It was completed in 2015 with support from the Learning and Teaching Centre. Questions were:

1. How are individual academics working to implement research-based experiences for students?
2. What are the challenges and barriers to doing so?

Context

The interdependence of research, teaching and learning is stressed in Macquarie University's strategic framework "*Framing our Futures*". A culture of teaching and learning in a research-enriched environment is a key strategic priority.

This is elaborated in the *Learning and Teaching Strategic Framework 2015-20* (p.4) which sets a strategic priority to provide connected, creative and innovative learning experiences, and to do this, among other things, by building linkages between disciplines and developing engagement with research. A key strategic goal is for students to become partners and co-creators in their formal learning:

"Universities are also distinguished by their engagement with research and the connected curriculum is built upon **research and enquiry-led discipline-specific content**. Enquiry-based learning is one of our strategic priorities and we will develop and embed teaching models and practices that support this. All students need to engage in the process of acquiring and creating knowledge, to understand how it is produced and to critique it as required.

We will bring teaching and research together within the curriculum through program based teaching which is informed by research, through integration of disciplinary research into courses (Research-enhanced teaching); and by providing opportunities for students to participate in and conduct research, learn about research, develop skills of research and enquiry and contribute to the university's research effort (Research-based learning). Collectively, these efforts will provide opportunities for students to participate in and conduct research, learn about research, develop skills of research and enquiry and contribute to the university's research effort. (*Macquarie University, Learning and Teaching Strategic Framework 2015-20*, p.5)

The intention to integrate research and teaching is clearly expressed in the goals for Key objective 2 of the *Learning and Teaching Strategic Framework*: "Ensure deep, broad graduate capabilities through a connected curriculum". Specifically, Point **2.3 Research-led Discipline Content** specifies the following goals:

1. In 2018, include as part of the program review cycle, approaches to embedding a broad based culture of enquiry and knowledge creation into teaching approaches, including research as an essential component of all coursework.

2. In 2018, provide opportunities and incentives (e.g. credit points for students, funding for staff) for coursework students to engage with the university's leading researchers.
3. In 2018, commence development of an academic pathway for targeted high school students who wish to pursue extra-curricular research opportunities and accelerate pathways into postgraduate offerings. (p.10-11)

These aspirations and goals are to be achieved through a number of strategic projects.

This report on ***The Challenges and Barriers to Implementing Research Based Experiences for Students*** is based on research conducted into current practice on these issues at Macquarie. It therefore provides information intended to inform all of these aspirations and goals. It is of particular significance in relation to the ***Students as Researchers Strategic Project (Learning and Teaching Strategic Framework***, page 12) which is designed to:

- Encourage the development and inclusion of research-appropriate assessment tasks throughout the curriculum, with a view to enabling future MRes and higher degree research (HDR) study (Dean HDR, Faculties, students)
- Define, scope, identify and extend research opportunities (e.g. Macquarie Matrix) to all coursework students (DVC A, DVC R, Dean HDR, Faculties, Students, Library)
- Establish systems, support and professional development for sharing research knowledge and research-enhanced teaching practices (e.g. seminars/learning commons) (DVC R, DVC A, PVC LT, Marketing, Faculties)
- Develop recognition and reward for enquiry-led teaching to showcase the best practices of staff (and corresponding student experiences) resulting from integrated teaching and research approaches (DVC R, DVC A)
- Identify funding sources for MQ research centers that enable structured involvement of students in undergraduate research programs (DVC-R, Faculty)(p.12)

Similar aspirations and intentions are expressed throughout ***the Strategic Research Framework***.

“Exposing our best and brightest undergraduates to Macquarie's research community is a key mechanism to creating a pipeline of outstanding students who identify themselves as being on a natural path to research” (*Goal 2 Strategic Research Framework*, page 25).

This aspiration is underscored in Goal 2 which aims to:

“Establish research internships in each faculty for undergraduate students to make research accessible and an obvious option” (*Goal 2.1 Strategic Research Framework*).

One of the targets and some of the supporting strategies for this goal include:

- “Annually increase the percentage of Macquarie undergraduates transitioning to the MRes to an optimal level:
- “Implement initiatives that enable high-potential undergraduate student exposure to, and participation in, current and emerging areas of research strength
- Work closely with the PVC (Learning, Teaching and Diversity) on the development of a structured curriculum to guide undergraduate students from entry to PhD;
- Encourage undergraduate participation in activities that actively promote participation in research (e.g. the Australasian Conference of Undergraduate Research); (Macquarie University *Strategic Research Framework* page 27)

Background

There now exist numerous studies of students' perceptions of research (see for example, Hajdarpasic, Brew & Popenici, 2015; Spronken-Smith, Walker, O'Steen, & Angelo, 2012; Turner, Wuetherick, & Healey, 2008). However, there are very few studies of how academics think about

and implement research-based experiences for students. An exception is Howitt, Wilson and Roberts, (2011) who suggested that academics may have restricted conceptions of how students develop research capability and that this can limit opportunities.

