

**Towards a pedagogy of supervision in the  
technology disciplines**

**A PEDAGOGICAL FRAMEWORK FOR THE  
TECHNOLOGY DISCIPLINES**

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Queensland University of Technology  
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## 2009

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## FOREWORD

This is the 3<sup>rd</sup> of a series of discussion papers (Table 1) around the pedagogy of supervision in the technology disciplines. The papers form part of an Australian Learning and Teaching Council Fellowship program conducted by ALTC Associate Fellow, Professor Christine Bruce, Queensland University of Technology.

**Table 1. Resources developed from the program**

| Resource type | Title   |
|---------------|---|
| Papers        | 1. Bruce, C. & Stoodley, I. (2009) <i>Fellowship plan and conceptual framework</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.   |
|               | 2. Bruce, C., Stoodley, I. & Gasson, S. (2009) <i>A review of the conversations and their content</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.  |
|               | 3. Bruce, C. & Stoodley, I. (2009) <i>A pedagogical framework for the technology disciplines</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.   |
|               | 4. Bruce, C., Bell, J., Gasson, S., Geva, S., Kruger, K., Oloyede, K., O'Shea, P., Stoodley, I., Raymond, K. & Wissler, R. (2009) <i>Summary and recommendations</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT. |
| Resources     | 5. Bruce, C. & Stoodley, I. (2009) <i>Resource for supervisors</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.   |
|               | 6. Bruce, C. & Stoodley, I. (2009) <i>Student resources for the use of supervisors</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.   |
| Workshops     | 7. Bruce, C. & Stoodley, I. (2009) <i>Workshop for supervisors</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.   |
| Cases         | 8. Bruce, C. & Stoodley, I. (2009) <i>Cases from the technology disciplines</i> . (Towards a pedagogy of supervision in the technology disciplines series.) Brisbane: QUT.  |

The purpose of this current Paper 3 is to:

- present the pedagogical framework that has been derived from conversations with supervisors in the technology disciplines
- present each part of the framework in a detailed way
- suggest ways in which parts of the framework might interrelate to influence practice.

Our intended audience is:

- supervisors, administrators and academic developers in the technology disciplines who are interested in the views of their colleagues about supervision as a teaching and learning practice; and
- colleagues and academic developers in other disciplines who are interested in views from the technology disciplines about supervision as a teaching and learning practice.

The purpose of Paper 1 was to:

- provide a brief summary of the intended directions of the ALTC program 'A Pedagogy of Supervision in the Technology disciplines'; and
- provide an overview of existing research outcomes which are likely to be of interest to the technology disciplines, including some cross disciplinary research and some focussed specifically on some part of the technology field.

The purpose of Paper 2 was to:

- document the processes through which data about technology supervisor's views of supervision as a teaching and learning practice were collected; and
- report key findings from workshops and interviews conducted with supervisors from the technology disciplines (Engineering and Technology).

The papers will all be freely available from:

- the ALTC Exchange site  
- <http://www.altcexchange.edu.au/pedagogy-supervision-technology-disciplines>; and
- the QUT electronic publications archive  
- <http://eprints.qut.edu.au/>.

Throughout this paper direct quotes from conversations are followed by reference to a specific interview ("I") or workshop ("W"). For example, "(I2)" means the quote is from Interview 2.

## FELLOWSHIP INFORMATION SHEET

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### TALKING ABOUT SUPERVISION IN THE TECHNOLOGY DISCIPLINES

This program aims to develop a framework for the pedagogy of supervision in the technology disciplines. The framework will be developed by investigating technology discipline supervisors' thinking and by searching the relevant literature. The viewpoints of technology supervisors will be collected using a qualitative methodology.

The outcomes will support strategic change in higher education institutions for the enhancement of learning and teaching at the HDR level. HDR supervision and its diversity has been a significant national issue for some time. There is a considerable literature attending to both what should be learned and how it should be learned or taught. As yet, however, we have little understanding of the value of these concepts to supervisors in the technology disciplines.

**Significance:** The process will raise awareness of HDR supervision as a teaching and learning practice, encourage sharing of practices amongst supervisors, and enable reflection and learning from research and scholarship.

#### Goals:

- To investigate and document technology educators' ways of thinking about supervision as a teaching and learning practice.
- To develop a framework, representing key aspects of a pedagogy of supervision, for use by supervisors and leaders in the HDR context for enhancing HDR supervision in the technology disciplines.
- To design recommendations for taking this agenda forward in consultation with key stakeholders across Australia.

**Key Fellowship Activities:** All strategies are designed to raise awareness of HDR supervision as a teaching and learning practice in different ways.

**STRATEGY 1: BRINGING THE PEDAGOGY OF SUPERVISION INTO FOCUS I.** This will involve using interviews and focus groups to investigate and document technology educators' ways of thinking about supervision as a teaching and learning practice.

**STRATEGY 2: BRINGING THE PEDAGOGY OF SUPERVISION INTO FOCUS II.** This will involve drawing together existing research and scholarship with the outcomes from Strategy 1 to develop a framework for use by supervisors and leaders in the HDR context for enhancing HDR supervision in the technology disciplines.

**STRATEGY 3: RAISING AWARENESS OF COMMON AND COMPLEMENTARY WAYS OF SEEING THE PEDAGOGY OF SUPERVISION IN THE TECHNOLOGY DISCIPLINES.** This will involve designing recommendations for taking this agenda forward in consultation with key stakeholders.

**Fellowship team:** Professor Christine Bruce (ALTC Fellow, QUT); Dr Ian Stoodley (Project Officer, QUT); Dr Catherine Manathunga (Project Evaluator, UQ); Professor John Bell (Assistant Dean Research, BEE, QUT); Susan Gasson (Manager, Research Students Centre, QUT); Assoc Prof Shlomo Geva (Director of Research, SIT, FST, QUT); Kerry Kruger (Coordinator, Research Training, Research Students Centre, QUT); Professor Kunle Oloyede (HDR Coordinator, BEE, QUT); Professor Peter O'Shea (Professor, SES, BEE, QUT); Professor Kerry Raymond (Professor, FST, QUT); Professor Rod Wissler (Dean of Research and Research Training, QUT).

## I. WHAT IS A PEDAGOGICAL FRAMEWORK FOR HIGHER DEGREE RESEARCH SUPERVISION?

Pedagogy refers to how we think about research education. The very idea of what it means to teach and learn in the supervisory context is highly variable.

The pedagogical framework presented in this paper:

- draws together the different ways in which supervisors think about teaching and learning in supervision (the 9 pedagogies described later in the paper); and links these with several other elements of research education.
- Aligns the multiple elements of the framework with six 'curriculum orientations' adapted for the research education context
- is constructed from research outcomes; and
- may be used in many ways.

### 1.1 SUPERVISION AS TEACHING AND LEARNING

Supervising higher degree research can be viewed as a teaching and learning practice. We can then focus attention on relevant aspects of research education such as:

- supervisors' approaches to such 'teaching';
- supervisors' views of research and learning to research;
- supervisors' ways of thinking about supervision as teaching and learning;
- the learning outcomes we seek;
- the strategies which it might be appropriate to use;
- the roles which may be appropriate for the supervisor, or team of supervisors to adopt; and
- the environment in which we teach.

In the framework, approaches, learning outcome, strategies and roles describe different possible educative behaviours of supervisors; the pedagogies, views of research and learning to research and curriculum orientations describe ways of thinking about aspects of supervision.

### 1.2 WHERE HAS THE PEDAGOGICAL FRAMEWORK COME FROM?

The 'pedagogical framework' presented in this paper draws together the thinking of twenty-nine supervisors with different levels of experience, and who work in a range of contexts: for example with full time or part-time students, internal or external students, international and domestic students, in workplace or academic settings, with small or large numbers of students, and with students from many cultural backgrounds. The framework also draws on a range of research into aspects of research supervision (see Bruce & Stoodley, 2009).

The supervisors who contributed came from the technology disciplines, including engineering, design and information technology. Their multidisciplinary and interdisciplinary interests spanning mathematics, computer science, medicine, health, education, information science, and engineering infrastructure and design suggest the possibility of the framework being of interest to supervisors from many disciplines.

### 1.3 USING THE FRAMEWORK

The framework is offered for use by individuals or groups of supervisors, as a tool for thinking about, planning, and refreshing our supervision.



It is intended to represent the ideas of colleagues, and is not intended to constrain us. It would be most appropriate for the framework to be 'modified' to suit the needs to different contexts, situations or groups. For example, some groups may prefer to use alternative language or labels, or may wish to add to the framework. Some individuals or groups may choose to emphasise some aspects of the framework over others.

