

2 UNDERSTANDING THE FUNDAMENTAL OUTCOMES OF RESEARCH SUPERVISION

2.1 Overview

The purpose of this chapter is to provide an insight into what the supervisor and the research student might seek to achieve as outcomes during the course of a postgraduate research program. This chapter therefore provides an overview of a broad range of issues, many of which will also be covered again, in more detail or from a different perspective, in subsequent chapters.

Those tasked with the supervision of a postgraduate research student will generally have already completed their own graduate research program and will be acutely aware of the basic requirements – that is,

- The completion of a systematically conducted program of research investigation
- Contributions to the relevant field of knowledge.

However, these are only part of what needs to be achieved in order for the research candidature to be deemed successful, in the context of adding real value to the individuals involved. The others are intrinsic to the conduct of the research itself and to the development of the postgraduate student as a high caliber professional.

Table 2.1 provides a summary of the areas that will be covered in this chapter.

<i>Outcome</i>	<i>Student</i>	<i>Supervisor</i>
Development of fundamental research skills (literature review, experimental design, presentation and defense of hypotheses, etc.)	✓	
Execution of a structured program of research	✓	
A contribution to (extension of) knowledge in a particular field	✓	✓
Development of rigorous documentation techniques and disciplined writing style	✓	
Development of oral/visual research presentation skills	✓	
Peer evaluation/acceptance of research	✓	✓
Published research findings	✓	✓
An understanding of the broader perspective of the research and research methods – and where these potentially fit into a graduate's ongoing career expectations	✓	✓
Establishment of a high caliber research team in which the research student is an active and valued member		✓
Creation and maintenance of a dynamic research and learning environment which actively encourages the exchange of ideas and opinions		✓
Establishment of a research team in which peer review of each member's work is an intrinsic part of the research effort.		✓
A dissertation/thesis for examination and defense	✓	
A professional career foundation	✓	
Underpinning research outcomes for future research grants		✓
Research outputs that feed into university research performance metrics (publications, citations, Doctoral completions)		✓
Establishment of a long-term professional relationship between the graduated student and the supervisor	✓	✓

Table 2.1 – Outcomes for Research Students and Supervisors

Two elements that aren't covered in Table 2.1, but which form critical learning outcomes from the postgraduate research learning process, are:

- A recognition that an important part of any research process,

which seeks to extend knowledge, often involves the making of mistakes – getting things wrong – recognizing the errors, and moving forward from that point

- Differentiating between what it is actually known; what is factual, and what is mere opinion or conjecture.

These may seem rudimentary to an experienced researcher but not so to recent graduates who have spent almost two decades of rote-learning during their school and university education.

Specifically, research students tend to come into the research environment from a paradigm where *correct answers* are rewarded and *incorrect answers* are penalized. They also come from a learning environment where an admission of *not knowing* is often a taboo. In some undergraduate learning environments, there is a failure to teach students that published literature is not infallible – that there can be errors or omissions, or biases – and often published material can be superseded – or rendered invalid – by changing knowledge. In the context of international students, it is also important to be aware that in some cultures, challenging or even questioning orthodoxies is discouraged in the undergraduate environment.

Postgraduate research students therefore need to come to terms with the idea that errors and mistakes are potentially a positive because they are a basic learning tool in research. An admission of *not knowing* is a hallmark of honesty rather than learning deficiency. To quote from George Washington,

"...I trust the experience of error will enable us to act better in future."

This recognition needs to apply equally to a postgraduate research supervisor. Each supervisor eventually recognizes that, in practice, the supervisory process rarely turns out to be a simple, linear sequence of steps from student induction to graduation ceremony. Specifically,

- Mistakes will be made
- Setbacks are altogether common
- Disputes will occur
- Resources will fall short of expectations
- Some students will drop out of their research programs and blame their supervisor
- Some students will lodge formal complaints against their supervisors for one reason or another
- Some students will fail during the examination/defense portion of the postgraduate research assessment.

These negative aspects therefore also need to be considered as possible

outcomes of the research supervision process. Whether any or all of these occur during the very first supervision is partly a question of serendipity, and partly a question of how much effort and consideration a supervisor puts into a research program.

Many novice supervisors commence their first supervision with high hopes and expectations, and considerable enthusiasm. It is not until the end of the research program is in sight that they recognize the scale of their responsibility – they are ultimately responsible for the future of a human being and for the consequences, if that human being fails to achieve his/her research and career objectives. Better then to consider what is required at the outset, than to be responsible for negative outcomes that could cause considerable personal, emotional and professional damage to a postgraduate research student's life at the end of the process.

2.2 Development of Fundamental Research Skills

The driving forces behind postgraduate research supervision are important to understand. For some research supervisors, the specific research project and its completion are the only objectives of the postgraduate study program. For others, who may hold a higher sense of purpose for their research students, there is a more mature recognition that the research project is predominantly a vehicle that is used in order to enable the research student to develop specific professional research skills.

At the highest levels of postgraduate research – the Doctorate – the program is fundamentally a vehicle to learn the skills of independence, no matter the subject, the starting point or the goal. If a program is structured correctly, a postgraduate should ultimately be able to:

- Locate, read and review pertinent literature
- Establish a program of investigation
- Document progress
- Meet research targets or milestones.

That one has a background in, say, chemistry should not preclude those skills being applied to any other field, even a non-scientific one. It is independence, structured analysis and execution that sets a high level postgraduate research degree apart from any other qualification

Table 2.2 shows the sorts of skills that supervisors need to work towards developing in their research students. There is a hierarchy – commencing with the most basic ones, pertaining to the conduct of a professional program of research investigation. At the next level, supervisors need to consider the development of their research students into mature research professionals – ones who are prepared to act in a completely impartial and ethical manner. Finally, there is a need to instill a level of personal, professional integrity and maturity within a research student, if it does not already exist at the commencement of the program. Perhaps the most important among these traits is a willingness, on the part of the graduating student, to take on the important and lifelong role of being a gatekeeper of knowledge – that is, a person who values the sanctity of knowledge above personal self-interest.

Not all research students will be capable of achieving all these lofty ideals but they should serve as a benchmark for supervisors to work towards.

<i>Level</i>	<i>Description</i>	<i>Outcomes</i>
1	<i>Basic Skills</i>	<p>An ability to conduct a comprehensive literature review.</p> <p>Based upon the outcomes of the literature review, and identified knowledge gaps therein, an ability to systematically develop a hypothesis which needs to be investigated rigorously.</p> <p>An ability to systematically investigate and consider the ethical implications of investigating the hypothesis – particularly where a hypothesis may pertain to humans or animals.</p> <p>An ability to develop/formulate a methodology that can be used to explore a hypothesis, within the ethics guidelines of the university environment.</p> <p>An ability to develop instruments (experiments, models, surveys) that can provide factual evidence to support or contradict the hypothesis.</p> <p>An ability to systematically aggregate and analyze data in order to determine the efficacy of the hypothesis.</p> <p>An ability to draw specific conclusions based upon the factual information derived from the methodology.</p>
2	<i>Professional Research Skills</i>	<p>A capacity to assess the health and safety implications of a research methodology and experimentation program.</p> <p>An ability to conduct one's research to an <i>open hypothesis</i> that does not predispose the research methodology and results to a particular outcome.</p> <p>An ability to act, at all times, as an impartial observer that presents a balanced view of the work of others as well as his/her own work.</p> <p>An ability to understand the broader implications and value of the contributions and value of one's research – within the research field and within the commercial/societal context.</p> <p>An ability to understand the context and relative contributions of one's own work in the broader field of endeavor – for example, is the postgraduate research an insignificant input in the context of an area that has already had several thousand person-years of effort already expended within it?</p>
3	<i>Personal Professional Integrity</i>	<p>An ability for critical self evaluation – the willingness to openly present and compare the worst possible interpretation of one's own work against the best possible interpretation of others' work.</p> <p>A capacity for humility/modesty in relation to one's own research – an ability to avoid overstatement and to allow the facts to speak for themselves.</p> <p>An ability to function in a team environment where individual strengths, differences and weaknesses are used to create a whole which is greater than the sum of its parts.</p> <p>An ability to put to one side one's own personal and career objectives in the search for knowledge – more specifically, a preparedness to put one's career on the line when the ethics of research or integrity of knowledge are threatened.</p>

Table 2.2 – Research Student Skills Development Outcomes

2.3 Execution of a Structured Program of Research

The more that one supervises postgraduate research projects, the more that one recognizes the similarities between them – particularly in terms of structure. Universities each have their own specific requirements for postgraduate research degree programs and assessments, but the fundamental elements tend to transcend institutions and fields of research. Table 2.3 shows the common elements that need to be achieved within a structured program of research.