In a study of the teaching of research skills in social sciences, Wagner, Garner and Kawilich, (2011) found that academics lack the knowledge base in respect to the pedagogy of developing research skills, and in an earlier study, Armstrong and Shanker, (1983) suggested that the supervision of undergraduate research is different in different disciplines.

The limited nature of this work suggests that more needs to be understood about academics' orientations to implementing research-based undergraduate experiences and that attention needs to be paid to disciplinary differences in understandings and practices.

Approach

Twenty semi-structured interviews were conducted with staff interested in developing undergraduate research. Interviews, which lasted approximately an hour, were transcribed and analysed thematically.

A cascade approach was used to identify research participants. Members of the Strategic Working Group on Undergraduate Research (2010-2013) were invited to participate and to suggest other individuals to interview. This approach had the advantage of including academics committed to the development of undergraduate research but the disadvantage that it did not include staff hostile to, or ignorant of, such developments. This does not negate the findings, but it must be recognised that the sample is a biased one.

Of the 20 research participants, nine had a formal or recognised role to develop undergraduate research. This was not necessarily related to their academic level which ranged from lecturers (3), senior lecturers (5), associate professors (9) and professors (3). Interviewees came from all Macquarie Faculties with most coming from Human Sciences and Science (see Figure 1).

To preserve confidentiality, in this report, interview transcripts are identified by a number in brackets followed by a colon and then the page location. In some cases discipline is indicated where it helps in the interpretation of findings. It should be noted that the views expressed in the findings are those of the research participants, not the authors.

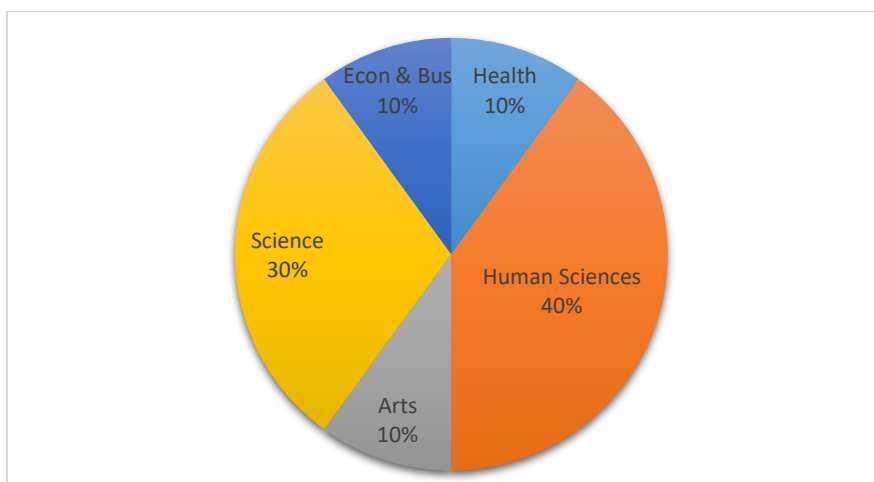


Figure 1. Research participants' faculties

The design of the study was based on the theoretical work of Archer (2003, 2007, 2012) who argues that people find themselves in ambiguous social situations that present a complex variety of conflicting opportunities to do what they want to do. Archer suggests that people balance the freedom they have against particular personal, institutional and structural constraints as they perceive them (Archer 2007). They use 'internal conversations' to work how to fulfil their own needs, desires and values within institutions. The interplay between the causal powers of agents and causal powers of structures means that influences become, through internal conversation, 'constraints' or 'enablements'.

The interview questions in this study were specifically designed to surface academics' perceived constraints and enablements in implementing research and inquiry based learning at Macquarie University. Academics were also asked whether they had a role to spread undergraduate research in their department and what actions they had taken. They were asked about academics' research practices in their department, their views on how important research is to the discipline and its influence on the curriculum. They were also asked to define undergraduate research and, throughout the interview, to provide examples.

Findings

The key perceived constraints were a number of Institutional policies and structures, academics' mindsets and lack of skills, and questions of time and money. Participants also mentioned issues of academics' communication, general points about academic working conditions and some also mentioned issues of student attitudes and competence.

Key perceived enablements were the existence of facilitative institutional structures, changing academic staff mindsets, providing professional development, integrating undergraduate research with one's own research, supportive people and engaged students.