As supervisors we may use many different approaches and strategies. Sometimes the approaches and strategies 'work' for the supervisors who use them, and sometimes they do not. If a particular strategy or approach is not working for a particular student, group of students, or in a particular time or place, it is useful to both new and experienced supervisors to have alternatives to consider and try. **One of the key purposes of this framework is to represent such alternatives.**

You could use the framework to ask:

- What options do I/we have?
- What if we were to do things differently?
- What if individuals or groups were to deliberately identify and experiment with alternative ways of thinking and acting?

If you are looking for:

- new ideas for how to work with your students – look at the strategies (section 3.2)
- ideas for how members of a supervisory team may work together – look at roles (section 3.5)
- ideas for what kinds of things you may want students to learn – look at learning outcomes (section 3.3)
- ideas about possible pedagogies – look at supervisory pedagogies (section 3.7)
- thoughts on how you might change your practice by adopting different strategies or roles – look at mappings (section 4.1).

If you are a new supervisor:

- you will find a wealth of ideas from colleagues with a wide range of types of experience
- you will not find solutions to all your problems, but it will suggest systematic ways of thinking about what you are doing and give you many options to choose from with particular students.

If you are an experienced supervisor:

- you may enjoy the wealth of ideas from colleagues
- you may find this document most useful as a tool for mentoring others or for identifying ideas with which to refresh your own strategies.

## II. WHAT DOES THIS PEDAGOGICAL FRAMEWORK LOOK LIKE?

This framework has been developed to highlight different aspects of thinking about supervision as a teaching and learning practice; as well as approaches and strategies and roles associated with supervision.

While the aspects of thinking about supervision as a teaching and learning practice (pedagogies, curriculum orientations, views of research and learning to research) are not *actions* or *strategies*, they do identify the 'drivers' or 'motivations' that may find expression in different strategies. For example, a strategy that involves the use of groups in supervision may be framed from a desire to develop critical competencies, or from a desire to collaboratively shape or 'steer' a research team. For this reason, strategies may be applied freely across the pedagogical framework and do not appear in the 'frames' presented below.

As supervisors we are likely to find that with different students, or in different contexts, we may 'locate' our supervision in different parts of the framework. We are unlikely to ever adopt only one frame. We are much more likely to blend or mix more than one frame.

We may emphasise, or prefer to identify with, particular parts of the framework. Ideally, we would be familiar with the many different aspects of the framework and would deliberately choose to adopt aspects most appropriate to our circumstances.

### 2.1 FRAMEWORK OVERVIEW

In its simplest form, the framework can be presented showing a set of 6 'curriculum frames' or 'orientations' and the ways of thinking about research, learning to research and possible supervisory roles that may be associated with these orientations. Each frame may also be linked with one or more of 9 different ways of thinking about teaching practices in the research context.

In Table 2 below, a summary version of the pedagogical framework, each row represents a curriculum frame, and each frame is associated with one or more ways of thinking about teaching and learning in research supervision. A selection of other elements of the framework is represented in the columns.

Each frame may be briefly described as follows:

The **academic discipline frame** emphasises discipline expertise, with the student increasing knowledge or discovering truth. In this frame:

- Teaching research students is viewed as upholding academic (discipline and institutional) standards.

The **competency frame** emphasises learning research techniques, with the student applying systematic procedures to new areas of investigation. In this frame:

- Teaching research students is viewed as imparting academic expertise (for example, by providing a model of successful research).

The **learning to learn frame** emphasises learning to make meaning, solve problems and create new ideas, with the student synthesising complex knowledge. In this frame:

- Teaching research students is viewed as promoting learning to research (for example, by developing study habits).

The **personal relevance frame** emphasises the location of self in the research process, with the student embarking on a journey towards personal understanding. In this frame:

- Teaching research is viewed as promoting the supervisor’s development, or
- Teaching research is viewed as enabling student development.

The **social impact frame** emphasises the impact of research on society, with the student pursuing benefit to society. In this frame:

- Teaching research is viewed as contributing to society (for example, by developing substantial solutions to human problems).

The **collaborative frame** emphasises research as a community activity discovering new views of the research object or territory, with the student coming to see differently and contributing to the team. In this frame:

- Teaching research is viewed as venturing into unexplored territory, or
- Teaching research is viewed as employing student expertise, or
- Teaching research is viewed as forming productive communities.

## 2.2 THE PEDAGOGICAL FRAMEWORK

Table 3 below offers a more detailed version of the framework. In Table 3, the pedagogies, views, approaches, perspectives and roles of supervision are shown in the columns and the corresponding curriculum frames in the rows.

Individual elements of the framework are described in detail in the following sections of this document. An even longer version of framework, which draws together all the elements in one place, is presented in Section 5.

Table 2. Framework for thinking about supervision as pedagogy in the technology disciplines (summary)

| Supervisors see teaching research students as   | Supervisors primarily see research as   | Supervisors primarily see students learning to research as                                  | Supervisors' suggested roles | Curriculum orientations |
|---|---|---|------------------------------|-------------------------|
| Note: As supervisors...   |   |   |                              |                         |
| a) We may 'locate' our supervision in different parts of the framework in different contexts;   |   |   |                              |                         |
| b) We are unlikely to ever adopt only one frame, but we are more likely to blend more than one frame in response to variables like the student's need, the topic, the stage of candidature; |   |   |                              |                         |
| c) We may emphasise, or prefer to identify with, particular parts of the framework;   |   |   |                              |                         |
| d) We could deliberately choose to adopt aspects most appropriate to our circumstances.   |   |   |                              |                         |
| <b>Upholding academic standards</b><br><i>Meeting the discipline and institutional communities' expectations</i>  | <b>Substantial</b><br><i>Working rigorously on difficult problems, resulting in important breakthroughs</i> | <b>Accepting constraints</b><br><i>Disciplined application of basic skills to new areas</i> | Manager (Directing)          | Academic discipline     |
| <b>Imparting academic expertise</b><br><i>Conveying expertise in research processes</i>   | <b>Investigative</b><br><i>Strategic, evidence-based problem solving</i>                                    | <b>Being apprenticed</b><br><i>Imitating a master</i>                                       | Manager (Directing)          | Competency              |
| <b>Promoting learning to research</b><br><i>Meeting students' learning needs</i>  | <b>Meaning-making</b><br><i>Seeking meaning through the synthesis of complex data or knowledge</i>          | <b>Journeying</b><br><i>Self-discovery by trial and error, towards independence</i>         | Coach (Responsive)           | Learning to learn       |
| <b>Promoting the supervisor's development</b><br><i>Pursuing the supervisor's established objectives</i>  | <b>Deepening</b><br><i>Increasing self awareness through an iterative process</i>                           | <b>Focussing</b><br><i>Pursuing mature, world-class expertise</i>                           | Director (Directing)         | Personal relevance      |
| <b>Enabling student development</b><br><i>Seeking students' academic and professional maturity</i>  |   |   | Nurturer (Responsive)        |                         |
| <b>Contributing to society</b><br><i>Having social impact</i>   | <b>Productive</b><br><i>Usefully satisfying a range of stakeholders</i>                                     | <b>Contributing</b><br><i>Exploring positive impact on others</i>                           | Partner (Collaborative)      | Social impact           |
| <b>Venturing into unexplored territory</b><br><i>Discovering the research agenda together</i>   | <b>Explorative</b><br><i>Following speculative leads which challenge norms</i>                              | <b>Stretching</b><br><i>Being stretched into new areas</i>                                  | Colleague (Collaborative)    | Collaborative           |
| <b>Drawing upon student expertise</b><br><i>Building from existing student abilities</i>  |   |   | Guide (Responsive)           |                         |
| <b>Forming productive communities</b><br><i>Drawing key stakeholders together</i>   |   |   | Colleague (Collaborative)    |                         |