Most of the elements in the table will already be known to those entrusted with the task of research supervision but it is necessary to highlight the importance of a few points therein.

Firstly, research students need to learn and understand that a systematic program of investigation is not based upon a *thought bubble* of what a student thinks might be a good idea in order to create new knowledge. The structured investigation needs to fit into a sequence of peer research that may have been under way for years, decades or centuries – and it needs to mesh with the views of learned peers in respect of where knowledge gaps exist.

Many research students, in their youthful enthusiasm, long to be paradigm-shifters, but the reality of postgraduate research is that they need to start their work as *incrementalists*, seeking to logically extend knowledge in gaps identified by other learned scholars. For this reason the literature review is the critical foundation for the research.

Secondly, students need to come to terms with the concept of the *null hypothesis*, and how this should fit in with their research objectives. In the narrow statistical sense, the Merriam Webster Dictionary (*Merriam-webster.com, 2015*) defines a null hypothesis as follows:

"...a statistical hypothesis to be tested and accepted or rejected in favor of an alternative; specifically : the hypothesis that an observed difference (as between the means of two samples) is due to chance alone and not due to a systematic cause."

In other words, statistically, the null hypothesis of a postgraduate research program is that two sets of data are basically the same and that differences do not have an identifiable, underlying cause. In a broader sense, the null hypothesis in research is that whatever a research student seeks to exert in his/her research has no effect on the entity being tested.

The research student's role is therefore to *disprove the null hypothesis*, and thereby establish that his/her contributions have a genuine impact on the entity being examined.

In the context of the null hypothesis, it needs to be noted that the formulation of an *open research hypothesis* is also particularly important to the conduct of a systematic and impartial investigation. An *open hypothesis* is one which does not predispose the research to a particular outcome but merely seeks to determine, in an impartial way, whether or not a particular phenomenon occurs. For example, an *open hypothesis* might be as follows:

"The objective of this research was to determine whether or not an increase in the administration of Xylatrin would alter the incidence of strokes in patients already using hypertensive medication."

A *closed hypothesis* might be as follows:

"The objective of this research was to demonstrate that an increase in the administration of Xylatrin would decrease the incidence of strokes in patients already using hypertensive medication."

Note that in the *open hypothesis*, the research produces a useful outcome, regardless of the experimental results. In the *closed hypothesis*, the research seemingly fails if it does not demonstrate a predefined outcome. In other words, it tends to skew the thinking of the researcher – and it dissuades that researcher from being an impartial observer in the research program. This is a fundamental flaw that needs to be picked up by the supervisor at the outset of the research, in order to ensure the integrity of the program of investigation.

The other point that needs to be made about the steps in Table 2.3 relates to local peer review. The most important review that a research student will receive for his/her research needs to come from those in the vicinity – in the research group, center, institute, laboratory, department or faculty where the research is conducted. The local peer review enables people directly in the environment to screen the work for its validity and integrity. Local peer review is not an adjunct to research, it is an integral part of the systematic investigation. Postgraduate research students need to present their work and findings to other research students and academics within the closest proximity to where the work was undertaken. If there are issues, then they can be best picked up by those familiar with the student; the facilities, equipment and instrumentation.

The next level of peer review – an independent level – should take place either through publication/conference presentation or by judiciously sending the work to peers/colleagues for assessment – and validation or repudiation. This provides an important step in the systematic investigation. Again, it is not an adjunct to the investigation, it is an intrinsic part of that investigation. The two levels of peer review should be considered as parts of the experimental process within the methodology.

Another key point to note in the context of a systematic investigation relates to the preparation of a thesis. This is often left by research students to the end of the research program – when it should be an ongoing part of the research documentation process, commencing at the beginning of the program. A thesis has a relatively rigid structure, regardless of:

- The field of research
- The methodology
- The experimental results derived from that research.

If the thesis is tackled as an ongoing part of the research program, then it can also serve as a systematic basis for the conduct of that research. For example, a thesis chapter on experimental design should be completed before a program of experimentation takes place – rather than as an afterthought to a collection of randomly conducted experiments. All too often, research students execute a research methodology without a rigorous template and, only during the late documentation of the thesis, discover that key elements were neglected or incorrectly performed.

Finally, research students need to discuss the context of their work in the broader field with their supervisor – in order to understand how one research project fits into a much broader field, and how significant the findings are within that field.

Step	Function	Description
1	Literature Review	The literature review provides background historical and current information on the field of interest. It identifies seminal findings and events; key researchers in the field; gaps in knowledge, controversies and disputes in knowledge and approaches, and potential future research directions. In structured research programs, a research student needs to demonstrate that his/her research hypothesis and directions from research arise from systematic reviews of the work of learned peers in the field, rather than as random ideas.
2	Formulation of Hypothesis	The research hypothesis is derived from a formal understanding of the gaps in knowledge which have been identified as a consequence of the literature review. The key objective is to ensure that the hypothesis is <i>open</i> and does not predispose/skew the research to a particular outcome.
3	Development of a Methodology	The methodology is the sequence of steps taken in order to substantiate the reasons for putting forward the hypothesis and then testing that hypothesis in a systematic and impartial manner, without necessarily having cognizance of the end result.
4	Design of Instruments/ Experiments to Evaluate Hypothesis	A series of instruments/experiments needs to be developed systematically in order to formally determine the validity of the hypothesis. Typically, these instruments/experiments would need to conform with normally accepted practice in the particular field – and the basis for them may need to be substantiated through the citation of independent, published scholarly work.
5	Analysis of Results/Findings	A systematic and fair (impartial) analysis of the findings needs to be presented to address the hypothesis.
6	Local Peer Review of Results/Findings	Research findings/results need to be presented for peer evaluation at a local level, within the center, institute, department or faculty to validate or repudiate the outcomes.
7	External Peer Review / Publication	Once a local peer review is completed, the research findings need to be presented to a larger audience – either through publication in scholarly, reviewed journals or conferences, in order to achieve independent validation/repudiation of outcomes.
8	Evaluation of Strengths / Limitations of Research and Results/Findings	The research student's project is generally only one small element in a chain of research in a given field. The research student needs to critically self-evaluate his/her research and identify shortcomings, weaknesses, etc. as well as strengths. The significance of the research student's contribution within the much larger chain of research in the field also needs to be determined.
9	Documentation of Research Program and Findings	The research work needs to be presented within a detailed document – dissertation/thesis – for assessment and defense as well as for the purposes of creating a historical record of the research and findings.

Table 2.3 – Basic Steps in Structured Postgraduate Research

2.4 A Contribution to (Extension of) Knowledge in a Particular Field

Universities each have their own guidelines about the nature of the knowledge contributions that need to arise from postgraduate research programs. In addition to these, there are conventions within individual fields of study, and centers, institutes, departments and faculties may also provide more specific criteria.

From the supervisor's perspective, what constitutes a sufficiently large contribution to knowledge, to be accepted by external peers conducting an assessment, is subjective. It is further complicated by the nature of the research itself. If the research is very narrow in its scope, and a clearly identifiable gap in knowledge is filled – to sufficient depth – then that may satisfy requirements. If the research is multidisciplinary in nature, then clearly one cannot expect a research candidate to achieve the same depth of contribution in multiple fields – perhaps a broader definition is required.

Consider the diagram in Figure 2.1 – known as *Pasteur's Quadrant Diagram for Research* (Stokes, 1997). This diagram quantizes research into various areas, based upon its applicability and its intrinsic knowledge content.

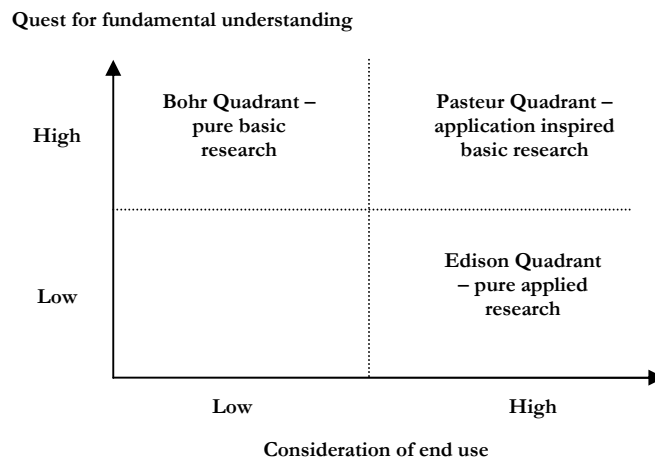


Figure 2.1 – *Pasteur's Quadrant Diagram for Research* (Stokes, 1997)

In determining what constitutes a reasonable contribution of knowledge from the research student, the supervisor needs to determine the region in which the student is conducting research. A student working in the *Bohr Quadrant*, say in a physics department, may need to close an identified gap in knowledge with a narrowband study, conducted to a high level of depth. A student working in the *Edison Quadrant*, say in an engineering department, may be seeking to take a range of existing knowledge components and apply them to a gap that exists in some application. The key points here are that

- The supervisor needs to understand the nature of the research outcomes and contributions
- The supervisor needs to ensure that the research student understands the nature of the outcomes and contributions
- The research student needs to be able to articulate, in his/her thesis and defense, the nature of the contributions to peer reviewers.