Perceived Institutional structures that facilitate and/or constrain

The commitment of the institution to undergraduate research at the highest policy level was considered important but that needed to be supported by facilitative structures. Teaching and research are seen as separate (and the development of undergraduate research is not helped by the institutional focus on research which means that people don't spend time changing assessments. Also, the fact that there was no formalized/ coordinated requirement for students to do research was considered a hindrance to its development. Further, pressure to recruit and teach large classes and the large student cohorts was thought to mitigate the introduction of research-based learning.

On the other hand, interviewees pointed to a number of facilitative structures for encouraging undergraduate research. These included: a whole of program approach, also 3 hour 'lecture slots, and the idea of the 'flipped' classroom were thought to provide time for inquiry-based activities during class time. Other suggestions included embedding inquiry as part of induction, providing maps of what's been done or a structure for scaffolding research within units. Requiring new course proposals to include research outcomes (1:10) would also be facilitative and one participant mentioned the idea of having research-led teaching associate deans in faculties so that they can integrate research and teaching strategy.

The ethics processes were mentioned by some participants as confusing and bureaucratic. A more simplified ethics process for low-risk coursework research was suggested as being facilitative.

There are a number of schemes for students to work on real research projects alongside academics. However the schemes that exist in the university, e.g. Merit Scholars, internships, vacation

scholarships, ISP projects, have conflicting recruitment schemes. Interviewees pointed to duplication of administrative effort given that there was no organizational structure for undergraduate research, for example, no undergraduate research unit. Merit Scholars, for example, were not always well matched to the projects they are allocated to. A system for undergraduate research including a formal structure for applying for grants for UGR and a coordinated approach for the allocation of undergraduate scholars would help.

Some academics pointed to the shortness of semester breaks in the Southern academic year. This was considered to mean that there was not enough time for students to do research projects. This is compounded by the fact that external research facilities shut during January. So having a whole unit/year program and money for this or an extra year of undergraduate study, or a model of undergraduate research where students could get academic credit would help.

Perceived academic attitudes, skills and mindsets

A number of participants pointed to academic attitudes/mindsets (and lack of knowledge/ skills of how to implement research-based learning or of the possibilities) as key constraints. One said their colleagues feel that what they're doing is not worth sharing.

The need for professional development of academics was strongly stated and this included for sessional staff. On the other hand it was pointed out that academics don't attend professional development meetings and there is "academic arrogance".

Related to this was a lack of communication/ discourse amongst staff in certain departments. Such "departmental silos" (11:6) mean that there is not an exchange of views about what is possible. Note however, that some academics pointed to a lot of discussion between academics in their department which is an enabler.

Staff confidence (not necessarily research done, and getting the idea and knowing what they can do) is facilitative as are opportunities for professional learning, e.g. one to one specific help working alongside staff, workshops and showcases, as well as having links to resources for staff and faculty pilot projects. In addition, having unit conveners who enjoy research and also the existence of staff with a USA background and thereby experience as an undergraduate researcher were also mentioned as helpful.

Finding ways to fit it in with your own research, ensuring there were tangible outcomes e.g. publication and also encouraging applications for research grants to include undergraduate scholars were also mentioned as enabling. You have to weigh up the time and costs/benefits of internships. Scientists mentioned having a research lab and post docs, and Phds in labs who can help mentor undergraduates was helpful.

Having a supportive head of department or significant senior person also helped but it was pointed out that this person need not be current but may have begun a history of UGR implementation in the past which has carried on.

Academics views of students

Academics' views of students and what they are capable of was also considered by some to hinder development. Some participants said that students need to see the relevance or to be convinced. One felt that students don't like learning research skills arguing that this was not the fault of the curriculum.

Some academics argued that undergraduates are not yet at the right level. They pointed to a lack of skills and considered that research was not felt to be appropriate for students' who are struggling academically or who don't have the right attitude to research from a health and safety perspective.

On the other hand, some academics said that students are positive, have an aptitude for research and want to learn. One participant considered that there were risky relationships with students if they engage casually in research, so should not be volunteers they should be paid.

*“So we can't offer this to all undergraduates and I think some of the thoughts in the green paper maybe go too far to saying about industry engagement. It's great for the bright ones and the well attuned ones and you can get them doing research but getting everybody in the undergraduate curriculum doing all sorts of stuff is virtually impossible I think. And I've got a real problem with placements into research roles with external providers. It's fine for the bright ones but what company will want to take students that are struggling academically. So I think that's a barrier. It is a barrier that a research lab is only so big and you know my group is 10 people so including the masters and the PhDs and so on and the research assistants and the postdocs. But a group of that size can't take too many undergraduates with it. But the undergraduate cohort's way bigger. So at the moment it is selective and it is not necessarily the very best that do it but its partly the ones that come and ask. So barrier is partly capacity. I think that would be the same across [the] university. Very hard to get all undergraduates doing genuine research projects in groups. But also at the moment one of the barriers is the undergraduates don't necessarily know about it so communication to the undergraduates about these opportunities is something that could be enhanced I think.
(15:8)*

On a practical level, one participant thought that there was no time in the curriculum for inquiry based learning and that there was no culture of evidence-based practice in their department. Another pointed to the fact that new staff don't yet have a lab, and that it takes time for it to grow. Time and cost benefit for internships.