Table 3. Framework for thinking about supervision as pedagogy in the technology disciplines

| Pedagogies   |                                      | Supervisors' approaches  | Sample learning outcomes  | Supervisors primarily see research as   | Supervisors primarily see students learning to research as                                  | Supervisors' suggested roles | Curriculum orientations |
|--|--------------------------------------|--|---|---|---|------------------------------|-------------------------|
| Supervisors see teaching research students as  | Supervisors direct attention towards |  |   |   |   |                              |                         |
| <b>Upholding academic standards</b><br><i>Meeting the discipline and institutional communities' expectations</i> | Established academic standards       | <ul style="list-style-type: none"> <li>• Scaffolding</li> <li>• Direction-setting</li> </ul> | <ul style="list-style-type: none"> <li>• quality publications</li> <li>• topic expertise</li> </ul>                           | <b>Substantial</b><br><i>Working rigorously on difficult problems, resulting in important breakthroughs</i> | <b>Accepting constraints</b><br><i>Disciplined application of basic skills to new areas</i> | Manager                      | Academic discipline     |
| <b>Imparting academic expertise</b><br><i>Conveying expertise in research processes</i>                          | Supervisor's knowledge and skills    | <ul style="list-style-type: none"> <li>• Scaffolding</li> <li>• Relationship</li> </ul>      | <ul style="list-style-type: none"> <li>• academic writing</li> <li>• literature review</li> <li>• technical skills</li> </ul> | <b>Investigative</b><br><i>Strategic, evidence-based problem solving</i>                                    | <b>Being apprenticed</b><br><i>Imitating a master</i>                                       | Manager                      | Competency              |
| <b>Promoting learning to research</b><br><i>Meeting students' learning needs</i>                                 | Students' learning needs             | <ul style="list-style-type: none"> <li>• Scaffolding</li> <li>• Relationship</li> </ul>      | <ul style="list-style-type: none"> <li>• to become an expert</li> <li>• reflection</li> <li>• study habits</li> </ul>         | <b>Meaning-making</b><br><i>Seeking meaning through the synthesis of complex data or knowledge</i>          | <b>Journeying</b><br><i>Self-discovery by trial and error, towards independence</i>         | Coach                        | Learning to learn       |
| <b>Promoting the supervisor's development</b><br><i>Pursuing the supervisor's established objectives</i>         | Supervisor's research agenda         | <ul style="list-style-type: none"> <li>• Direction-setting</li> </ul>                        | <ul style="list-style-type: none"> <li>• join established team</li> <li>• enter supervisor's projects</li> </ul>              | <b>Deepening</b><br><i>Increasing self awareness through an iterative process</i>                           | <b>Focussing</b><br><i>Pursuing mature, world-class expertise</i>                           | Director                     | Personal relevance      |
| <b>Enabling student development</b><br><i>Seeking students' academic and professional maturity</i>               | Student maturity                     | <ul style="list-style-type: none"> <li>• Relationship</li> </ul>                             | <ul style="list-style-type: none"> <li>• mature researcher</li> <li>• question status quo</li> </ul>                          |   |   | Nurturer                     |                         |

| Pedagogies  |                                      | Supervisors' approaches   | Sample learning outcomes  | Supervisors primarily see research as  | Supervisors primarily see students learning to research as        | Supervisors' suggested roles | Curriculum orientations |
|---|--------------------------------------|---|---|--|---|------------------------------|-------------------------|
| Supervisors see teaching research students as   | Supervisors direct attention towards |   |   |  |   |                              |                         |
| <b>Contributing to society</b><br><i>Having social impact</i>                                 | Society's needs                      | <ul style="list-style-type: none"> <li>• Direction-setting</li> <li>• Relationship</li> </ul> | <ul style="list-style-type: none"> <li>• develop innovative solutions</li> </ul>                        | <b>Productive</b><br><i>Usefully satisfying a range of stakeholders</i>        | <b>Contributing</b><br><i>Exploring positive impact on others</i> | Partner                      | Social impact           |
| <b>Venturing into unexplored territory</b><br><i>Discovering the research agenda together</i> | New frontiers                        | <ul style="list-style-type: none"> <li>• Direction-setting</li> <li>• Relationship</li> </ul> | <ul style="list-style-type: none"> <li>• employ out-of-the-box thinking</li> </ul>                      |  |   | Colleague                    |                         |
| <b>Drawing upon student expertise</b><br><i>Building from existing student abilities</i>      | Student's contribution               | <ul style="list-style-type: none"> <li>• Relationship</li> </ul>                              | <ul style="list-style-type: none"> <li>• become world expert</li> <li>• teach the supervisor</li> </ul> | <b>Explorative</b><br><i>Following speculative leads which challenge norms</i> | <b>Stretching</b><br><i>Being stretched into new areas</i>        | Guide                        | Collaborative           |
| <b>Forming productive communities</b><br><i>Drawing key stakeholders together</i>             | Community's contribution             | <ul style="list-style-type: none"> <li>• Direction-setting</li> <li>• Relationship</li> </ul> | <ul style="list-style-type: none"> <li>• develop networks</li> <li>• span disciplines</li> </ul>        |  |   | Colleague                    |                         |

Note: As supervisors... a) We may 'locate' our supervision in different parts of the framework in different contexts; b) We are unlikely to ever adopt only one frame, but we are more likely to blend more than one frame in response to variables like the student's need, the topic, the stage of candidature; c) We may emphasise, or prefer to identify with, particular parts of the framework; d) We could deliberately choose to adopt aspects most appropriate to our circumstances.

### III. WHAT ARE THE KEY ELEMENTS OF THE FRAMEWORK?

In this section we present each element of the framework:

1. Approaches to supervisory pedagogy;
2. Strategies of supervision;
3. Supervisors' desired learning outcomes;
4. Supervisors' views of research and learning to research;
5. Supervisory roles;
6. Supervisory environment; and
7. Nine supervisory pedagogies - Ways of thinking about teaching and learning in supervision.

#### 3.1 ELEMENT ONE: APPROACHES TO SUPERVISORY PEDAGOGY

We have identified three general approaches that we as supervisors seem to take:

- a scaffolding approach,
- a relationship approach and
- a direction-setting approach.

In reality, we are likely to adopt a blend of these approaches. The extent to which any one is dominant could be said to reflect our personal approach, or possibly the approach 'encouraged' by our experience of our context or environment.

We could speculate that an appropriate balance of all three is likely to result in a healthy supervisory environment

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#### SCAFFOLDING

When adopting a **scaffolding approach**, as supervisors we emphasise the procedures of supervision.

We may, for example, provide structure early in the candidature by clarifying the student's role, devising a monthly plan and developing an overview of the thesis. We would ensure outputs through regular reporting, early journal and conference writing, and describing the candidacy as a delimited mission.

The scaffolding approach is concerned with the need for structure for students, especially around project management to encourage systematic progress. Pedagogy is likely to be associated with the detailed organisation of practical activities surrounding supervision.

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#### RELATIONSHIP

When adopting a **relationship approach**, as supervisors we emphasise personal interactions.

We may, for example, establish learning communities by learning with the student, forming a substantive relationship with them, and encouraging work with other students and industry partners. We would negotiate expectations.

The relationship approach is concerned with the interactions and needs of the people involved in supervision. Pedagogy is likely to be associated with bringing people together to further directions valued by the individual or group.

## DIRECTION SETTING

When adopting a **direction setting approach**, we emphasise research objectives.

The direction setting approach is concerned with the need to give clear guidance to students, in terms of the goals of their candidature. We may, for example, incorporate new students into our established research programmes, prompt students to assess their project objectives in the light of their workgroup context, or establish goals that we can mutually agree on.

Our pedagogy is likely to be associated with bringing about maximum advantage to achieving research goals. It may mean we focus on objectives external to pedagogy and only accept candidates which are of the highest quality and who are most likely to successfully advance our research goals.

### 3.2 ELEMENT TWO: STRATEGIES OF SUPERVISION

As supervisors, we use a wide range of strategies. Most of these strategies can apply across the framework; others sit more comfortably in particular frames. (See the tables in Section 6.1 for examples of how the strategies might work when adopted by particular approaches or roles.)

Possible strategies and techniques are identified below. Strategies represent the pedagogical practices of supervision. Examples of techniques associated with them (activities employed to put a strategy into effect) are given as dot points.

**Strategy A. Creating groups:** Drawing key players together for conversation, on a regular basis. Techniques include:

- Small groups – single student (held weekly, fortnightly or monthly)
  - One supervisor and one student meet on a fortnightly basis, with the student bringing their progress on an assigned writing project
  - One or two supervisors and one student meet on a monthly basis, with the student bringing questions that have arisen
- Larger groups – many students (held weekly, fortnightly, monthly or annually)
  - Weekly reading groups, led by the students
  - Monthly discussion groups where students bring questions, open to any students (not just those supervised by the academic present)
  - Monthly seminars, with many students, supervisors and industry partners, where students present short papers
  - Annual mini-doctoral consortia, where many students present their work to a panel of supervisors
- Groups outside the university
  - Students present peer-reviewed papers at conferences
  - Students attend summer schools, to acquire specific skills

*The weekly meetings for me are a religion... it's like going to church on Sunday, you have to come, it's got to be every week, better be a good reason why you didn't turn up. (I1)*

**Strategy B. Creating Structure:** Project managing or planning, with an emphasis on the process. Techniques include:

- Early clarity about responsibilities
  - Discuss the goals of the project and supervisor/student responsibilities
- Monthly plan, especially for first year students
  - List project objectives for this period and associated tasks
- Early development of a Table of Contents and an Abstract



