

# 10

## University Research

Read this chapter if you would like the following issues addressed:

- What is university research?
- How does university research impact upon undergraduate students?
- How do undergraduates determine whether or not their university undertakes quality research?

Many students go through their entire period of undergraduate study without ever understanding the details of the research that goes on within their university. Some students graduate without any understanding of how universities conduct research, or how the quality of outcomes is assessed. There is usually a simple acceptance that what goes on has some value, and that university research is well outside the realm and interests of undergraduates. However, university research is of importance to undergraduates for two reasons, specifically:

- The basic tenet of university learning is that academic staff have a role to play in not only imparting fundamental theories but also cutting edge knowledge from their field of specialisation. Academic staff therefore need to undertake research to remain at the forefront of the knowledge wave in their area. This is a benefit that should flow on directly to the students.
- A proportion of undergraduates (typically between one and ten percent) will go on to undertake some form of professional research (in either universities or industry) after they complete their first degree, and they need to understand the nature of professional research.

The common public misconception in regard to research, whether conducted at universities or elsewhere, is that it is an open-ended and unstructured quest for knowledge and/or solutions to problems. There is also a view that researchers can simply

undertake whatever investigations they feel are appropriate, unfettered by any boundaries or financial considerations.

From the outside, therefore, it can appear that the university research environment is simply composed of a collection of intellectuals, acting in some random manner, and occasionally producing some major breakthrough in science or perhaps medicine. However, as we shall discover through the course of this chapter, professional research, such as that conducted in universities around the world, is far more structured; far more systematic, and far more restricted in its scope. For example, while it may be the broadly stated objective of a major research institute to cure a particular disease, the reality for individual researchers is that they would conduct their research on one small element of a large research program, which may have thousands, or tens of thousands of individual elements. Even within that small element, the number of pathways investigated by an individual researcher is restricted by time and resources.

So, the first point that needs to be noted about university research is that it differs from the notion of “invention” in the sense that it is not simply about fossicking around for a solution to a problem, or about creating a new product for which there is no existing basis.

University research, like other forms of professional research, needs to have a logical starting point and needs to be conducted systematically in a logical sequence, specifically:

- (i) Identifying a problem or a hypothesis to be tested.

- (ii) Investigating what has been done in the past and what other researchers are currently doing through an analysis of documented information (literature) produced by learned individuals.
- (iii) Based upon the review of scholarly literature, identifying the potential starting points for resolving a problem or testing a hypothesis.
- (iv) Based upon the review of scholarly literature, identifying a logical sequence of steps for resolving a problem or testing a hypothesis
- (v) Developing a strategy for implementing the steps or testing the hypothesis.
- (vi) Developing a range of experiments, models or surveys that can be used to evaluate the method and/or hypothesis.
- (vii) Impartially evaluating/assessing the results of an investigation.
- (viii) Publication of the research outcomes in scholarly journals for assessment by others.

Step (ii) is particularly important because it highlights an important issue pertaining to professional research – that is, the research pathway is not just randomly selected because it might be a good idea, as is often the case in unstructured invention. The pathway tends to be based upon a consideration of what has gone on before and, in particular, what has been rigorously documented by other experts (learned scholars). While there is some scope for

“pioneering” research, for which there has been no prior (documented) basis, this is more the exception than the rule, and a luxury which is normally accorded to more senior staff who already have an existing track record of achievement in delivering outcomes from the structured research environment.

The other point to note about Step (ii) is that knowledge and information is passed on from researcher to researcher by the written word, whether this be in a printed book or journal or, increasingly, in electronic form on the Internet (as an electronic journal). The purpose of publishing research is to enable other scholars to view the work; attempt to reproduce it and, perhaps, to move the work forward. In many cases, other researchers who attempt to reproduce earlier published work find that they cannot do so, and they may publish findings which dispute previous research.

In the long term, the process of publishing scholarly work creates a public forum in which research can either be confirmed or repudiated. So, if a researcher or research team publish a finding, and over a period of time other researchers corroborate that finding, then those that view the overall process of research discovery can have greater confidence that the original work was valid. Conversely, a lack of corroboration by subsequent researchers could lead to a view that the original work was flawed.

In the university context, therefore, publication is central to the way in which the quality and value of research is assessed. The more times that a piece of published research is cited by others (in a positive sense), the more significant the work is deemed to be. Sometimes, however, research is published but not cited by others simply because there is no broad interest in pursuing the field

further – this does not imply that the initial research was poor or even flawed – simply that it did not create any momentum in the environment to cause others to pursue it further.