What was thought to be needed was a culture where undergraduate research is seen as normal. It is important to grow a culture of evidence-based practice, and philosophy of research-based teaching. Research needs to be seen as a living thing.

*“I think communication is the main thing from where I sit in this department... that research is something that happens in universities. It is research that the educational opportunity you're getting here is built on ultimately and that research is a living thing And that you can be doing research and you can be engaging with it very early on that's what I would say.
(7:10)*

Time, funding and resources

Another set of key constraints mentioned by most of the interviewees related to time, money and resources. This academic summed up the views of many concerning the main constraint to implementation:

“I see it as time and money and the fact is that the money is focused on higher degree research and the undergraduate research is not compensated financially.” (20:10)

Funding, even small amounts of funding, were perceived to be facilitative.

Workload formulae were perceived to be a particular problem for many academics. This was particularly so with the amount of time allocated per student/assessment/semester. Implementing undergraduate research was considered to be labour-intensive and casual/sessional staff do not have time, inclination or knowledge. This issue is neatly summed up in the following quotation:

“one of the biggest challenges [is] the assessment policy that we’re only assigned one hour and 20 minutes per student for the whole of the unit ... And so if I’m doing the marking okay that is fine but if I’m ... paying tutors I can’t in all conscience ask them to do more than that cos that’s what they’re getting paid for. So you know some of them, most of them will put more time into it because they’re dedicated and they’re committed to the students and committed to the degree and to the program, but I can’t ask them to do more than that one hour and 20 minutes because it’s not fair. So that’s one of the problems. Time just time not in terms of marking now but in terms of managing projects. That’s another difficulty because for our workload model for example we get I think it is three hours per hour of lecture in terms of time. That doesn’t take into account any extra assistance for students to do projects” (16, p.8)

Nevertheless, two academics did point out that it was not a question of a lack of time, but a question of priorities. One participant suggested that if a subject or unit of study had some element of inquiry in it, then if it was weighted more in terms of workload this would be encouraging to staff.

How interviewees had encouraged their colleagues

Although only nine of the interviewees had a formal role to encourage their colleagues to implement research-based experiences for students, only one indicated that they did not encourage their colleagues in any way. Three academics indicated that everyone should play a role in spreading ideas and practice.

A number of strategies were used for encouraging others. These ranged from opportunistic ‘badgering’ (10:5, 13:5) to taking a multi-pronged approach including providing examples, talking to colleagues about what staff are doing/what’s possible and modelling good practice, and encouraging academics to put forward projects in scholarship schemes.

Some interviewees indicated that a program-based approach to course development, and the course review process provided useful mechanisms for introducing ideas. The Working Group on undergraduate research had also been useful in spreading ideas, as had the undergraduate research newsletter (URNA) and undergraduate research conferences (e.g. ACUR). Some academics had set up internship research programs, another had worked to encourage staff to overcome hesitancy over ethics applications and yet another was trying to influence policy.

As was mentioned above, discussion amongst academics was a key facilitator in encouraging the spread of ideas about undergraduate research and inquiry and some interviewees indicated that they encouraged such talk and a willingness amongst staff in their department. One academic indicated that they could bring up undergraduate research in Associate Dean meetings.

Other interviewees mentioned the work they had done to spread ideas amongst students, for example, by setting up research projects, providing support for student societies such as the Biology Student Society (9:6) and the Macquarie University Undergraduate Research Student Society (MUURSS) and through actively encouraging Macquarie students’ attendance at ACUR.

Academics' research and its influence on teaching

In order to establish a baseline for understanding how academics were working to implement research-based experiences for students, interviewees were asked to indicate what kinds of research academics do in their department. What was interesting about responses was how often academics enumerated a wide range of practices and/or theoretical approaches. For example:

"It is quite broad in education because you have a number of disciplines feeding into to education, you've got education psychology, education sociology, education history, politics, social policy. So I think the interests of our department probably reflect that diversity." (Education: 3, p. 1)

"we are researching many different aspects across the Department of Ancient Cultures especially Mediterranean cultures. But not only. We do Egypt right across to the west and the east across the Silk Road to China. So it is quite a large area." (History: 7, p. 1)

"So earth sciences is built on three main areas – one is theoretical. So geophysicists will tend to do seismic analysis but they also do modelling so understanding the interior of the earth. Takes modelling to do so the theoretical component cos we can't collect samples from the core to the mantle. So and understanding the solar system we do have meteorites but we also need to do a lot of theoretical work. The other big component is field work. So going out and actually collecting rocks and looking at rocks. And the third one is experimental and that is a more recent one and that's where you take rocks or make up chemical solutions that would represent the earths' crust for example and then you put them under pressure temperature in the laboratories. (Science: 20, p.1-2)

When asked how important research is to the discipline, academics responded that it was essential.