- Develop headings and subheadings with descriptive sentences, which are progressively expanded into full chapters

*The first year is very important, especially the first half year, I think. So normally at the very beginning I ask the students to make a plan. I want them to control their time because we have three months before something is due. I ask them to give me a plan, month by month, and the first month week by week. (I11-2)*

**Strategy C. Generating Outputs:** Ensuring timely deliverables, the outcomes aspect of project management.

Techniques include:

- Representing the study as a mission, a project that has an end
  - Identify an examinable thesis as the ultimate goal
- Commence outputs early (writing, presentation at events, etc.)
  - Submit to realistic events, such as lower level conferences
- Regular reporting, for example monthly
  - Complete a standard form which covers the essential aspects, then work through this in a meeting

*I tell them when they are even 50% happy with something or they have come to a point where they don't know what direction to take, "Give it to me" because I don't want them to try to figure it out and then find it's a completely wrong direction. So I try to see drafts and I try to see their thoughts very early before they are emotionally committed to them. (I20)*

**Strategy D. Creating Space:** Providing intellectual space, reducing structure to allow creativity and inspiration.

Techniques include:

- Have open conversations, to help discover the possibilities
  - Withhold critical comment to allow speculative thoughts to be aired
- Give students the opportunity to make their own discoveries
  - Indicate the way to find the answer to a question, rather than give the answer directly

*It's the esoteric thoughts that you really need in research. You need the wacky thoughts, "Why don't we try looking at it this way?" If you're not comfortable, you're only going to say things that are safe. (I13)*

**Strategy E. Establishing Collaboration:** Forming learning communities, with the student as a colleague. Techniques include:

- Learn with the student, work side by side with them
  - Learn to use a new laboratory instrument together
- Form a substantive relationship with the student
  - Explore new thoughts together, through open speculative discussion, perhaps during informal lunch meetings
- Encourage collaborative work with other students
  - Situate a student in a like-minded group or in a team working on a common project

*You create a bidirectional flow whereby... this organization has a very dense network... You have all these dots, but all these dots are very well connected... there is a maximum density in this network. Every single student is another bouncing partner for all the other PhD students in that network. (I12-2)*

**Strategy F. Focusing on the Big Picture:** Incorporating the context of the candidature, the long-term objectives.

Techniques include:

- Consider the student's career goals

- Provide teaching opportunities, if student is pursuing an academic career
- Factor in the student's and supervisor's strengths and weaknesses
  - Matching a student who requires significant mentoring with a supervisor who is able to offer this level of engagement

*I often have conversations with students about what they want in terms of a career and we try to somehow take that into consideration in devising their programme of activities. (I12-1)*

**Strategy G. Negotiating Expectations:** Setting up the programme for success, by establishing high standards.

Techniques include:

- Early establishment of clear expectations
  - Draw up a supervision contract, outlining university's expectations of the student, including the student's growing independence
- Only accept candidates who display a satisfactory proficiency
  - Screen applicants to choose only high quality students who are interested in the supervisor's research group's topic area

*I get people to send me some writing before I take them on so I can see their basic level. So, making sure that the students who come in are actually ready for a PhD level. (I20)*

**Strategy H. Pursuing Established Programmes:** Contributing to previously determined research agendas. Techniques include:

- Inserting students into supervisor-defined, established programmes of research
  - Place students in established programmes, to advance those programmes' agendas

*Generally the way I do work with students is that during the first year they are probably working as a research assistant, learning the ropes. This is what you have to do, you have to do the literature review and this is the kind of program you will have to write and this is how we are going to test it, etc.(I1)*

### 3.3 ELEMENT THREE: SUPERVISORS' DESIRED LEARNING OUTCOMES

As supervisors we seek many learning outcomes from the higher degree research candidature. Table 4 presents an overview of some learning outcomes we expect of research students.

**Table 4. Some learning outcomes sought by supervisors**

| Some learning outcomes   | Supervisors see teaching and learning research students as  |
|--|---|
| <ul style="list-style-type: none"> <li>• discipline, to be hard workers</li> <li>• knowledge about academia</li> <li>• quality publications, indicating a complete project</li> <li>• topic expertise</li> <li>• discipline expertise</li> <li>• approaching findings with scepticism</li> <li>• rigour</li> </ul> <p><i>I would like them to become like... Isaac Newton... one of the reasons I think that he was so effective in making groundbreaking answers was that he was both very thorough and very diverse... that enabled him to... make linkages. (I2 – Engineering, male, experienced)</i></p>   | <p><b>Upholding academic standards</b><br/> <i>Meeting the discipline and institutional communities' expectations</i></p> |
| <ul style="list-style-type: none"> <li>• how to conduct research... using my approach</li> <li>• how to do a literature review</li> <li>• what doing research means</li> <li>• a scientific method, how to lead an experiment and give an account in the proper way</li> <li>• ability to publish</li> <li>• how to get resources</li> <li>• project management</li> <li>• how to present succinctly</li> <li>• ability to write academically</li> <li>• how to write for different audiences</li> <li>• how to sell their topic</li> <li>• about the process of being a rigorous investigator</li> <li>• how to ask questions and think creatively</li> </ul> <p><i>I expect them to learn a lot about the process of being a rigorous investigator and along the way they learn about their topic... The topic I think is almost less important in my mind. (I9 – IT, female, no completions)</i></p> <p><i>They've got to learn how to write, because if they can't write, they can't write publications, so it doesn't matter if they can do the experiments because if they can't write they're not doing research, as simple as that. (I3 – Engineering, male, very experienced)</i></p> | <p><b>Imparting academic expertise</b><br/> <i>Conveying expertise in research processes</i></p>                          |
| <ul style="list-style-type: none"> <li>• to become a devil's advocate</li> <li>• how to become an expert</li> <li>• that research is difficult... that a PhD is frustrating</li> <li>• reflection skills</li> <li>• developing study habits</li> </ul> <p><i>They all need to learn that a PhD is frustrating, that it's a long, slow process. (I5 – Engineering, male, experienced)</i></p>   | <p><b>Promoting learning to research</b><br/> <i>Meeting students' learning needs</i></p>                                 |
| <ul style="list-style-type: none"> <li>• fit into an established research team</li> <li>• contribute to supervisor's projects</li> </ul> <p><i>during the first year they are probably working as a research assistant, learning the ropes... you have to do the literature review and this is the kind of program you will have to write and this is how we are going to test it... (I1 - IT, male, experienced)</i></p>  | <p><b>Promoting the supervisor's development</b><br/> <i>Pursuing the supervisor's established objectives</i></p>         |

| Some learning outcomes  | Supervisors see teaching and learning research students as  |
|---|---|
| <ul style="list-style-type: none"> <li>• learn about themselves</li> <li>• develop as a person</li> <li>• develop a passion for research</li> <li>• have confidence</li> <li>• how to organize themselves, their thoughts</li> <li>• entrepreneurial and leadership skills</li> <li>• an independent, mature researcher in their field</li> <li>• ability to stand on their own and question the status quo</li> </ul> <p><i>I'd like them to have the courage to approach things from unorthodox ways, if necessary. So, a kind of independence of thought and not being afraid to go out on a limb, but to do that responsibly. (I16 – IT, male, experienced)</i></p> <p><i>getting very deeply into an area is I think very useful for students, for them to understand better about the world in general. How much you know and how much you don't know... I think that helps grow one's understanding maybe in all spheres of life. (I19 – IT, male, very experienced)</i></p> | <p><b>Enabling student development</b></p> <p><i>Seeking students' academic and professional maturity</i></p> |
| <ul style="list-style-type: none"> <li>• to develop substantial and innovative solutions</li> <li>• contribution to society through research</li> </ul> <p><i>I do try to make sure that students are aware of the overriding consideration of trying to advance knowledge and that should be, in ethical terms, something that guides how we do research. (I19 – IT, male, very experienced)</i></p> <p><i>to create ground-breaking systems that help other people (W2)</i></p>   | <p><b>Contributing to society</b></p> <p><i>Meeting society's needs</i></p>                                   |
| <ul style="list-style-type: none"> <li>• creation of innovative systems</li> <li>• employ courageous, out-of-the-box thinking</li> </ul> <p><i>learn things that are difficult and innovative, create their own very substantial solution... And... solutions to complex problems, as well, not just simple ones. (I2 – Engineering, male, experienced)</i></p>   | <p><b>Venturing into unexplored territory</b></p> <p><i>Discovering the research agenda together</i></p>      |
| <ul style="list-style-type: none"> <li>• become the world expert</li> <li>• teach the supervisor</li> </ul> <p><i>I expect them to come out at the end of the three year period able to run rings around me in the particular project area that they are doing. I want to learn from them and I want them to understand that I want to learn from them. (I22 – IT, male, very experienced)</i></p>  | <p><b>Drawing upon student expertise</b></p> <p><i>Building from existing student abilities</i></p>           |
| <ul style="list-style-type: none"> <li>• to develop an international network</li> <li>• team work skills and membership in a research community</li> <li>• to work effectively with others</li> <li>• work across discipline boundaries</li> </ul> <p><i>a student who is a couple of years in is almost taking someone under their wing, someone who is a little newer. In some ways the more experienced student is bridging the gap between you and the new student. (I14)</i></p>   | <p><b>Forming productive communities</b></p> <p><i>Drawing key stakeholders together</i></p>                  |

### 3.4 ELEMENT FOUR: SUPERVISORS' VIEWS OF RESEARCH AND LEARNING TO RESEARCH

As supervisors we may view research and learning to research in various ways. Our views may also influence the specific learning outcomes we seek.