Unless all these three criteria are fulfilled, then it is entirely plausible that those examining the research work will be out of synchrony with the research student and the project – and this could have serious consequences. If, for example, a research program is conducted in the *Edison Quadrant*, and examiners are expecting a high level of investigative depth in one narrow field, then they may undervalue the contributions of the student.

Deciding where the specific contributions of a postgraduate research program fit may be too onerous a task for the research student to undertake in isolation – particularly in the early phases of the research program. The supervisor's judgment, mentoring and negotiation with the student will be important in ensuring that there is some insight as to what will ultimately be required. In reaching this point, it may also be necessary for the supervisor to review his/her own assessment of the situation after taking advisement from others – particularly colleagues or peers in the field.

The starting point for these discussions between the supervisor and the student clearly needs to be the student's literature review, and the supporting case that he/she can make as to the need for the research, and the void that it fills – as determined by other scholars in the field. The next stage is getting a meaningful perspective, from published literature, as to what potential assessors may see as a sensible outcome.

The important issue here is that the research student and the supervisor need to acquire an intimate knowledge of the research examiners – not necessarily by name, but by nature and predisposition. And, while the

research may be intrinsically significant in its own right, the reality of postgraduate study is that, ultimately, decisions of its worth and significance are made by an independent, external target audience. It is the supervisor's role to understand that target audience and to assist the research student in coming to terms with it.

2.5 Development of Rigorous Documentation Techniques and Disciplined Writing Style

2.5.1 Introduction

A postgraduate research student, having completed primary and secondary education – as well as at least one tertiary qualification – should be expected to have a reasonable ability to write and document a series of professional events and outcomes. However, the practical reality for many research students is that this is not the case.

If a research student is able to achieve great things in research but is unable to communicate them to peers in a systematic and compelling form, then what outcome has really been achieved by the postgraduate research study? Research writing is an integral part of the research process.

Importantly, research writing is something which needs to take place on an ongoing basis – a research student needs to document/record work accurately, on a day-to-day basis. This means not only keeping a good laboratory or note book but ensuring that meetings are documented, and the consensus agreed upon, to track progress. Documentation, and the organization of documents, becomes ever more critical the more busy the student's program becomes. So, instilling a *document/record everything* culture goes some way to creating a disciplined writing style. The thesis, progress reports and journal articles then become a logical extension of an everyday process.

There is a strong case to be made that it is the supervisor's responsibility to ensure that a research student develops this skill as a specific outcome of the research training program.

It is important to note at this point that one is not talking about having a research student developing a skill as a novelist. The writing outcome may be rather pedestrian in a literary sense. However, one needs to develop in the research student an accurate, logical flow of information. Prose, narrative and plot may have a role in some fields, but these are generally extras. A well-written research document may be dry but not tedious, because it should flow naturally. And, by flow, one also necessarily includes the information which needs to transfer from one brain to another – specifically, that of the reader.

Research supervisors often feel that it is not their role to teach students the art of research documentation and disciplined writing – some feel that it is beneath their dignity. However, the impartation of documentation

techniques to the student is not an option. A supervisor cannot supervise practically unless he/she receives from the student properly written documents. Verbal reports do not pass muster because, ultimately, research knowledge needs to be transferred in written form. The research supervisor is the student's first reader/consumer of record. If the person closest to the student's research cannot read/understand his/her reports then what hope has anyone farther afield? In a practical sense, therefore, it is non-negotiable that the supervisor *owns* this problem and the responsibilities that go with it.

Universities generally have supporting departments which are able to assist students with preparation of theses and research papers – but these tend to be generalist departments, with no field-specific knowledge of the requirements of a particular area of research. The harsh realities of modern research supervision, and the nature of research students – particularly in an international learning environment – is that the research supervisor needs to take overarching responsibility for student research documentation skills.

There are three aspects to writing for (and communicating) research. These are:

- A clear, succinct understanding of what the research is about – establishing a central research theme
- An ability to present a rigorously accurate and compelling depiction of reality in the context of the conducted research program
- An ability to write and structure documents in a concise and systematic form.

The starting point for all communication is that the research student needs to understand what it is that he/she is endeavoring to communicate. This may appear to be self-evident, but the lack of a clear understanding of the research project and its implications is a major underlying cause of communications problems, particularly in research dissertations.

It is particularly important that a research student is able to create historical documents (research papers and dissertation) that are based upon facts/evidence, or the carefully weighed opinions of learned scholars. Research documents also need to provide appropriate attribution/citation of the work of others, adopting whatever referencing scheme is accepted in the field of research. When there are a range of conflicting views in the field of discourse, the research student needs to be able to present these in a balanced and impartial manner.

In the context of the research activity itself, the research student needs to be able to present:

- A hypothesis
- Supporting and contradictory arguments
- Formal evidence/results
- Critical self-evaluation of the research.

Overstatement of the significance of the research and/or outcomes needs to be avoided and, in order to present an accurate picture of reality. In particular, the value of the research needs to be placed into the context of the contributions of others.

All these things should already be familiar to an academic charged with research supervision but rarely are they apparent to a novice research student, who may be eager to please or eager to succeed – and thereby tempted to bypass/ignore a few facts, datasets and contrary learned views along the way.

The final aspect of developing a disciplined writing style pertains to the mechanics/semantics of the language being adopted. This presents considerable challenges for supervisors, particularly when students are not writing in their native language.

Herein, we examine some of the issues that need to be addressed in order to achieve the sorts of outcomes expected from postgraduate scholars.

2.5.2 Starting with Basic Research Objectives – A Central Research Theme

The starting point for research communication is that the author needs to have a clear understanding of the subject that is to be communicated. The unfortunate reality is that research students often do not understand what it is that they are attempting to communicate. This lack of understanding, combined with poor writing ability and complex technical material, can lead to disastrous results in a lengthy dissertation.

Research students can sometimes naively feel that if they express their research in simple terms, they are undermining its value. In fact, the opposite is generally the case, because the purpose of written communication is to build a bridge between the author and the reader. A complex starting point makes it difficult to build that bridge. Consider the Venn Diagram in Figure 2.2.

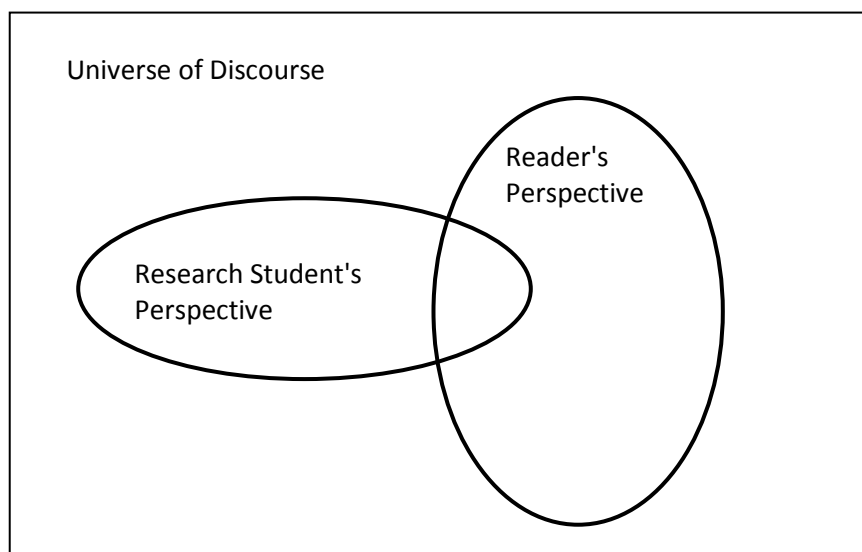


Figure 2.2 – Understanding the Basic Problem of Research Writing

The research student author and a reader may have a significant amount in common in terms of the field of research. However, they are also two different people, each of whom has developed his/her perspectives of the world independently. In writing documents, research students need to understand that it is their responsibility to begin the communication

process with a common area of understanding, in order to transfer knowledge to the reader. The common area of understanding is simple speech – free of technicalities and research jargon.