"the research is fundamental to the discipline to pushing forward the boundaries of the discipline (Linguistics: 16, p.2).

"It is absolutely crucial. The discipline is made of research" (Geophysics: 15, p.2)

"In psychology at every university in the country and probably overseas as well research is seen as integral" (Psychology: 10, p.7)

"I think it is critical I mean I don't think you can have good education without an evidence base." (Education: 3, p. 1)

Academics perceived research to have influenced the curriculum either in terms of the activities that students engage in, the way the curriculum is structured or in terms of benefits to their own teaching:

"undergraduate training in psychology is entirely based on the discipline. So it has a very strong research basis ... the research informs clinical practice so it is an evidence based practice. So psychology undergraduates ... get a very strong grounding in the research literature. And they do research in the sense that ... they collect data usually on themselves in class and write that up as a lab report." (Psychology: 10, p. 1)

"So I'd say for us how important it is, it is pretty well critical. And certainly drives a lot of the way in which we've been restructuring undergraduate teaching recently." (Geophysics: 14, p.2)

“Very important, yeah fundamental. Keeps your teaching up-to-date. For example in this discipline if you’re not up-to-date you’ll fall behind pretty quickly and the only way to stay up-to-date is to actually be actively involved in research and attending conferences” (Science: 20, p.3)

Academics’ definitions of undergraduate research

Academics were asked to provide a definition of undergraduate research. For some, undergraduate research referred to everything that students did at university, whereas for others it referred only to a specialized set of activities which were available only for a few students. Some academics focused on undergraduate research as being closely structured and guided whilst others confined it to saying that students needed to be doing independent research. Some academics considered that if students were involved in various stages of the research process, for example, collecting data or engaging in bibliographical exercises then they would call that undergraduate research but others considered that students had to be involved in the whole process of research from setting questions or hypotheses, designing experiments or data collection right through to reporting on the findings in some kind of publication; i.e. that it was engaging in the whole research journey or trajectory that was important.

Another important distinction in conceptions of undergraduate research was whether the focus was on skills development or on broader student development with an emphasis on students’ views of the role of research in their future lives. Academics also differed in their views of the quality of the research that students conducted. For some, student research was inevitably inferior; it may replicate existing research but could not contribute to knowledge generation. For others, student research was real research. Students were contributing to the generation of new knowledge and their research was publishable. Finally, for some academics undergraduate research was viewed within the confines of students’ courses of study where students were treated merely as students, whereas for others undergraduate research was viewed as having a wider role as preparing future researchers and students are viewed as junior colleagues and treated as such. Responses are summarised in Figure 2.

Although the language used in different disciplines to express these definitions varied, perhaps surprisingly, these definitional differences did not appear to reflect disciplinary differences. The implications of these different views are discussed below.

Everything all students do		A specialized process only for a few students
Guided research -semi guided -supervisors, mentors	vs	Independent research -semi independent -groups or individual
Involvement in stages of research -ie. data collection	vs	Involvement in complete research process -from question to write up/ presentation -trajectory, continuity
Doing in UGR -focus on skills	vs	Being in UGR -focus on developing the student

UGR is secondary, lower quality research – not publishable May replicate existing findings	vs	UGR is original research generating new knowledge
UGR is for the student cohort and for the degree only	vs	Student treated as part of the research community and knows they have a wider role as a future researcher

Figure 2. Academics' definitions of undergraduate research

Forms of engagement in undergraduate research

In conducting the interviews, it appeared that how academics defined undergraduate research determined what they thought was possible or desirable. This led to the specification of a number of forms of engagement in undergraduate research. These forms differ in the kinds of activities that students engage in, how the activities are related to each other, and in their implications for students' outcomes. They are summarised in Figure 3. Different colours are used to differentiate levels of engagement: undergraduate learning/competency; atomistic approaches to undergraduate research development and wholistic undergraduate research.

Importantly in the context of Macquarie University's strategic objectives, these forms each have different implications for the spread of research engagement across the undergraduate curriculum and in co-curricular activities. These are discussed below. Typical quotes are given following brief descriptions.