Research in universities can broadly be categorised into two types:

- Pure (basic).
- Applied.

Pure/basic research is research that is not targeted towards achieving a specific outcome (e.g., curing a disease). It is simply performed for the sake of increasing knowledge in the field. The fact that pure research does not lead to any direct outcomes does not imply that the work has no value – on the contrary, the extensions to human knowledge that it creates may form the basis of important, subsequent outcomes that have direct benefits for society. Nevertheless, because pure/basic research does not commence from the perspective of achieving a specific outcome, the time period between the commencement of pure/basic research and a tangible outcome can be decades.

Applied research is that which has a specific outcome in mind, at the time it is commenced. For example, the objective of an applied research program may be to develop a more fuel-efficient jet engine. The timeframe between the initiation of an applied research program and the translation of its results into a tangible outcome may be as short as a few years.

Universities generally undertake a combination of pure and applied research, with some universities focused more heavily on one than the other. In general, the more traditional universities

endeavour to focus their activities more on pure/basic research and the newer universities focus theirs on applied research. Governments in most countries recognise the importance of both branches of research and tend to have funding mechanisms for both.

Universities also mix their ratios of pure and applied research to achieve various strategic ends – some universities seek a technological focus while others seek a more theoretical focus. In developing countries, universities tend to pursue a higher proportion of applied research because it leads to short term gains that aid in economic development. In developed societies, there is sufficient wealth to enable the pursuit of long term outcomes.

University leaders are acutely aware that an excessive concentration on pure research tends to divorce researchers from reality and leads to progressively more esoteric research directions. On the other hand, an excessive reliance on applied research means that researchers use existing knowledge but do not necessarily create new knowledge – in the end, if all research was applied then eventually society would stagnate because there is no new knowledge to drive that society forward.

The next question that generally arises in the context of university research is, “*who actually carries out the research?*”. In practice, the research is carried out by a number of different players, including:

- Academic staff (i.e., professors, lecturers, etc.)
- Research staff (i.e., postdoctoral researchers, research engineers and scientists, research assistants, etc.)

- Postgraduate research students (i.e., students working towards their Master's or PhD degrees).
- Postgraduate coursework students (i.e., students who undertake coursework leading towards a Master's degree, and who also have to undertake a research project as part of that degree).
- Final year undergraduate/honours students (i.e., students undertaking final year theses).

Within the above spectrum of researchers, the academic staff are generally funded through a university's recurrent operating funds (i.e., are ongoing staff of the university), but most of the other researchers need to be funded by project-based funding – such as government or industry grants for specific research programs. For this reason, in the university system, some of the senior researchers have the responsibility for generating the income required to fund the others. Hence, the more senior an academic staff member, the less “hands-on” research they would actually perform, and the greater their role in seeking funds, managing research programs, and supervising other researchers and students.

In order to attract funds for research projects from various sources (and, in particular, the government), researchers normally need to compete against one another to win funding from a limited pool. Funds are theoretically allocated in terms of the quality of the researchers and the quality of their applications. This process is known as a competitive granting process, and is in common usage in many countries. The objective of the competition is notionally to encourage excellence amongst research groups.

There are, however, four major disadvantages of the competitive research granting system, specifically:

- A proportion of academic staff, whose salaries are funded by their universities to undertake research anyway, are not able to do so if they are unsuccessful in competitive grants.
- The process of applying for grants is bureaucratic and costly (because academics spend weeks of tax-payer funded time to prepare grants, and teams of tax-payer funded people are required to judge grant applications from many fields).
- In order to have a grant application assessed, researchers effectively have to submit their applications to competitors in the same field. In a large competitive granting system, such as that in the United States, this is not a large problem but, in small countries, such as Australia and New Zealand, where most of the researchers in a particular field know one another, it is a significant shortcoming because it introduces biases into the system.
- The fact that grants are awarded to individual researchers rather than universities makes it difficult for universities to plan and build research programs in a strategic sense, because there is no secure, ongoing source of funding. This also makes it difficult for universities to move research “forward” from a discovery through to applied research, and

subsequently commercialisation – once the competitive funding ceases, so too does the research.

The competitive research granting processes are also questionable in terms of achieving national or societal outcomes – for example, a researcher applying for funds in research field “A” ends up being directly compared with a researcher applying for funds in field “B” – in other words, the system compares apples against oranges – sometimes it chooses to fund the apples (because apples are better than oranges) and sometimes the oranges (because oranges are better than apples). Moreover, on each funding round, the competitive process funds excellence in research teams, rather than a consistent and logical sequence of research programs from an individual team that lead to some societal benefit. In other words, once a “new” team of researchers in field “B” is deemed to be superior to an existing team of researchers in field “A”, then research program “A” tends to be discarded in favour of pursuing excellence in “B”.