The challenge then is for the research student to be able to understand his/her area of research to the extent where it can be expressed succinctly, in terms that even a lay-person should be able to understand.

The problem with this exercise is well known. In the 17th Century, Blaise Pascal wrote (*Quoteinvestigator.com, 2012*),

"I have made this longer than usual because I have not had time to make it shorter."

The implications of the quote, claimed by numerous authors (including Mark Twain) since that time, are abundantly clear – that is, it takes time to create clear, concise communications. The problem is that research students can get themselves so busy *doing* that they don't take the important time required to *understand* and to *communicate*.

In order to achieve good communications skills outcomes, a supervisor should work with his/her research student until such time that the student can enunciate the objectives of his/her research in a few simple sentences. Until Pascal's writing objective is met, students have little chance of being able to communicate their research effectively – in oral, visual or written form.

It may be that a good approach to developing a compelling central research theme is to initially have the research student treat the exercise as an oral or visual task rather than a written one. How would the student communicate his/her work to an audience who are outsiders to the field? What would the opening slide of a short, succinct presentation look like?

A good analogy to the central research theme is what, in business circles, is referred to as an *elevator pitch*, wherein a person is required to sell an idea or product in the context of a short elevator ride with a potential buyer or financier. What is the most compelling description that can be made during the elevator ride? In postgraduate terms, this should be the central research theme.

A serious mistake that research students can make in their dissertations is in attempting to create long, complex documents based upon convoluted (i.e., poorly understood) research objectives. A long, complex document needs to be based upon a well-understood, well-articulated, central theme – otherwise the result can become incoherent for the reader.

Moreover, without a central underlying theme, it is difficult for a research student to identify what should be included in a complex

document and what should be omitted. The end results can then be disappointing. For example, research dissertations can end up being submitted with irrelevant material included, and vital information excluded.

A research supervisor's objective early in the research program is therefore to work with the student to:

- Develop the central research theme
- Ensure that the student understands and accepts the central research theme – that is, genuinely believes in it
- Encourage the student to keep a printed declaration of the central research theme on display wherever he/she works.

This should prevent students from losing track of what they are supposed to be doing, and what they will need to communicate to others.

In the context of developing a central research theme, consider Examples 2.1 and 2.2.

Example 2.1 – Pretentious, Technocratic Summation of Research Objectives:

"The investigation of heterarchical, societal control structures (HSCSs) has been widely documented in a number of colloquial, quasi-complementary tomes in the sphere of sociology which draw succinct but peripheral analogies from the intrinsic behavioral patterns..."

Example 2.2 – Thoughtfully Considered Summation of Research Objectives:

"The objective of this research was to answer a single question. That is, what are the factors that influence the controlling structures in a society?"

The writing in Example 2.1 almost immediately alienates the reader, who is left with the task of decoding technical expressions and acronyms in order to get a glimpse into the world of the research student. The writing in Example 2.2 invites the reader into the researcher's world, with simple grammatical expression that naturally covers a common understanding between the writer and reader.

Importantly, the central research theme becomes the reference point for all the research student's subsequent activities. Specifically:

- Reviewed literature
- Experiments/surveys/tests
- Results and analysis

all need to be checked against the simple theme for relevance.

The central theme also sets the agenda for the research documentation process, including published papers and the final dissertation/thesis. Every sentence that goes into a research paper or dissertation is assessed against the central theme – if the sentence relates directly or indirectly to the theme then it is included – if it does not relate to the theme, then it may need to be excluded.

Research students can, and will, argue that it is not possible to express the objectives of their research in simple, clear speech – especially in complex areas of science or engineering. This is when supervisors need to step in and work with their students to ensure that they understand the broader, basic objectives of the research, devoid of specific technicalities and jargon.

The development of the central research theme is arguably the first and most fundamental outcome of any postgraduate research program – because all the other outcomes pivot around it. It maintains focus and clarity of purpose, and it prevents unnecessary mission creep in research objectives.

The central research theme will be examined further in the context of the preparation of a postgraduate thesis, in Section 12.5.

2.5.3 Developing Writing Discipline Early in the Research Program

It is important that the basic discipline of research writing is established early in a postgraduate research program in order to be effective, and to avoid a compounding of problems later. Documentation also needs to become an everyday activity for research students as a matter of systematic recording of events – it should not become an adjunct or an afterthought to the process which is only given consideration when a research paper or thesis needs to be written.

A logical starting point is for the supervisor to formally assess the student's initial capabilities in writing, as well as to introduce and instill the discipline of the writing style specific to the research field.

A particularly useful task to achieve these ends is to have the postgraduate researcher formally document his/her thesis introductory

chapter or initial literature review, for assessment by the supervisor.

The emphasis here is in having the student present a complete and professional piece of work – not a *draft*, which can be a euphemism for unfinished/unprofessional work.

Supervisors need to develop the mental toughness to reject draft documents as a satisfactory initial outcome – simply because these tend to become the path of least resistance for both the research student and the supervisor. It is at this early, critical point in the research program that supervisors need to step up – with maximum effort – to ensure that a student's writing style becomes professional in a research context. This will provide major, ongoing benefits for both the supervisor and the research student throughout the course of the program – and ultimately time savings.

Disciplined writing is not only a basic requirement for research in its own right, but it also trains a research student to collect and structure his/her thoughts systematically for the purposes of research conduct.

Once a research student is ready to submit an initial document, and before the supervisor accepts it, a worthwhile exercise is to have the student go through and *pre-screen* his/her own initial submission – by parsing the work, sentence by sentence. A supervisor, based on his/her own experience in the specific field of interest, should be able to prepare a checklist for the student to use in parsing this submission. An example of a six-point checklist is shown in Table 2.4. This should serve to illustrate to the student that:

- Each and every sentence in disciplined research documentation needs to be watertight in its own right – that is, factually correct and independently verifiable
- Research is about evidence, facts and data, and not about personal opinions.

Check	Assessment Criterion	Action
1	Is the sentence based upon the student's personal opinions?	Delete the sentence
2	Is the sentence factual – as supported by independently verifiable data or facts?	Delete if not factual – otherwise present/refer to verifiable data/facts
3	Is the sentence based on the opinions of other published scholars in the field?	Ok – include – but also include dissenting views for balance
4	If the sentence contains the opinions of other published scholars, and there are contradictory, published opinions elsewhere, does the sentence juxtapose/balance both arguments?	Ensure that varying scholarly opinions are balanced and fairly represented
5	Is there any unsubstantiated numerical phrasing/wording in the sentence? For example, does the sentence use expressions such as "most", "none", "all", "always" or "the majority" without being able to factually justify the numerical implications?	In the absence of other factual substantiation, replace numerical expressions with non-numerical equivalents (e.g., "many", "few")
6	Does the sentence contain <i>lazy phrasing</i> ? For example, "...people have often stated that..."	Name the people or quote supporting data

Table 2.4 – An Example of a Sentence by Sentence Parsing Tool to Check Writing Discipline

Other specific elements to research writing that need to manifest themselves early in the research program include:

- Citation styles and consistency
- An ability to present arguments in a cogent, systematic sequence
- An ability to formulate forward research directions based upon a review of others' work, and based upon knowledge gaps identified by peers in the field.
- An ability to draw balanced and fair conclusions from the work of others.

A very common – but altogether naive and costly – mistake that a novice supervisor can make is to assume that a research student's writing style will fix itself through natural osmosis, and therefore improve along the

way. Generally, it will not. Somebody has to do the hard work of ensuring that learning the art of research writing starts as soon as the research program does – and that somebody needs to be the research supervisor. Unchecked problems early in the program will exacerbate as the research student moves forward with the investigative process, and the remedial task will become more complex and multi-dimensional.

It is important here to reiterate that instilling writing discipline is a critical and integral part of the research learning process. For this reason, when research supervisors sub-contract this important teaching role to others, they are potentially undermining the value of disciplined research writing in their own field.

A research student also needs to understand that the discipline of research writing isn't merely about creating neat research documents. It is about developing the underlying, rigorous, systematic thought processes that bring about that disciplined writing. This is something which can only be taught effectively by the supervisor in the context of the specific field of research and the writing conventions therein.