Undergraduate learning	Atomistic undergraduate research development			Wholistic undergraduate research	
0	1	2	3	4	5
Units of study	Units of study	Units of study	Co-curricular engagement	Units of study	Co-curricular engagement
Individual work	Individual uncoordinated skills development	individual & group coordinated Skills development	Research-based scholarly experience/tasters	Scholarly practice within courses	Integration into the scholarly community
<ul style="list-style-type: none"> students are an audience for academics to tell them about their own and others research. Lectures on research methodology. Assessment through Essays and/or reports 	<ul style="list-style-type: none"> essays and reports framed as research Bibliographical exercises/ critical literature reviews practicing individual research techniques, e.g. laboratory techniques, field work, etc. 	<ul style="list-style-type: none"> combined and scaffolded research techniques through the curriculum. disciplinary techniques, e.g. setting hypotheses,, collecting data, practiced on unconnected topics 	<ul style="list-style-type: none"> working alongside staff, PhDs, Post Docs etc on existing research projects. Engaged as research assistants and/or as part of a wider scheme e.g merit scholars may be voluntary 	<ul style="list-style-type: none"> Program based approach to design of units of study coordinated set of research skills and experiences Engagement within units of study in whole process from question setting to publishing 	<ul style="list-style-type: none"> individually tailored research projects working alongside academics Engaging in whole process from question setting to publishing summer/winter vacation scholarships, or internships.
<p>Students:</p> <ul style="list-style-type: none"> develop basic student competency largely unaware of research and research opportunities 	<p>Students:</p> <ul style="list-style-type: none"> develop skills of academic writing and critical analysis develop knowledge of some techniques research in the university unconnected unaware of research and opportunities. 	<p>Students:</p> <ul style="list-style-type: none"> develop particular research techniques lack understanding of relationship to chosen profession 	<p>Students:</p> <ul style="list-style-type: none"> introduced to research life and practices typically paid a stipend or salary or may gain academic credit 	<p>Students:</p> <ul style="list-style-type: none"> develop disciplinary professional tool kit gain a clear sense of the process of research practice skills in coordinated manner know how research relates to profession 	<p>Students:</p> <ul style="list-style-type: none"> fully integrated into the scholarly community treated as equal with academics ownership of a particular project know how their research furthers the discipline. Gain a stipend or academic credit
RED: Insufficient Undergraduate Research Development	AMBER: Some recognition of need to develop undergraduate research skills but practice is patchy and coordination across programs requires more work			GREEN: Some good recognition of the need for coordinated development and integration of students into the scholarly community.	

Figure 3. Forms of engagement in undergraduate research

0 - Undergraduate learning

Everything students do in university is research. There may be lectures where students are an audience for academics to tell them about their own and others research. They may have lectures on research methodology and assessment through essays and/or reports. Students develop basic student competency. They may be largely unaware of research and research opportunities.

“For the vast majority of students the research they get in their undergraduate degree is how to write an essay (English, 1, p.15)

“there’s a built in assumption if we get you to write an essay on this topic ... that the student is doing research. I mean we haven’t been expected to spell that out.” (Linguistics, 6, p.9)

“see my view is that students every time they read a book and they are thinking about a question they are actually researching. So research is an activity that happens every hour of every day in university’s cos people are thinking .. they get this interesting idea: I wonder why this happens, ... Research is problem solving but you have to be able to come up with an interesting problem to solve and so that’s what the basic teaching does. So it’s a way of thinking.” (Psychology, 10, p.4)

1 - Individual work, study and uncoordinated skills development

Students do “Research essays” or “research reports” i.e. essays and reports framed as research and linked to research/journal article writing. Students carry out bibliographical exercises and/or critical literature reviews and they practice individual research techniques, e.g. laboratory techniques, data mining, field work, questionnaire design etc. Students develop skills of academic writing and critical analysis. They develop knowledge of particular disciplinary techniques but these may appear unconnected with research in the university and professions. They may be largely unaware of research and research opportunities.

“every unit has some kind of research project. ... Usually it is a library based research project, well yes I think probably all of them have some kind of library based research that culminates in an essay or other kind of assessment .. like a research portfolio. ...

Interviewer: So the students doing an essay – do you call that research?

Respondent: Yeah I would call that research. If I tell them that ... I want them to do research on debates about legalisation or decriminalisation of [topic], .. then I expect them to do a lot of research looking at the history of [topic] legalisation or decriminalisation in other contexts and the history of the legal prohibition of [topic] and so on. So yeah that is going to involve figuring out what to read and how to construct an argument. So in that sense it is research. ... We call it a research essay” (Anthropology, 17, p.5)

2 - Coordinated Skills development through individual and group work

Research techniques are combined and scaffolded throughout the curriculum. Students learn how to set hypotheses, generate questions, collect data, write reports, and engaged in disciplinary techniques etc. but these may be practiced on unconnected topics. Students develop knowledge and skills in particular research techniques but are unlikely to develop understanding of how the research they are doing relates to their chosen profession nor life afterwards.