#### VIEWS OF RESEARCH

As supervisors we may see research as:

1. Substantial - Working rigorously on difficult problems, resulting in important breakthroughs

Some key ideas associated with this view are: Substantial ideas, tackling difficult problems, finding solutions, arriving at an informed view, sound methodology, 'good' results, rigor, hard work, disciplining the mind, intensive.

*It's an intense, full-on occupation, being a researcher. (I1)*

*It's not really just about mimicking, it's about coming up with new ideas, new and substantial ideas. So, we start talking to them about vision because you need to have a vision to get to that place where you can be a substantial researcher. (I2)*

*They've got to learn the rigours, that badly done research is pointless and so if they are working with an engineer and it frustrates them that they have to spend so much time designing an experiment or a technique, that they understand that that is valuable at the end of the day. If you're going to do it, you've got to do it properly. (I5)*

2. Investigative - Strategic, evidence-based problem solving

Some key ideas associated with this view are: Problem-solving techniques, persistence, being systematic, strategies for understanding, obtaining relevant resources, evidence-based.

*Because we work in science so they have to learn a scientific method of research. So, trial and error, to try a certain experiment, see if the experiment is successful, if it is not successful try to find answers. (I4)*

*Persistence is high on the list. Not giving up too soon. Being willing to try the 401 things that didn't work, before you got to the one that does work. Being systematic, in the sense that your research is replicable by somebody else. (I14)*

3. Meaning-making - Seeking meaning through the synthesis of complex data or knowledge

Some key ideas associated with this view are: Gaining insight, finding solutions to problems.

*I expect them to learn how to... how to solve problems on their own... create their own very substantial solution... and innovative solutions... solutions to complex problems (I2)*

*I expect them to learn how to think, to critically analyse the problem, to come up with a variety of solutions, and to narrow that down. (I13)*

4. Deepening- Increasing self awareness through an iterative process

Some key ideas associated with this view are: Iterative, narrowing focus, deepening self, understanding your own contribution.

*To work their way into the topic and to identify what they think are the key issues that they need to resolve. (13)*

*They... learn about themselves... it's an exercise in discipline, it's an exercise in organisation, it's an exercise in hard work and frustration... research is difficult... and never is as simple as it looks. (15)*

*The students have to sort of embody this themselves... there is a guidance... modulated by the student and their strengths and weaknesses... providing them with enough so that they can start an internal process whereby they start manifesting themselves. It's not an externally driven sort of thing... you walk together and then suddenly it's like they hit a gear and then they start going off doing things and finding that they have the confidence to do that. They sort of launch off. (116)*

#### 5. Productive - Usefully satisfying a range of stakeholders

Some key ideas associated with this view are: Useful to industry, satisfying stakeholders, commercial value.

*Doing research... means publishing research outcomes. (13)*

*Some of them have industry sponsors either sponsoring research or as a source of evidence for the research and I basically said to them, "It is your responsibility to ensure that this sponsor organization gets value for what you are doing." (112-1)*

*The overriding consideration of trying to advance knowledge... should be, in ethical terms, something that guides how we do research. (119)*

#### 6. Explorative- Following speculative leads which challenge norms

Some key ideas associated with this view are: Newness, following leads, thinking outside the square, big risks leading to big steps, exploring esoteric thoughts, asking big questions, questioning norms.

*To have the courage to approach things from unorthodox ways... So, a kind of independence of thought and not being afraid to go out on a limb, but to do that responsibly. Of course... you become part of a field and that field has its own norms but still to be aware that you are not to be trapped by that. (116)*

*The nature of the research that we do is that we have to be somewhat reactive according to what happens. We may try to solve a particular problem but it may not come out as we expect... depending on how it develops we might say, "This is really promising we'll go further with this and push the rest of the plan aside accordingly." (119)*

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## VIEWS OF LEARNING TO RESEARCH

As supervisors we may see students learning to research as:

#### 1. Accepting constraints - Disciplined application of basic skills to new areas

Some key ideas associated with this view are: Developing habits, applying basic skills, methods and tools (to new problems), disciplining the mind, applying a high work ethic, grasping fundamentals, constructing an argument, interrogating existing research, seeking out resources, structuring any topic.

*You have to learn a number of techniques depending on the field you are working in and you have to master these techniques in order to give a result that is at an international level. (14)*

## 2. Being apprenticed -Imitating a master

Some key ideas associated with this view are: Imitation, apprenticeship, following a model, walking alongside a researcher (initially), following expert advice, understanding process and standards.

*The preferred model for me is master/apprentice, when you're at the coalface together and working on the details together. (I16)*

*I guess it is the master-apprentice approach, where you basically teach them how you do it. (I1)*

## 3. Journeying - Self-discovery by trial and error, towards independence

Some key ideas associated with this view are: Working into the project, learning about self, discovery by trial and error, learning to choose focus, stumbling journey (with excellent hindsight), climbing by yourself (with encouragement and guidance), developing independence, being self-starting and self-monitoring, linking broad and deep knowledge, tolerating rejection and learning from it, learning to choose which advice to listen to.

*They have to learn about themselves that they can take a subject, understand it and develop it and learn a level of independence. (I5)*

*They have to learn a scientific method of research. So, trial and error, to try a certain experiment, see if the experiment is successful, if it is not successful try to find answers. (I4)*

*I expect a PhD student to be a little bit more self-directed and prepared to learn the method. They have a little more time... to complete the work, so let them learn by trial and error. (I8)*

*There's a big difference between the beginning and the end of the PhD. They should be independent, functioning PhDs at the end. I expect them to take more and more responsibility as they go along. By the time they get to the end it is really being done mainly by themselves. I tend to work in a team, anyway, so by the end the student should be functioning like we do as colleagues. (I20)*

## 4. Focussing - Pursuing mature, world-class expertise

Some key ideas associated with this view are: Pursuing a passion, aiming to be the world's expert, developing into a mature researcher and colleague, embodying research, internal processes, shouldering responsibility for the research, 'hitting a gear'.

*Something I've said to students for many years now is that they should be the world's foremost authority in the narrow area of their research by the time they complete. (I12-1)*

*I think it's got to do with if the student has really found a question that they are passionate about, that they have got a lot of energy for. To use an organic analogy, the initial stage is all about nurturing that and then it starts to sprout. In a number of cases I have actually seen things sprout and go in directions that I didn't expect, and in fact didn't even agree with... if I have a feeling that it academically or intellectually passes muster, then I allow them to take it in that direction. (I16)*

## 5. Contributing – Exploring positive impact on others

Some key ideas associated with this view are: Coming to understand the impact of research on society, striving for ethical research practice.

*I guess the ability to reflect very effectively, on their processes to improve them, to be able to contribute better to society. (I2)*

*I do try to make sure that students are aware of the overriding consideration of trying to advance knowledge and that should be, in ethical terms, something that guides how we do research. (I19)*

6. Stretching - Being stretched in new ways

Some key ideas associated with this view are: Expanding into new areas, big changes, cutting edge.

*It's the esoteric thoughts that you really need in research. You need the wacky thoughts, "Why don't we try looking at it this way?" If you're not comfortable, you're only going to say things that are safe. If you are going to bother doing research, you may as well not make it incremental. (I13)*

*It's nice to build on people's strengths but is it really developing them in the best way? Is it stretching them? ... With the very good student our relationship was such that we could talk about half formed ideas and as you were talking about them you could clarify something together. Whereas, if it's a student that is not up to that level, if you have a half formed idea and you start talking about it you probably just confuse them and they end up thinking that you don't know what you're talking about. Whereas, for a student who is more experienced to be talking about something that's half baked is probably exciting because it means that you really are close to that cutting edge where you're still forming things. (I14)*



### 3.5 ELEMENT FIVE: SUPERVISORY ROLES

As supervisors we may see ourselves as filling different roles. These roles are not ‘styles’, they are not meant to represent ‘typical stances’, but rather to layout the range of options available to supervisors, which may be adopted through a candidature.