2.5.4 The Issue of Grammar and Writing Competence

An important aspect of developing a disciplined research writing style pertains to the intricacies of language and grammar. The world's *Top 10* universities, as classified by the Academic Ranking of World Universities (*Shanghairanking.com, 2015a*), are all English speaking and so is their published research. It is therefore difficult to get around the fact that, for most research students – regardless of their originating countries – English will be the required language for their dissertation and research publications.

This clearly presents a problem for those who have English as a second language and, in most English-speaking universities, there is a significant number of research students for whom this is an issue.

There are two internationally accepted English language testing regimes that are in common use in universities around the world. These are:

- TOEFL (Test of English as a Foreign Language)
- IELTS (International English Language Testing System).

The TOEFL system has a range of individual scores (from 0-30) for reading, listening, speaking and writing (*Ets.org, 2015*). The IELTS has a range of overall performance bands that cover reading, listening, speaking and writing (*Ielts.org, 2015*). The IELTS bands range from 0 to 9, with a Band 9 performance indicating complete proficiency with the language, and a Band 1 performance indicating no real ability to use English as a language.

Universities tend to use TOEFL and IELTS scores to determine entry prerequisites for students wishing to undertake postgraduate research programs. In some cases, supervisors will never encounter those who do not achieve appropriate proficiency ratings because they will have been screened out by university administration during the postgraduate application process. However, supervisors will eventually need to come to terms with how well these two scoring systems reflect the requirements for postgraduate research students in their field. And this will generally only come about after extensive personal experience with students who have achieved varying levels of proficiency.

It is not uncommon for students to perform reasonably well in either TOEFL or IELTS and still have considerable difficulties with developing a research writing style. After all, students with English as a second language have the dual tasks of coming to terms with the complexities, nuances and inconsistencies of the English language, as well as the complexities of a disciplined research writing style.

At some point, regardless of the TOEFL/IELTS scores that a research student has achieved prior to admission to a postgraduate research program, the supervisor will need to determine whether or not the student is capable of independently generating a complex research document in the form of a research paper or dissertation. In some cases, the answer will be no – and this causes considerable dilemmas for the student, the supervisor and the university.

The basic notion of a postgraduate dissertation is that what is presented to examiners for assessment is the actual work of the student. But what exactly is being assessed? Consider the following issues as examples:

- Are students in physics, chemistry or mathematics to be deemed incapable of high level research in their field because their English grammar and phrasing are poor?
- Do students conducting research into mathematics need to have the same level of English proficiency as those undertaking research into English literature?
- What happens if an engineering student is capable of writing concise, systematic arguments in a well structured sequence –

only to be let down by shortcomings in phrasing or the nuances of language?

There are two opposing schools of thought on these sorts of issues. Many universities believe there is a case for providing editing support to research students who have English as a second language, because they are ultimately being assessed in terms of their competence in their field of research, and not on their English grammar skills. There is also a case to be made for not providing any editorial support for research students, on the grounds that examiners should be reading a document prepared entirely by the student – with all its intrinsic grammatical errors and inconsistencies – rather than one which has had expert editing elsewhere – and which does not reflect the writing capabilities of the research student.

There is a possible middle ground on this issue. And that is an acceptance that, for those students who are undertaking research into areas where language and grammar are not the pivotal/central parts of the assessment, writing support should be provided to create a professional dissertation. This provides a well written historical document for future research reference. The assumption of the examiners is then that the quality of the writing is ignored in the assessment, on the grounds that it may or may not be the work of the research student. The downside of this approach is that future employers may assume that the graduating student has writing skills commensurate with the dissertation – and to this extent the thesis may prove to be an inaccurate reflection of reality.

Notwithstanding the problems that may arise in future careers, one also has to consider that technology has largely overtaken the argument about the originality of grammar and phrasing. After all, it is possible to use common word processing features to correct or improve spelling and grammar – and isn't this the same as the university providing professional human support for the exercise?

Accepting that a significant proportion of research students will require (and get) language support for the preparation of their dissertation and research papers, the issue that needs to be resolved is who will provide this?

Research supervisors generally don't see it as their role to do editorial work for their research students, but there are efficiencies to making such an effort. Firstly, the generalist editorial support service provided by universities can sometimes create as many problems as it resolves. Even common words and phrases can have a different meaning when used in the context of a specific field of research. So, it is possible that generalist editorial staff can confuse commonplace words – which have been chosen to convey specific information in a research context – as being incorrect in a grammatical context. The end result can be a completely muddled

document which appears to be grammatically correct but is incorrect in the context of the research field.

Secondly, the writing style of a generalist editorial support unit can be out of touch with the style in which particular research fields are documented. This means that the supervisor has to undo work which has been already been changed by the editorial unit.

Thirdly, there is an inefficiency in having a research student submit work to an editorial support unit at the university, only to then have the supervisor make further changes, and create an iterative chain of editing bureaucracy.

If, on the other hand, a supervisor makes the effort of performing both the technical and grammatical editing of a first chapter (e.g., the literature review or thesis introduction), then the student is likely to fall in with the supervisor's preferred approach, and the subsequent editing load and editorial changes diminish significantly.

Finally, the supervisor's efforts in editing his/her research student's work have collateral benefits – specifically, the supervisor can maintain a close oversight of the student, and make ongoing assessments of capabilities, limitations and deficiencies that need to be addressed. Progress towards the end objective can be monitored closely, and the supervisor is always acutely aware of which work has emanated from the student. This isn't always possible with third-party editing.

2.6 Development of Oral/Visual Research Presentation Skills

The ability to communicate the outcomes of research in an effective and compelling manner to a live audience is an important outcome of the research training process. Oral and visual presentation skills can also be particularly useful in focusing a student's mind on clear, succinct arguments that can subsequently be used in research papers and theses.

All research students, at some point in their programs, will be required to present their work to an audience – either at in-house seminars within their own research group/department/faculty, or externally at professional conferences.

The common problems with research student presentations include the following:

- An inability to précis the research into a straightforward introduction
- An inability to construct a systematic sequence of information morsels which convey the research in a concise and intelligible manner
- Lack of perspicuity – no insight into what the audience wants to hear about the program – a disconnect between the speaker and the audience
- An eagerness to present everything the research student knows about the subject, rather than key points and findings
- A temptation to provide overly long presentations that lose the audience interest
- General oral communications problems – poor diction; soft-spoken presentation voice, mumbling, constant use of time-wasting words - "*ums and errs*"
- Poor visual presentation skills – visual slides that are too complicated and contain too much information; slide text too small for audience viewing; too many slides; transition speed between slides too fast, etc.

Some of these problems can be resolved by basic improvements in technique but many presentation problems arise because students do not have a clear picture in their own minds as to the nature of their own research or its contributions. In Section 2.5.2, the importance of the central research theme was emphasized. In oral/visual communications the central theme is also critically important.

When a research student begins his/her presentation to an audience, the

first task is to make a connection with that audience and, as in writing, this comes through the introduction of the research theme, in simple terms, intelligible to the lay-person.

From a supervisory perspective, it may be necessary to work actively with a student in developing presentations, until they become comfortable with the expectations. A good approach – particularly when supervising numerous students – may be to develop a presentation template that ensures that research students present in a concise, systematic and disciplined manner. Table 2.5 provides an example of a presentation template.

<i>Slide</i>	<i>Content</i>
1	Basic Identification – Institution, Department, Researcher Name, Title of Presentation
2	Central Theme of Research
3	Background Issues/History (Who? What? Where? When? Why?)
4	Summary of Specific Work Being Presented – Experiments, Designs, Surveys, etc.
5	Summary of Results Derived
6	Comparison/Benchmarking with Earlier Research
7	Broader Implications of Research Findings
8	Conclusions

Table 2.5 – Example Oral/Visual Presentation Template

Even within the context of a structured presentation template, research students are likely to want to present everything they have learned about a particular area, rather than key findings. A case of too much information and not enough knowledge transfer. One approach to stopping this is for the supervisor to impose strict time constraints that force students to decide what is relevant or irrelevant to their research theme.

In some countries, there are national programs which encourage postgraduate research students to compete with succinct, sharp presentations by creating a short-time-presentation environment. One such program is the *Three Minute Thesis* program (threeminutethesis.org, 2015) – which, as the name suggests, asks students to present their research theses – theme, outcomes, etc. – within a three minute timeframe. In that program,

only a single presentation slide is permitted – without animations or transitions. Points are deducted for presentations which are rushed. The objective is to create a disciplined approach to creating a compelling oral/visual presentation of research.