Governments around the world have argued that the competitive research granting process ensures excellence in the system because each funding round requires research teams to be excellent in order to secure funding – this claim, however, remains largely untested, primarily because it is difficult to find equivalent countries who run alternative systems. Certainly, the competitive research granting process is an anachronism compared to industry research practice, where a sequenced program of research is planned and monitored in accordance with strategic requirements. Nevertheless, given that competitive granting processes are an

international phenomenon, they are unlikely to change in the coming years.

Considering the above issues, it should be evident that the process of applying for research grants is a relatively complex one, and undergraduate students will be sometimes made aware, by academic staff members, that those staff are unable to deliver a particular undergraduate outcome because they are preoccupied with writing or submitting grant applications. While this is clearly a “downside” to research, from the undergraduate’s perspective, the “upside” should be that undergraduates get exposure to the cutting edge research conducted by such academics – whether it be from final year research projects; specialised lectures or laboratory sessions.

In universities, research can be carried out in a number of different forums, including within:

- Faculties and departments, where academic staff, research staff and postgraduate research students work in the normal university framework
- Research institutes and centres, where research-only staff are specifically appointed to undertake research.

Research conducted within a faculty or department normally tends to mirror the undergraduate and postgraduate learning activities. The purpose of research institutes and centres, on the other hand, is to concentrate research effort into a specific field – for example, meteorology or neuroscience – these fields may not relate directly to the undergraduate learning areas. In research institutes and centres, there tend to be a range of staff who are either

employees of the institute or else seconded by the university from their normal activities to work in the institute or centre. For these reasons, institute and centre staff do not necessarily interact with undergraduate students and, unless undergraduates actively pursued final year or honours projects with such institutes or centres, they may never see what goes on inside them or interact with the staff.

Regardless of whether research is conducted within conventional faculties or within research institutes and centres, there are a number of ways in which the quality of the research effort, and the overall quality of the university, in the context of research, are assessed. Essentially, these include measuring:

- The number of journal/conference publications produced by staff
- The number of times that journal articles produced by staff are cited by other learned researchers (this is known as the citation rate).
- The number of competitive research grants (or dollar income) that universities get – because the grants themselves are an indicator of the quality of the researchers.
- The number of research student completions over the course of each year.
- The number of patents registered by a university.
- The number of awards and honours accorded to university staff (e.g., Nobel Prizes).

The measurements that relate to the number of publications and citations are referred to as bibliometrics. These are used extensively around the world as measures of research activity and performance – the reason being that publication is viewed by universities as the basic forum in which research quality is tested.

The problem, however, with all measurements that relate to university research performance is that they are only indicators of performance and quality – they are neither absolute nor definitive. Moreover, universities and individual researchers inevitably seek to maximise all the performance parameters without necessarily actually providing the substance that is required behind the numbers themselves. It therefore requires considerable expertise, maturity and subjectivity to analyse university research performance data and determine whether such data provides an accurate reflection of reality – simply accepting such information at face value contains an element of risk in regard to misinterpretation. In other words, while research performance data contains information, the translation of that information into a meaningful understanding of performance requires considerable expertise.

Many undergraduate students trawl through university selection guides and choose universities based upon their perceived prestige in regard to research performance. The assumption is that the better the research performance of the university, the better the level of learning for the undergraduate. There are a number of problems with this line of thought. The first is that numerical university rankings, regardless of their widespread acceptance, tend to be simple, formula-based applications of research performance data. Although rankings provide some indication of quality,

students should not read too much into them, simply because of the expertise required in order to interpret them. For example, one university may numerically rank better than another simply because of its size, rather than the intrinsic quality of its staff. As Figure 2.1 clearly shows, Australia's publicly funded universities tend to perform better overall (in learning and research) as they get bigger in terms of the number of academic and research staff, rather than for any intrinsic reason relating to the actual staff in any individual university (or group of universities).

Another example where university research rankings can be misleading is where they count the number of eminent researchers (typically Nobel Prize winners or Fields Medalists), as one of their performance indicators. In this case, the significance of such a number depends upon whether the recipients conducted their prize winning research at the university in question, or whether they were simply recruited at a later date in order to buy prestige – in other words, whether the university nurtured international research stars or simply purchased them after they became eminent. These are all issues that need to be considered by experts, rather than simply accepted as facts, based on data in a university "score sheet".