Table 5 presents an overview of the three roles supervisors see themselves filling – directing, collaborative and responsive.

**Table 5. Types of roles adopted by supervisors**

| Roles defined predominantly by supervisors’ expectations                        |  | Roles defined predominantly by students’ needs                              |
|---|--|---|
| Directing   | Collaborative  | Responsive  |
| <ul style="list-style-type: none"> <li>• Manager</li> <li>• Director</li> </ul> | <ul style="list-style-type: none"> <li>• Partner</li> <li>• Colleague</li> </ul> | <ul style="list-style-type: none"> <li>• Mentor</li> <li>• Coach</li> </ul> |

The directing roles emphasise the supervisor’s input into the candidacy. The collaborative roles emphasise supervisors working with others as equals. Directing and collaborative roles are defined by supervisors’ expectations.

Concerning the directing and collaborative roles, some supervisors distinguish between their role at the beginning of a candidacy and their role at the end of a candidacy, whereby they expect that their role will change from a more directing one to a more collaborative one.

The responsive roles are defined predominantly by students’ needs and are adopted as required throughout the candidature.

Examples of the different roles are:

#### DIRECTING ROLES

1. Manager – ensures milestones are met, output quality is high and students’ expectations are moulded.

*Being clear about milestones... So, reports are submitted, deadlines are met, progress is sufficient and if it's not to initiate the appropriate action... it's important that students do not spend too much time on areas that are not going to be productive for the PhD. (19)*

*The manager is the person who can really make sure that that program will end, the candidate will do the thesis and will graduate. (122)*

2. Director – points the student in the right direction, indicates the source of answers to their questions and provides early intellectual content.

*It's a lot about helping them find a project and setting a realistic goal... It's very much at the front working through the particular pathway. (15)*

*It's not answering the questions for them. It's pointing them in the right direction... It's being wise to the ways of the forest rather than having the answer myself. (16)*

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**COLLABORATIVE ROLES**

1. Partner – adopts a position as a fellow-learner alongside the student, forming a research team.

*It's a research partnership, it's not a student-teacher relationship in the same way it is as an undergraduate student. I've learned an awful lot from PhD students and from Masters students. (I8)*

2. Colleague – treats the student as an equal academic, with high expectations of the student as a significant contributor to the project.

*It's great to have someone skilled because it means they can work semi-independently and probably get a lot of research done. Your relationship is starting off a lot more as colleagues than as supervisor and student. (I14)*

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**RESPONSIVE ROLES**

Include:

1. Coach – involvement in the project at a high (visionary and planning) level only

*The role of the coach should be to help the coachee's thinking rather than to solve problems for the coachee. (W2)*

2. Master– orienting the student to the profession

*I actually have a responsibility which is more than just the research and the production of the thesis. I think I have a responsibility to try to do general professional development... The PhD is one of the few areas of life where we still have the masterpiece... your thesis is going to the examiners, the existing Masters, who judge it to see if you should be admitted to their ranks. (I6)*

*I want to make sure that they're ready, so that when they get out there they are not green and when they get out there the big bad world doesn't scare them too much. (I17)*

3. Mentor – instilling the 'spirit of the discipline' and developing their colleagues

*As mentor you are going to build that person to become a true research professional in the discipline that they have chosen. So, your job is to instil in them the spirit of the discipline. I have a test -- when they have gone to the bikkies and drinks at the graduation ceremony... Would you say, "That person is really my colleague, they are not my student any more but now my colleague"? That's what I call a mentoring role. (I22)*

*It's important for the principal supervisor to give the associate supervisor plenty of opportunity to develop their skills rather than just be in the background. So, the principal supervisor would need to have it made clear to them that they are also meant to mentor the early academic. (I17)*

4. Advisor – answering questions raised by the student

*I like the American term "adviser". Obviously there is a lot of experience that I've got as a researcher, to guide and advise them and help them understand how the research community works. (I19)*

5. Example – modelling to the student how research may be done

*I do not pretend that I am going to teach them every possible way of research, rather because I consider myself quite a successful researcher I believe that the way I do it works and therefore I try to teach it the way that it can be done. A good way of doing it... (I1)*

## 6. Networker – supplying contacts and a breadth of resources

*Give them initial contacts, people to talk to. (I3)*

*To see the dots, to bring the dots together. If someone sits in my room and says, "I am currently facing this situation." I hope that I can contribute for example, "This guy works on a similar problem." Giving them external, empirical evidence. "I'd like to do a survey, who can I talk to?" We try to open these doors to empirical evidence. We understand that the student doesn't have this kind of network and we want to find the best case for their scenario. Looking at the group from a bigger picture and seeing more connections than the individual students. It's facilitating the journey and providing access to people, to organizations, to empirical evidence. (I12-2)*

## 7. Presales consultant – looking for the next opening in the discipline

*I feel like I'm a presales consultant, you go and chase the next topic, maybe big brain, what is the next wave. (I12-2)*

## 8. Supporter – encouraging, providing damage control at crisis points

*Scholarships expire, industry partners are unhappy and there are moments of personal crisis in the life of the student. To re-insert confidence to minimize the damage. (I12-2)*

## 9. Editor – providing proofreading and argument advice

*Editing is still there... in the early stages of the work and suggesting improvements, but not telling them how to write because everyone has their own personal writing style. However, I'm now finding with the international students that this is a very blurred line. I'm finding sentences that make no sense and I'm having to figure out what the students are trying to say and making suggestions. You can refer them to the help that's available at the university level, however it can take more than a month to get into these referral services. That's a little late to be giving this sort of feedback. (I8)*

## 10. Nurturer – discovering and building on the student's interests and abilities

*It's not about having hard and fast rules about what I do, it's about trying to meet the needs of each student. (I9)*

*For the students often it's a matter of finding what they are able to do easily and what they are able to do with a certain effort and what they are completely unable to do. You cannot ask them to do what they are completely unable to do unless you want them to waste a lot of time. So, you have to lead them along a certain path and find out their skills, because they arrive with certain skills and you have to build on these skills, rather than building everything from scratch, because that is difficult in the time span that you have. (I4)*

*The point is, we administer the students, we don't nurture them. It'd be great if we could identify the outstanding talent, invite these guys to coffee, find out their areas of interest... (I12-2)*

## 11. Custodian – monitoring their content knowledge

*I feel like I'm a custodian for the content but not for the bureaucratic process. (I16)*

## 12. Quality assurer – ensuring they come up to expected academic standards

*Every now and then I have to add some intellectual content, too, in terms of trying to ascertain if what they've done has actually been reasonable, that the ideas they've developed actually have a good, sound physical*

*basis, or a mathematical basis, that the experiments have actually been done reasonably and that they've actually used shielded cables and they haven't just seen noise in the measurements and things like that. (I3)*

13. Counsellor – helping the student maintain motivation

*I think deadlines work well and in general pressure can be effective but it can also be counter-productive. They can stall as a result of that, so there has to be a lot of motivation in there as well, a building of motivation in conjunction with deadlines. (I12-1)*

*We tried to pick topics of interest to industry where we wanted some momentum. We wanted the students from day one to think it was the best thing since sliced bread that they're working on. I tend to say that to every single student, "This is the most important topic in our field." This is a kind of feel-good factor. (I12-2)*

14. Intermediary – liaising between the student and QUT

*We've got one with IP issues at the moment, so we're all learning as we go. In that particular case I believe I'm an intermediary between the student who is externally funded and QUT... So, you've got to be a bit of an advocate for the student but you also have to make sure that you are doing things within QUT's guidelines. That's why it's a professional role, because it is not something that is just a black-and-white thing. (I17)*

15. Parent – keeping an eye on the students' personal needs

*If you've got the right people to manage them daily then it's almost a parenting role to make sure they're happy, and if you can look human to them then they're more likely to come and tell you their problems. (I5)*

*I also tend to be a bit of a mother as well. I will offer personal advice where one is aware that there is a girlfriend crisis... I might be old-fashioned but where there's a student in front of you in tears because his girlfriend has left him, you've got to give him a hug and you've got to just be mother. Whether this is because I'm a woman I find it easier to do this role, I don't know if male supervisors give their students a hug. (I6)*

*I've come across it a couple of times, that the student has their own predisposition to do things a certain way, some students are really quite stubborn. What you need to do then is almost like a parent and explain that you really need to do some things that you don't really like. That's when you're starting to get them to confront their weaknesses. So, part of that is helping the students become aware of their weaknesses. (I16)*

16. Friend – providing for social needs

*I like to be friends with my students, if I can help them with issues that they have and leave it at the level they want to leave it at. Some students like to talk to me more about their personal situations and some don't and so it's whatever they want to do... Sometimes it can be a concern, how students are doing, especially if they have come from overseas or from outside Brisbane. So I try to make sure that they are in with a community here. (I9)*

17. Safari leader – supporting the student as they branch out

*One of your roles is that guidance -- the safari leader. There are all sorts of distractions along the way and that's up to your judgement... Some theses you just guide all the way through but most do strike off on their own, particularly half way through or towards the end of the second year. Then you just wait to see what you're going to get, really. (I21)*

### 3.6 ELEMENT SIX: SUPERVISORY ENVIRONMENT

The supervision environment influences supervisory pedagogy, helping or hindering supervisors in their roles. Important helps to the supervisory process are people and culture, resources, and synergies. Table 6 summarises these.