Another approach to developing these skills is the five/ten approach – where students present for five minutes but need to defend their work by answering questions from peers for a further ten minutes after their presentation. This Socratic approach encourages research students to think long and hard about what is presented and how well they have been able to communicate their message.

In the absence of a specific local program, there is nothing to preclude research supervisors from working together to develop their own in-house activities to build presentation discipline among research students in their own research group, center, department or faculty. Technology can also provide useful supporting devices. For example, (*DeSantis, 2012*) and (*A Blog Around The Clock, 2016*) look at the advantages and disadvantages of using networking tools, such as Twitter, to encourage students to come up with very short summaries of their work. The objective is to use writing brevity as a vehicle for focusing the thought processes behind the research – and to ensure that the research student is absolutely clear on what he/she is endeavoring to achieve.

Regardless of the training method that is adopted, the basic objective/outcome is to establish a mindset which seeks to rank presentation quality (i.e., knowledge transfer) above presentation length. In so doing, this should encourage the research student to critically evaluate his/her own research directions and findings.

2.7 Peer Evaluation/Acceptance of Research

Jonathon Swift, the author of *Gulliver's Travels*, once remarked,

“That was excellently observed”, say I, when I read a passage in an author, where his opinion agrees with mine. When we differ, there I pronounce him to be mistaken.”

And therein lie the strengths and weaknesses of peer review. They are often based upon the peculiarities and prejudices of humans. Notwithstanding their limitations, in research, peer reviews still represent the best means of assessing the validity and limitations of research. Like many other aspects of research, peer evaluation isn't an annoying adjunct to the research, it is an intrinsic part of the professional process.

Postgraduate research students are subjected to a range of different peer reviews during the course of their program. The most obvious one is that of the research supervisor, who should be providing peer review on an ongoing basis. Of course, supervisors should never be the sole peer reviewers because they advise students on research directions and can therefore never be entirely independent.

For this reason, supervisors need to encourage their research students to subject their work to as many outside peers as they can. Some of the peer review mechanisms will be formal – such as in refereed journal publications – but various informal mechanisms are also valuable.

The informal peer review mechanisms that are available to the research student are numerous and include:

- Review amongst fellow research students – group meetings are a good way of getting local peer review as well as practicing presentations in a supportive environment and without pressure from academic staff
- Consultation with other academic/research staff in the research group, center, department or faculty
- Consultation with academic/research staff in other local universities
- Electronic correspondence with academic/research staff at an international level
- Online *preprint* on recognized scholarly websites that are designed to elicit immediate feedback from peers.

The objective is to ensure that during the course of the research program, and prior to final examination/defense, the researcher learns about the:

- Range of peer perspectives on his/her research
- Strength with which various views are held, and the predominance of any particular views among peers
- Strengths, limitations and/or potential fundamental flaws in his/her research methodology.

Ideally, these views should also be ascertained prior to submission of research findings to refereed journals for formal assessment.

The outcome is not just an understanding of the level of acceptance of the research, but also a determination of the sorts of views that are held by potential future examiners. This will assist the student in formulating a Socratic defense for his/her work, with a full awareness of the arguments that need to be made in its support.

Importantly, peer review assists research students in understanding that a research dissertation is not a book, wherein an author's views can be expressed to a general audience as unsubstantiated truths. A dissertation is aimed at a very specific, targeted audience –and the research student author needs to write accordingly.

It is also common in various research fields for differing, conflicting views to be held firmly. In the context of the final assessment, whether or not the student's research ultimately represents a universal truth is then a matter for the judgment of the target audience – based upon the Socratic defense mounted by the research student.

There are other outcomes which arise from the ongoing use of peer review within the confines of the research unit in which the postgraduate student is stationed. In particular, local peer review provides the highest level of scrutiny of the research. Within the confines of a university research group, it is likely that everyone knows what everyone else is doing – so, when conflicts arise about who contributed what elements to a piece of research, they can be resolved in-house. Additionally, within the local research group, research staff and students are generally acutely aware of whether various experiments were actually conducted – and, therefore, the chances of individuals fabricating data can be minimized.

In some circumstances, informal peer review is difficult to achieve – particularly when a research student is part of a larger collaborative program, and intellectual property and confidentiality issues come to the fore. However, this is one aspect that needs to be carefully considered

when research contracts are negotiated – because removing internal peer review mechanisms is effectively removing an integral part of the research student's learning paradigm.

2.8 Published Research Findings

The publication of postgraduate research findings is one of the most obvious outcomes of the learning program, and it also constitutes an important mechanism for formal, external review of the research. Additionally, the formal publication of research work effectively stakes a claim, on the part of the research student, to a contribution of knowledge. It may also be beneficial in a career sense as an achievement in its own right.

The specific benefits include:

- A formal peer acceptance of the research student's research approach and findings
- Exposure of the research work to other scholars in the field
- A formal contribution to the research output metrics of the university and of the supervisor who may be a co-author of any published work.

There are some caveats that need to be considered when supervisors are seeking to publish work. These include:

- Is the work being published as a significant research outcome in its own right, or because of pressure from the university to publish work?
- Is the work that is being published a complete and accurate depiction of reality – or just a partial depiction of reality?

These are critically important issues. Publications need to arise for the right reasons – that is, as genuine contributions to knowledge in the field – and not as solely as a career benefit for the supervisor or student.

The second question – the complete depiction of reality – is one that every supervisor needs to address. Does the publication only represent positive outcomes of the research program, or does it reflect the negatives as well?

If the research program has been structured correctly in the first instance – with an *open hypothesis* – wherein all possible results are a useful contribution to knowledge, then the issue of a complete depiction of reality is a moot point. However, if the research program has been initiated with a *closed hypothesis* – such as,

"The objective of the work is to demonstrate the efficacy of an increased dosage of Xylamine in patients with..."

then there are serious issues that need to be addressed. Specifically, would the research still be published even if the results were negative for the closed hypothesis? If not, then why not? Ultimately, if the objective of research is to give a complete picture of reality, then both positive and negative results need to be published.

In some areas of research, particularly in medicine/pharmaceuticals, this is a serious issue, because a failure to publish negative outcomes can lead to invalid conclusions from the broader community. For example, if ten trials are conducted on the efficacy of a particular pharmaceutical, and nine negative results are not published, then publication of the tenth (positive) gives a statistically incorrect picture of the field – even though the tenth study may be statistically valid in its own right.

In recent years, there has been growing concern in the research community about the publication of predominantly positive results, without balancing publication of the negatives. In the medical research field, various groups have banded together in organizations such as AllTrials (*AllTrials, 2015*) to lobby for registration and publication of both positive and negative research findings. More broadly, in a world increasingly placing information online, the publication of an incomplete picture of research is likely to be exposed in any event, and potentially damage the reputation of the research student, the supervisor and the institution.

It is the responsibility of the supervisor to ensure that, firstly, research is conducted in a genuinely open manner – to an *open hypothesis* – that does not predispose outcomes into a particular form – or render some results worthless because they prove the hypothesis negative. Secondly, the supervisor needs to utilize his/her experience in ensuring that publications arising from the research are genuinely valid and meaningful in the broader context of the field in which they are published – and in consideration of all the available evidence.

Another important consideration in terms of publication of work is how many publications a research student should produce during the course of his/her studentship. It is imperative that this decision is driven by the academic merit of the outcomes arising from the program, rather than the supervisor's personal career imperatives. Finally, research supervisors should discourage students from *gaming* the research metrics system, by dividing what should be a single research paper into Part A, Part B, etc. in order to maximize research metrics.

2.9 An Understanding of the Broader Perspective of the Research and Research Methods

Research students generally need to conduct their research within a narrow band of interest, and to a reasonable depth. For this reason, they can end up viewing their own research through the aperture of a *straw* – with a very narrow interpretation of its significance.

The supervisor's role is to work with the student to develop a greater understanding and appreciation of the research and its outcomes. These include:

- The relative contributions of the research within the broader field, and within a historical context
- The significance of the research methodology within the current field, and potentially other fields
- The potential commercial applications of the work and its value to various products or services.

The research student needs to have a good understanding of the relative importance of his/her work. If the research student's work is a three-year study, in the context of thousands of person-years of effort in the same field, then this needs to be observed within the final dissertation, so that the importance of the outcomes is not overstated (exaggerated).

On the positive side, there may be genuinely useful outcomes arising from the research that go well beyond the results/findings themselves. In some instances, research results may lead to the development of improvements in commercial products or services, and some consideration needs to be given to the relative contribution of the research to such commercial outcomes.