A person considering the choice of a university can, however, take some comfort in knowing that the major university rankings do present a reasonable portrait of the world's universities in terms of their ability to:

- Achieve critical mass in research.
- Nurture and develop world leading (eminent) researchers.

- Provide research infrastructure and support.
- Attract world leading (eminent) researchers who can go on to create other international research leaders.

However, and perhaps more importantly for undergraduate students, good research performance does not necessarily translate into good learning experiences for students – even though research should be a natural driver for education and learning. Sometimes, staff who are outstanding researchers are either poor educators or have little or no interest in (or understanding of) undergraduate learning – for those staff, research is their primary interest. Conversely, some academic staff who have a limited research track record are outstanding educators because that is their primary interest. It is also the case that universities with strong research track records tend to reward staff for their research performance rather than their ability as educators – it is not surprising, therefore, that in such universities, undergraduates may be relegated to a lower level of importance than they would be in less research intensive universities.

Within the university system, undergraduate students also need to learn to accept the anomalies of variations in academic staff quality for what they are. Students need to accept, for example, that highly regarded researchers may contribute greatly to their learning despite the fact that such staff are poor educators – their contribution to student learning is in passing on cutting edge knowledge – and not in terms of providing well-prepared, “*easy to understand*” lectures.

Students also need to understand that one of the benefits that they enjoy in the majority of their early undergraduate subjects is that, because those subjects tend to be “fundamental” in nature, and have been taught for years or decades, the learning tools used to convey the long-established knowledge have been well refined. As students move into their more senior years, they are exposed to more and more leading edge knowledge, and information based upon research. For this reason, the educational tools that have been developed to convey this knowledge to students tend to be less refined. At the same time, because the students receiving the information are more mature, there is an expectation that they will be able to fill in the blanks left by the gaps in the education process. Overall, therefore, students need to provide some latitude in the quality of the learning process as it pertains to state-of-the-art knowledge emanating from research – but, students should neither blindly accept nor endure a marked lack of interest in their learning emanating from research oriented academics.

For most students, the primary connection between university research and undergraduate study comes in the more senior years, where students undertake more project/thesis work, and less structured lecturing and/or laboratory work. Students may be given the opportunity to undertake projects in conjunction with research-focused academics in the faculty, or with research institutes/centres connected with the university. In some cases, students will have the opportunity of working with Doctoral or Master’s research students or, perhaps, postdoctoral researchers who are experts in a narrow field of research. Exposure to such research projects and staff maximises the benefits that students can derive from their university

education and students should endeavour to pursue such options wherever possible.

In undertaking final year or honours projects with research staff or research oriented academics, students also need to be wary that they are not exploited for non-educational purposes. Given the nature of the university research environment – that is, one which is focused on publication and competitive grants, it is not surprising that staff may endeavour to maximise their performance in these activities. Part of this can occur by asking final year or honours students to write and publish papers on their work. In principle, publication in an international journal can be of significant benefit to undergraduate students, particularly if they wish to pursue a research career later in life. In a broader sense, however, it is not the role of the undergraduate student to enhance the career prospects of a university's academic and research staff. For this reason, care needs to be taken in deciding whether activities that are allocated to students during undergraduate final year / honours subjects are for the purposes of learning, or for the benefit of the staff. If it is the former, then students should take advantage of the opportunity – if it is the latter, then students should voice their concerns.

At the end of the undergraduate learning process, perhaps as a consequence of their involvement in final year or honours research projects, some undergraduate students may be inspired to continue their research as postgraduates within the university system – and become the knowledge creators of the future.

**Chapter 10 Summary:**

- (i) *University research is a systematic and structured process of investigation that differs markedly from the notion of invention.*
- (ii) *University research can be undertaken by academic staff; research staff (postdoctoral researchers); research students (PhD and Master's candidates) or even senior undergraduates*
- (iii) *University research can either be undertaken within conventional faculties or within research institutes and centres.*
- (iv) *University research tends to be funded on a project by project basis, and the funding for projects is normally issued on a competitive basis. The result is that the greater the research income for academics, the more likely they are to be perceived as high calibre researchers.*
- (v) *The basic measures of research are publication (and subsequent citation by others) because this is the way that the validity of research is tested – by exposing it to other learned experts to extend, reproduce or challenge.*
- (vi) *There are numerous ways of measuring research outputs and research quality. Some of these are used to rank universities. However, understanding numerical rankings requires significant expertise in its own right.*
- (vii) *Students should benefit from university research through exposure to leading edge knowledge and through participation in research projects in their senior undergraduate years of study.*