**Table 6. Sample helps to the supervisory process**

| People and culture   | Resources   | Synergies  |
|--|---|--|
| <ul style="list-style-type: none"> <li>• Student motivation, interests and abilities</li> <li>• Colleagues, co-supervisors, mentors</li> </ul> | <ul style="list-style-type: none"> <li>• University administrative support</li> <li>• University seminars and workshops on research topics</li> </ul> | <ul style="list-style-type: none"> <li>• A peer network of students in similar fields</li> </ul> |

A diversity of cultures makes the supervision experience enriching. Students bring to the process a wealth of insights which stimulate supervisors to think differently about their area. Fellow supervisors contribute positively to the candidacy, providing a more complete experience for the student. The university administration, learning support, librarians and case officers all help the students. The library, desk space and group areas are important physical resources. A student peer networks in related areas of study provide a diversity of input into the students' work.

*Trying to find an associate supervisor that matches the needs of the student's project, the expertise and the need, that's complementary to what I'm missing, to provide the student with some advisors, whether that's an expert who is in industry or whether that's an expert who is a fellow academic. (I8)*

*I think where they are physically placed is quite important and influences how the interaction goes. Having the students on the same floor as my office is quite important. (I19)*

Notable barriers to the supervisory process are also associated with people and culture, resources, and synergies. Table 7 summarises these.

**Table 7. Sample barriers to the supervisory process**

| People and culture  | Resources   | Synergies   |
|---|---|---|
| <ul style="list-style-type: none"> <li>• Poor student quality</li> <li>• Language barriers</li> </ul> | <ul style="list-style-type: none"> <li>• Lack of finances</li> <li>• Lack of time (including strict deadlines)</li> </ul> | <ul style="list-style-type: none"> <li>• Low student numbers</li> </ul> |

Challenges include the students' academic level at commencement, language barriers and role expectations. Colleagues may not help the candidate, with technical support not up to the level desired and faculty factions pursuing their own agendas. Inefficient administrative procedures, inadequate facilities, inadequate screening of candidates, inconsistent workload allocation, unrealistic demands and insufficient supervisor training may all hamper the supervision process. Strict deadlines that are perceived to be non-negotiable and insufficient funding can limit the scope of the candidacy. Low numbers of students working on similar topics offer limited opportunity for group work.

*What also helps, of course, are resources. This is also what impedes us because we don't really have control in the faculty over the budget. Everything you need, you've got to put your hand out. You can't go and order stuff. You can't prioritise how the research budget will be spent. I would like to see a bottom-line budget that the supervisor manages, so the supervisor can decide which conferences, if at all, should be attempted. (I1)*

*I would love to supervise my students in a much more hands-on way, but I just can't. We get something like thirty five minutes a week, it's some ridiculous thing. There's so much pressure on us as academics to do a lot of other stuff, but I do the best I can. (I7)*

### 3.7 ELEMENT SEVEN: NINE SUPERVISORY PEDAGOGIES–WAYS OF THINKING ABOUT TEACHING AND LEARNING INSUPERVISION

As supervisors we appear to think about teaching and learning in higher degree research supervision in nine distinct but related ways. These 9 perspectives or ‘pedagogies’ may be mapped (Table 8) against a) dimensions of teaching and learning (the columns) and b) an expanding awareness of who is involved with the candidature (the rows).

In the columns, ‘**Content**’ refers to what is considered to be the substance of the material to be imparted to the student; ‘**Intention**’ refers to the motivation behind imparting that content; and ‘**Strategy**’ refers to how the content is imparted to the student.

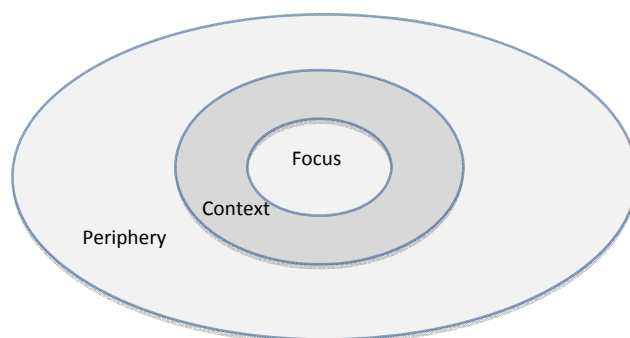
These ways of thinking exert an influence across the approaches, strategies and other framework elements described earlier in this paper. Many of us adopt more than one of the ways of thinking presented here. Of particular interest are those ways which dominate our thinking and exploration of the implications of adopting alternative or previously unfamiliar ways.

**Table 8. Supervisors’ ways of thinking about teaching in the research context**

| <i>Focus</i>                                   | <i>Content</i>                           | <i>Intention</i>                            | <i>Strategy</i>                     |
|--|--|---|-------------------------------------|
| Teaching in the research context is viewed as: |  |   |                                     |
| Supervisor perspective                         | 1<br>Upholding academic standards        | 4<br>Promoting the supervisor’s development | 7<br>Imparting academic expertise   |
| Student perspective                            | 2<br>Promoting learning to research      | 5<br>Enabling student development           | 8<br>Drawing upon student expertise |
| Wider community perspective                    | 3<br>Venturing into unexplored territory | 6<br>Contributing to society                | 9<br>Forming productive communities |

These ways of thinking about teaching in the research context are described further below. Each description contains:

- Those things which supervisor’s attention is directed towards (**Focus**).
- Those things which are considered relevant to supervision (**Context**).
- Those things which are considered less relevant to supervision (**Periphery**).
- The viewpoint from which supervision is seen (**Perspective**).



**Figure 1. Sample category figure**

Each way of thinking is represented diagrammatically, as concentric ovals. The focus is in the centre, the context in the next oval out and the periphery in the widest oval.

## UPHOLDING ACADEMIC STANDARDS

When teaching research students is thought of as upholding academic standards, supervisors ensure the expectations of the academic community (discipline and institutional) are met, concerning the standard of work produced and the time within which it is produced.

*Something I've said to students for many years now is that they should be the world's foremost authority in the narrow area of their research by the time they complete... If they are going to be rigorous enough and deep enough, then they have to be relatively narrow and it's not a stretch to assume that they will be the world's foremost authority in that narrow area. (I12-1)*

Supervisors –

- **Direct attention towards:** established academic standards.
- **Consider the following aspects relevant to supervision:** MOPP; graduate capabilities; external examiners; timelines; thesis as a deliverable; journals; conferences.
- **Are less likely to consider:** Students and others.
- **See supervision from:** their own perspective.

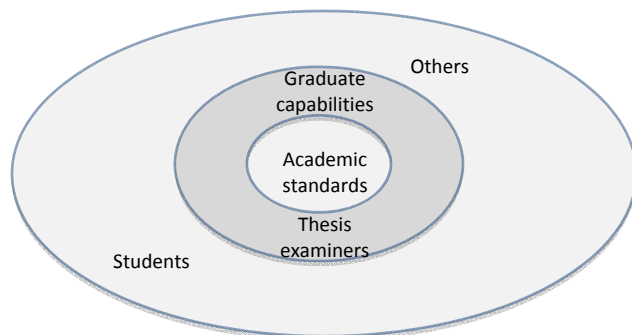


Figure 2. Upholding academic standards

## PROMOTING LEARNING TO RESEARCH

When teaching research students is thought of as promoting learning to research, supervisors perceive and respond to the needs of the student, to enable the student to reach the end goal of their candidacy.

*As they say, "Every child is different", so every student is different. So, each one is a new learning in how to do it... I try to work in detail with the students. (I16)*

Supervisors –

- **Direct attention towards:** students' learning needs.
- **Consider the following aspects relevant to supervision:** Student's mental, physical and emotional well-being; institutional support structures.
- **Are less likely to consider:** Others beyond the student.
- **See supervision from:** a student perspective.