2.10 Establishment of a High Caliber Research Team in Which the Research Student is an Active Member

A novice academic/researcher may commence supervisory activities with a single research student, but rarely will that student be working in complete isolation. Initially, the supervisor and the student may both be part of an existing research group, center, department, institute or faculty. As the supervisor develops and assumes an increasingly senior role, he/she may work towards having a new research group with a team of research students.

The transition from supervision of a single student to supervision of a research group may take place before the first student has even completed his/her research program. For this reason, the supervisor needs to work towards building a team – in which the research student will be an integral part. Traditionally, the entire structure of academia has centered around individualism and individual excellence. However, given that many research students will not ultimately work in an academic environment, it is hardly reasonable to limit their future professional development by creating loners who work with a silo mentality.

Academics seeking personal excellence generally find it difficult to work in a team, and because the environment tends to create competition and rivalry, it is not generally a good model of teamwork. Sometimes, the university model is better suited to the creation of mavericks than institutional builders and team players. The modern research supervisor, however, needs to work towards making the academic model more reflective of contemporary practices in the outside world. Unless he/she has had management training on team building then there is a case to be made for background reading on the subject to ensure that the research student is working in a healthy, functional and productive environment.

Ultimately, in order to be successful in knowledge advancement, a research supervisor needs to:

- Attract high caliber individuals as research students
- Retain them as postdoctoral researchers
- Ultimately, collaborate with them as academic peers.

Invariably, high-caliber individuals in any field are both mobile and desirable, so it is all the more difficult to attract and retain them if a research group is dysfunctional. A good research supervisor should work towards ensuring that his/her research group is functional and positive.

2.11 Creation and Maintenance of a Dynamic Research and Learning Environment Which Actively Encourages the Exchange of Ideas and Opinions

The creation of a functional research group, in which individual members feel comfortable, is not sufficient to attract and retain high caliber postgraduate researchers. There are a number of key factors that need to be addressed in order for a research grouping, perhaps led by the supervisor, to become a magnet for talented individuals. These include provision of:

- (i) *Quality Resources* – technical, administrative, information technology (IT) and office space. An institution that wants to attract world-class research students needs to be world-class in basic infrastructure. Not all institutions can be world class but, at a minimum, resources need to match institutional research goals
- (ii) *Quality Staff* – smart students want to mix with other smart students and smart academic staff
- (iii) *Challenging Research Programs* – high caliber research students want to work on high caliber projects that can have significant transformative outcomes at a global level
- (iv) *An Inclusive Environment* – where the research students are welcome to provide opinions and suggestions –and where their intelligence is valued in practice not just theory
- (v) *A Fun Place to Work and to Be* – intelligent people require more than just intellectual stimulation in an academic sense – they need to be able to engage their sense of humor as well
- (vi) *Connectivity* – research is global, and local opportunities in any given field are limited, so research students need to feel that their environment is a respected node in the global research effort in their field. Connectivity should also extend to relevant business and industry
- (vii) *Ongoing Research Funding* – research students need to feel that there is some potential to stay on and have a career in their research group.

A novice supervisor is unlikely to be able to address or provide all these sorts of facilities in his/her own right. However, an acute awareness of the need for them is critical to steering any existing research groupings towards these goals.

2.12 Establishment of a Research Team in Which Peer Review of Each Member's Work is an Intrinsic Part of the Research Effort

In Section 2.7, it was noted that peer review – which takes place as close as possible to the conduct of the research – is the most effective form of evaluation and feedback. Within the confines of the research group, center, department, institute or faculty, it is possible to provide close scrutiny over the research that has been performed, and to have a reasonable level of certainty that the person claiming credit for the work is the one who actually performed it.

Once research leaves the confines of the intimate research grouping – and goes to external publication – then the opportunities for effective assessment are diminished. It is not realistic to expect referees working for journals to be able to determine whether research results presented to them are genuine or have been embellished – or even completely fabricated. The principles behind publication in international journals are all based on a level of trust in the university in which the research is conducted. There is an implicit assumption that the university has integrity measures in place to ensure that what is presented for publication consideration is:

- Research which has genuinely been undertaken by the authors of the research paper
- Based on genuine evidence as described in the research paper – and not on fabricated data/information
- Original content that has not simply been reproduced from some other source without appropriate attribution.

As a starting point, within the university environment and as they pertain to postgraduate research, these checks are the responsibility of the postgraduate supervisor. Further, there is an onus on the supervisor to inculcate a culture of peer review within his/her own team as an intrinsic part of the research process. Apart from the conduct of in-house research seminars, there needs to be an understanding within the research team that hypotheses, methodologies, results and conclusions need to be evaluated by more than just those conducting the research.

Formal, bureaucratic methods often beget formal, bureaucratic responses. So, if a supervisor can achieve a culture where his/her research students willingly and enthusiastically offer up their research for ongoing assessment by their fellow research students, then a significant outcome has been achieved in the context of postgraduate research integrity.

2.13 A Dissertation/Thesis for Examination and Defense

2.13.1 Nomenclature

In this book, the terms thesis and dissertation are used interchangeably – as they are in many universities around the world. In some North American institutions, the thesis often refers to research work presented for a Master's qualification, and a dissertation refers to research work presented for a Doctoral qualification. Herein, given the lack of global uniformity in definition, there are no distinctions made in terms of nomenclature based upon postgraduate qualification levels.

2.13.2 The Supervisor's Role in Thesis Preparation

An academic charged with the responsibility of postgraduate research supervision will already be well aware of the challenges associated with the development of a thesis; its examination and defense. However, each novice research supervisor will have generally had only a singular experience with the process – that is, his/her own thesis – and so there is something to be gained by looking at the broader perspective.

The thesis is the principal tool for assessment of postgraduate research but it is also:

- A historical document, catalogued for reference by future researchers
- A handbook on how a hypothesis is explored via a particular methodology and investigative process
- A document which brings together scholarly literature from relevant fields in a comprehensive review that backgrounds the research.

A common error amongst postgraduate students is to view the thesis as an afterthought to a program of investigation, rather than a document which develops and drives the investigative process in a systematic manner. It is altogether common to find theses which have been written after the research event, and which contain too much irrelevant material and not

enough of the material that is required to substantiate the hypothesis and investigative process.

An important point which many novice researcher supervisors and research students fail to appreciate at the outset of the program is the generic structure of a thesis. In general, a sound, basic thesis structure can be independent of the field of research and independent of the hypothesis and investigative process. Consider Table 2.6 as a generic example of a thesis structure.

Regardless of the specific chapter breakdowns that are chosen, the basic attributes of the thesis, as exemplified in Table 2.6, do not change greatly, whether the research is in the field of business, economics, physics, social science, engineering or medicine.

Once a research hypothesis is identified – and expressed in the form of a central research theme – and an initial literature review conducted, then there is no reason why the bulk of a thesis cannot be written up until the point of the results and discussion sections. The key point here is that the thesis preparation process should start at the beginning of the postgraduate research program – and not at the end.

It is not uncommon to come across research students enthusiastically performing experiments and gathering data, only to find at the end of the process – when they do attempt to reverse-engineer a thesis around what they have done – that the hypothesis, methodology and results do not come together as a whole. The research supervisor's task is to avoid this scenario by having research students rigorously document their methodology and investigative process in a thesis that develops alongside – and often preceding – the experimental/investigative process. To a large extent then, the thesis is a research outcome that should emerge before much of the other work.

Chapter	Title	Content
1	Introduction	Presentation of the Who, What, When, Where and Why basics of the research program and overview of the hypothesis and approach
2	Literature Review	A review of scholarly literature that places the current research into context and highlights gaps/deficiencies identified by other scholars that the current research is intended to fulfill
3	Methodology	An explanation of how the hypothesis is to be tested and evaluated
4	Experimental/ Investigative Design	A guide which documents the systematic investigation of the hypothesis through experimentation or evaluation of other independently verifiable information
5	Results of Investigative Process	A presentation of the results of the investigative process
6	Broad Context Discussion of Results	A discussion on the broader implications of the results and a critical self-evaluation of the identified shortcomings in the current research program
7	Conclusions and Recommendations	Based upon the results, benefits and shortcomings of the current research, recommendations for future investigations.

Table 2.6 – Example of a Thesis Structure

2.14 A Professional Career Foundation

The area of investigation for a postgraduate research student tends to be very narrow in scope – often intentionally so, in the expectation that it will be explored to significant depth. However, by the same token, this means that career opportunities for those emanating from postgraduate research programs are equally limited – in the context of the research field itself.