“I think it is any learning activity or content that has some focus or element of research to it. So it could in fact be, students could .. interview each other to learn about interviewing. Students could engage with primary research. ... I used to try and get them aware of a range

of methods or give the class a set of data and then have them in groups interpret it using different approaches. ... More actively ... we could use the whole class ... like a sample of respondents: get everybody to fill something in and then collectively collate that data and see what we would do to it, we've done that. ... I've had them go out and interview or survey in the community and bring those results together. Look if you bring in a journal article or some other commentaries like that that's engaging with research. ...I used to like to get guest speakers in: people who have published their research ... And had the students quiz the author on how ... they did their research. That's always really nice that they meet a real researcher. I used to love that. So there's endless possibilities and I've used all of those and I'm sure there's many more. " (Education, 13, p. 5)

"it is that skills development in the scientific research method that's important in the undergraduate and that's what I define and the research component of it. So they're constantly developing research skills, analytical thinking being able to think about what data mean and interpreting it, being able to drill into papers and what not. So I guess for me undergraduate research is developing that critical analysis skill set that they need ... for outside science later on in their life." (Geology, 14, p.6)

3 - Research-based scholarly experience/tasters

Students work alongside staff, PhDs, Post Docs etc. They are involved in data collection or analysis on existing research projects. Students may work as research assistants and/or as part of a wider scheme e.g merit scholars or projects individually set up by academics. Students are typically paid a stipend or salary or they may gain academic credit. Engagement may be voluntary. Students are introduced to research life and practices of scholarly engagement but the work does not relate to their learning in units of study.

"some labs are more accessible for undergraduate stuff than others. But for example my research group have had two undergraduate interns this year. And actually it was independent of the .. the formal internship program. And essentially these two students carried out field work with me and a PhD student of mine and spent considerable periods of time actually in the field learning how to capture, in this case [animal] and how to mark them and measure them and carry out population surveys and so we do get them involved. ... One of the ones the I had this year was in his third year of advanced biology ... It wasn't necessarily designed to integrate in with any particular knowledge base they might have developed as part of the undergraduate [course]... [It's] completely independent of that. They at the same time learn particular research skills. Knowing what the project was about. ... (Biology, 9, p.5-6)

4 - Scholarly practice within courses

Units of study where students devise questions/hypotheses, set up experiments/ fieldwork to answer them, collect the data/do the experiments/analyse the resulting data and report on findings/results. Program based approach to the design of units of study ensures students acquire a coordinated set of research skills and experiences. Students develop their disciplinary "professional tool kit". They gain a clear sense of the process of research in the discipline, can practice skills needed and they know how research relates to their chosen profession and life afterwards.

"undergraduate research in order for it to be defined as research has to have sort of [a] trajectory that takes them on the path of what for an anthropologist or a qualitative researcher, what that involves. So formulation of the question, figuring out how to answer it,

going out and interviewing people or serving people or doing whatever and then analysing it and then writing it in a presentable form. It doesn't have to be writing. I've seen students do documentary projects, media projects, presentations, you know somehow presenting it in a digestible form. So that trajectory I think that's what research is for me is. You can do parts of research you can teach methodology, but you're not teaching research if you just do methodology so you need the beginning to the end." (Anthropology, 18, p. 5-6)

5- Integration into the scholarly community

Students work alongside academics on individually tailored or devised research projects. They devise questions/hypotheses, set up experiments/ fieldwork to answer them, collect the data/do the experiments/ analyse the resulting data and report on/publish findings/results. Engagement may be as summer/winter vacation scholarships, or internships. Students are typically paid a stipend or may gain academic credit. Students are fully integrated into the scholarly community. They are treated as equals with academics/researchers and have ownership of particular projects. They know how the research they are doing furthers the discipline.