Modern postgraduate research programs came into existence in the 19th Century, when the first research Doctorates were awarded. In the early years of postgraduate research, only a handful of elite students were chosen, from each final-year class, to move from a basic degree to an advanced research degree. This small cohort was chosen to be given an apprenticeship in research so that it could move on to fill faculty positions within the university. In the 21st Century, circumstances have changed considerably and, yet, postgraduate research programs are still largely based upon a research apprenticeship model, which focuses upon the creation of university academics and researchers.

The reality of the modern world is that the number of people emanating from universities each year, with postgraduate research qualifications, is an order of magnitude larger than the annually available number of tenured positions within the global university system. Of course there are also many non-tenured positions available within the university system, and there are also commercial and government research and development facilities where research degree qualifications can be of value. Nevertheless, the practicality that research supervisors need to face is that the bulk of their research students may not ultimately work within the university sector. Many will not even work in any field of research.

If it is to be at all meaningful in the context of a career in the modern world, the postgraduate research learning program needs to address these hard facts. To do less than this is to do a disservice to the research students.

For these reasons, the research investigation which is undertaken during postgraduate study is now seldom the underpinning element of the research student's long-term career. However, if the research training during the program has been conducted professionally then there are numerous other attributes that can service a broad range of career options. Specifically, these relate to a postgraduate researcher's ability to:

- Ascertain the current state of knowledge in a given field through systematic exploration of published scholarly work

- Design and undertake a rigorous and disciplined investigation
- Act in such a manner that personal biases and antipathies are removed, and to balance arguments from a range of different perspectives
- Work independently to perform systematic analysis of problems, information and datasets and to determine their significance
- Write in a disciplined, systematic manner, devoid of personal opinions
- Develop recommendations based upon hard evidence and without personal bias.

These should be the crux of a postgraduate research program and form the basis of a long-term career in leading-edge organizations – whether they be in the academic arena or the commercial/entrepreneurial or government sector.

In addition to these attributes, another output of a postgraduate research program is the high level of tenacity which is engendered, and which is required to persevere through a lengthy investigative process.

All these traits are generically applicable ones which are important in commercial, as well as academic and government research and development.

The research supervisor can, however, also improve upon these basic attributes by ensuring that the research student has sufficient supplemental training (either formal or informal) in areas such as:

- Entrepreneurship
- Venture capital
- Product/service commercialization
- Team building
- Financial management.

In some universities there are specific programs which encourage and support research students to use their research work as the basis for start-up companies or as tools for other commercial ventures.

At the core of it all, the supervisor has an important role to ensure that the research student is fully aware of all the skills and attributes that he/she has acquired during the course of the research program, and how these can best be put to use in a range of possible career/business choices.

A career foundation cannot, however, be built within a few weeks after a research dissertation is submitted for examination. The process needs to

start early in the research program. The supervisor needs to determine:

- What future aspirations the research student has
- Whether the student's personal attributes (i.e., strengths and limitations) are applicable to the desired career/business choices
- How adjustments/supplements to the basic research program can be used to help achieve these ends and to help address any underlying limitations.

Importantly, the research student needs to be given an honest and practical assessment of how feasible his/her career aspirations are, particularly if they are in the university sector. It is not uncommon for supervisors to exaggerate the prospects of a long-term career in academia, when, statistically, the chances of these being fulfilled are limited. Importantly, if academic prospects in a particular research field are limited, then one of the student's background tasks during the research program will be to determine ways and means of establishing a career outside academia – perhaps in commercial research; more generalized professional practice, or management.

Some research students may also seek to commercialize their research work and start their own companies. A research supervisor needs to understand how and when this will take place – and whether it fits within the intellectual property arrangements that are in place for the postgraduate project.

2.15 Underpinning Research Outcomes for Future Research Grants

A postgraduate research program has a limited time-span but, for the academic supervisor, there may be ongoing work and research requirements within the institution. Before embarking on a postgraduate research supervision, the research supervisor needs to understand the broader picture for his/her own professional research activities, and how the postgraduate program fits into these.

A postgraduate research program, which is an end in itself, may have only limited value, but one which can be used as the basis of future competitive research funding can have multiple benefits. Firstly, if the competitive research funding provides resources for postdoctoral positions then it may be possible to retain the research student after graduation. Secondly, additional funding may enable the supervisor to expand the scope of the current postgraduate research in order to achieve more significant outcomes in the field.

At this point it should be noted that it is generally not a research student's role to actively pursue funding, but a supervisor should have it in his/her mind that the postgraduate research investigation may be a good basis on which to base future research grants.

The timeline for many competitive research funding schemes can range from several months through to an entire year – from initial submission to receipt of funding. For these reasons, consideration needs to be given to research grant applications as soon as a postgraduate research program starts yielding meaningful results.

In some instances, the research undertaken by postgraduate students may be applied in nature, and the pathway may not be a traditional research grant but, rather, precompetitive research and development, which may require commercial/seed/venture capital funding. If this is the case, then the research supervisor needs to consider the option of packaging early postgraduate research outcomes into an attractive value proposition, which can then be presented to potential commercial sponsors. Some of these may wish to form a partnership to take the research further at the conclusion of the program – others may wish to invest in the intellectual property or, perhaps, enter into a royalty arrangement.

2.16 Research Outputs that Feed Into University Research Performance Metrics

Despite the altruistic motives that universities or academics may have, the reality is that modern institutions work in a nationally and globally competitive environment. In order to secure research funding, institutions need to demonstrate performance in the form of accepted metrics, which include the following:

- Research publications
- Citations for publications
- Patents
- Awards (e.g., Nobel Prize, Fields Medal)
- Competitive research grant income
- Endowments
- Doctoral research student completions
- International collaborations/joint publications.

An intrinsic limitation of all metrics, and all parametrically-driven performance systems, is that humans tend to *game* the system in order to maximize numbers for personal self-interest or advancement. Sometimes this occurs at the expense of institutional building, and other times at the expense of colleagues or, worse still, the basic truths which researchers have a duty to uncover and protect. It is important supervisors understand the performance environment in which they operate but, more importantly, that undesirable *gaming traits* are not passed on to postgraduate research students.

Research student activities will clearly contribute to some or all of the performance metrics, depending on the nature of the research; the capabilities of the research students, and their productivity. The decisions relating to "how much?" a research student contributes are left to the subjective determinations of each research supervisor, so it is imperative that the supervisor acts in the best interests of:

- The research student
- The integrity of knowledge and learning.

To do less than this, and to use research students as tools for personal career advancement is not only unethical, but it is an activity that can metastasize through an entire research grouping or department – ultimately destroying any institution-building capacity, as well as damaging the credibility of the unit, and potentially making it dysfunctional.

2.17 Establishment of a Long-Term Professional Relationship Between the Graduated Student and the Supervisor

The Reverend Russell Conwell, founder of the Temple University in the United States, recited a famous speech over 5,000 times between 1900 and 1925. The speech was entitled *Acre of Diamonds* (*Americanrhetoric.com, 2015*). Contained within that speech was the story of a farmer, who had considerable wealth and a successful farm. After a priest told the farmer of the value of diamonds, and the places where they could be found, the farmer became restless and discontent with his lot in life. He sold his farm and abandoned his family in order to search for the enormous riches of diamonds, only to ultimately perish in his attempt. The man who purchased his little farm subsequently found that that farm ironically had one of the world's greatest riches of diamonds just below the surface:

“Thus...was discovered the diamond-mine of Golconda, the most magnificent diamond-mine in all the history of mankind, excelling the Kimberly itself. The Kohinoor, and the Orloff of the crown jewels of England and Russia, the largest on earth, came from that mine.”

The moral of the story is readily apparent – and that is to not go searching elsewhere for riches that may already exist in one's own lot.

Universities expend considerable time, energy and resources cultivating relationships with external bodies in government, business, industry and alumni. The objective is to seek research funding or endowments that can be used for the betterment and advancement of the institution. However, each of those people in government, business and industry was once a student – and all are humans who can remember – fondly or otherwise – their school and university lives.

It is important that every supervisor understands that every research student can become a potential benefactor to the university and to research in the future. Further, there is little point looking for external benefactors when many potential benefactors exist in one's own *farm*. The end of the research supervision process should not become the end of the relationship between the supervisor and research student graduate – it should be the beginning of a new professional relationship. It is the supervisor's role to cultivate that relationship by maintaining contact with the research student as they move onwards and upwards through their career. If the supervisor has performed his/her role fully, ethically and fairly during the period of research candidature, then this is something that the graduating research student should embrace.