"I suppose very simply where an undergrad level student does some primary research where they have a project, where they, with the help of a supervisor, they develop an idea and then they do some reading to understand the context of the project. And then they develop with aid what they will do. So collection of rock analyses or measuring some geophysical attribute or whatever so the doing part of the research project and then all of these have an interpretational write up stage where they put it all together. So I would characterise it as students actually doing genuine research which in some cases could be publishable in a Journal. Having a student be able to get a scholarship to do this is helpful. ... So there needs to be some sort of framework to fit them in. ... And having post docs and PhD students who can in their lab mentor the more junior people: Masters students and especially undergraduates who are learning stuff can be very helpful. ... And that sort of extra help from the broader group of researchers at the university I think is an important part. So the undergraduate feels they're fitting in to a broader team or group so I think that's an important part of it. (Geology, 15 p. 6-7)

Discussion

It is particularly noticeable that opportunities for development are different depending on the different definitions of undergraduate research given by academics in this study. Some definitions preclude development. For example, if everything that all students do is considered to be undergraduate research or if undergraduate research is viewed as a specialized process only for a few students, then the university's objectives can only be fulfilled if such definitions are challenged and changed. Some definitions are based upon a deficit model of students. These need to be challenged. Indeed, opening up mindsets (both staff and students) to new possibilities is essential if Macquarie is to achieve its aspirations as expressed in the Learning and Teaching, and Research strategy documents. For example, a range of opportunities for engaging in both guided research and independent research, involving students both in the stages of research and in the complete research process need to be fostered, possibly at different levels. Accepting that there may be occasions when students are engaging in lower level research in order to learn, and other occasions when they are engaging in generating new knowledge is also indicated. And while there are times when a focus on skills is appropriate, ways need to be found to encourage in students researcherly attitudes and behaviours and for them to know that these are relevant in whatever profession they undertake.

We looked at whether these different ways of defining undergraduate research were related to discipline and found examples of each of these in scientific disciplines and in Arts and Human Sciences. Further discussion in specific departments would provide a mechanism for changing mindsets. At the very least, the definitions of undergraduate research found here amongst academics at Macquarie provide a framework for audit and review and suggest clear directions for the implementation of the strategic teaching and learning plan and the research Strategic Framework.

The forms of undergraduate research engagement presented in this report have been devised from the data on definitions together with examples provided by interviewees in this study. These provide a helpful way of characterizing different practices.

Again, at each extreme, development is difficult. For example, if everything students already do is considered to be research, then it will be assumed that the university's aims in undergraduate research have already been met and there is no need to do anything different. On the other hand, integration into the scholarly community is thought to be resource-intensive and only likely to be available to very few students. So without lots of extra resources, development at this level is limited.

However, in between, there is considerable scope. It may be that atomistic undergraduate research development is appropriate in the early years, moving to more wholistic development in third year. The University's strategic documents suggest moving progressively to achieve Scholarly practice within courses (No. 4), with an increasing number of students gaining experience of integration into the scholarly community (No. 5). The Forms of engagement can additionally provide a mechanism for audit and review. As a baseline for implementation of the Learning and Teaching Plan, departments may find it a useful way to characterize current practice.

Recommendations

1. Provide and support facilitative structures for encouraging undergraduate research, such as: a whole of program approach, inquiry included as part of induction, facilitative maps and structures for scaffolding research within units provided.
2. Require new course proposals to include research experiences and outcomes.
3. Consider appointing research-led teaching associate deans in faculties so that they can integrate research and teaching strategy.
4. Continue to simplify ethics requirements for coursework
5. Develop a coordinated system for undergraduate research internship programs including a formal structure for applying for grants for UGR and a coordinated approach for the allocation of undergraduate scholars
6. Provide exemplars for undergraduate research where students can gain academic credit.
7. Create multiple opportunities for professional learning for academics and sessional staff including sharing good practice, encouraging discussion and debate and providing resources to support this.
8. Provide resources for academics to fit undergraduate research into their own research programs.
9. Develop a system of rewards for academics who integrate research into their courses. These might be financial, or workload related.
10. Develop a culture where undergraduate research and evidence-based practice is seen as normal.
11. Utilise the course review process to encourage and support research-based learning.

12. Provide support for student societies that encourage research and for student participation in scholarly conferences, e.g. ACUR

Conclusion

This report has brought to the fore, the challenges and barriers to implementing research-based experiences for students as perceived by academics at Macquarie University. The interview study, has also surfaced aspects that Macquarie academics consider are facilitative of changed. In the light of Macquarie University's strategic aspirations, it is hoped that the recommendations in this report can be used to assist in the development of these aspirations and that by building on the elements mentioned in this report, students' experiences of research can be enhanced. In this regard, we end with a quotation about the benefits to students from one of the interviews:

"the students are so engaged when they're doing their own research, they are just on fire and interested in a way that they aren't when they're just reading about the research that other people do. They're so interested and they learn more, they learn about everything, every part, from every part of the research project including failure. You know they fail, they make mistakes they have problems, things don't go well and they learn from that. It is just an incredible process and you see how turned on they get when they're doing their own research projects. And that's why I make all the effort that I do to make it happen in the classes that I teach because I see this degree of engagement that's just beyond what you see when you're just teaching them about other people's research" (17, p. 8-9).

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