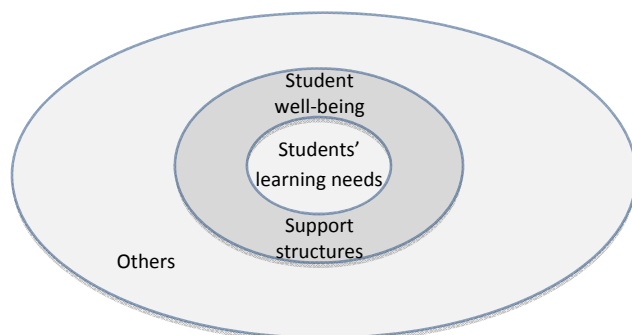


Figure 3. Promoting learning to research

## VENTURING INTO UNEXPLORED TERRITORY

When teaching research students is thought of as venturing into unexplored territory, supervisors form a research team whose members work together to discover the research agenda.

*I expect them to learn about how to ask questions and think in a creative and expansive way that is not limited by what other people have said or done. (I9)*

Supervisors –

- **Direct attention towards:** new frontiers.
- **Consider the following aspects relevant to supervision:** team inter-relations; team's strengths and weaknesses; new insights; non-standard approaches.
- **Are less likely to consider:** societal needs.
- **See supervision from:** an academic community perspective.

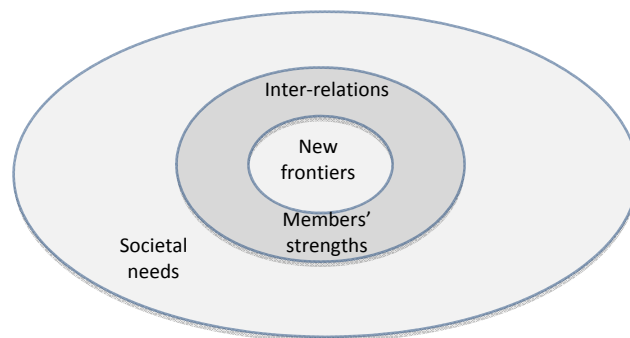


Figure 4. Venturing into unexplored territory

## PROMOTING THE SUPERVISOR'S DEVELOPMENT

When teaching research students is thought of as promoting the supervisor's development, supervisors pursue their established objectives, determined by their personal and their team agendas.

*generally the way I do work with students is that during the first year they are probably working as a research assistant, learning the ropes. This is what you have to do, you have to do the literature review and this is the kind of program you will have to write and this is how we are going to test it, etc. (I1)*

Supervisors –

- **Direct attention towards:** supervisor's research agenda.
- **Consider the following aspects relevant to supervision:** established agendas; existing network, in order to simplify supervision; leveraging past work; personal survival; hierarchy's expectations of supervisory load.
- **Are less likely to consider:** students and society.
- **See supervision from:** their own perspective.

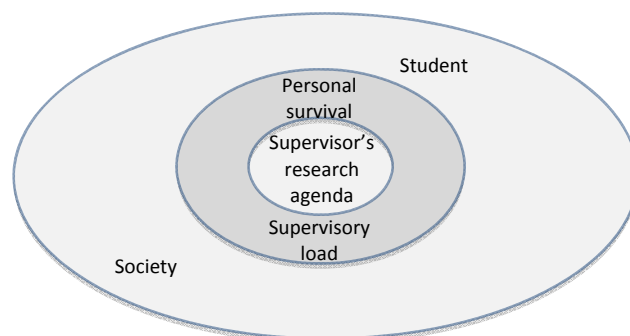


Figure 5. Promoting the supervisor's development



## ENABLING STUDENT DEVELOPMENT

When teaching research students is thought of as enabling student development, supervisors work towards student growth into academic and professional maturity.

*Basically, an independent researcher so they can do all the things that they need to do. They can do their lit review, come up with a variety of solutions and then work on it. So, they will develop a level of independence. (I13)*

Supervisors –

- **Direct attention towards:** student maturity.
- **Consider the following aspects relevant to supervision:** student weaknesses and strengths; student ambitions and interests; student potential.
- **Are less likely to consider:** social needs.
- **See supervision from:** the student's perspective.

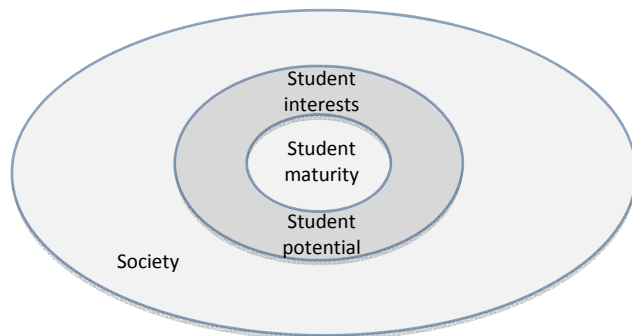


Figure 6. Enabling student development

## CONTRIBUTING TO SOCIETY

When teaching research students is thought of as contributing to society, supervisors define research in terms of society's needs and work towards having positive social impact.

*the ability to reflect very effectively, on their processes to improve them, to be able to contribute better to society. (I2)*

Supervisors –

- **Direct attention towards:** society's needs.
- **Consider the following aspects relevant to supervision:** contribution to society; meeting others' needs; responsible scholarship; relevance to industry; potential to commercialise.
- **Are less likely to consider:** personal and student goals.
- **See supervision from:** the wider community's perspective.

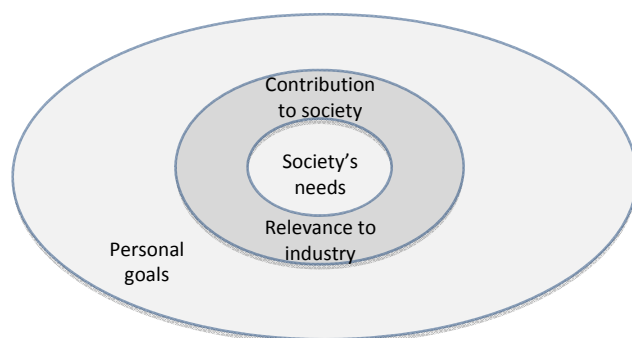


Figure 7. Contributing to society

## IMPARTING ACADEMIC EXPERTISE

When teaching research students is thought of as imparting academic expertise, supervisors convey their expertise in the knowledge and skills needed for research.

*my approach is to lead the student to a path that they find successful by using, as much as possible, my experience on one side and their desire to succeed on the other side. I mean, I always give to the students a certain basis of what I know. (14)*

Supervisors –

- **Direct attention towards:** supervisor's knowledge and skills.
- **Consider the following aspects relevant to supervision:** supervisor's area of interest and expertise; institution's facilities; control over the candidacy.
- **Are less likely to consider:** student and community goals.
- **See supervision from:** their own perspective.

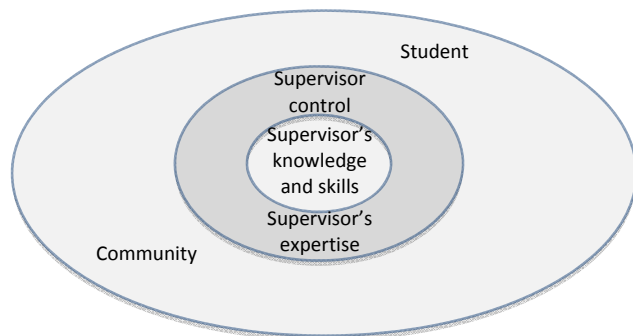


Figure 8. Imparting academic expertise

## DRAWING UPON STUDENT EXPERTISE

When teaching research students is thought of as drawing upon student expertise, supervisors build from existing student abilities and interests in order to pursue a mutually defined question.

*the most important thing I think is to actually get the student to work their way into the topic and to identify what they think are the key issues that they need to resolve. (13)*

Supervisors –

- **Direct attention towards:** student's contribution.
- **Consider the following aspects relevant to supervision:** student interests and expertise; student insights; student as a source of knowledge; student control.
- **Are less likely to consider:** community goals.
- **See supervision from:** the student's perspective.

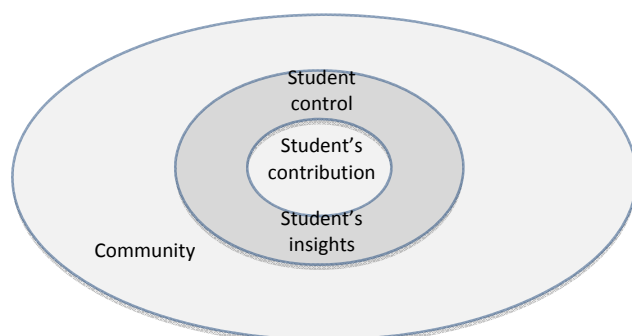


Figure 9. Employing student expertise

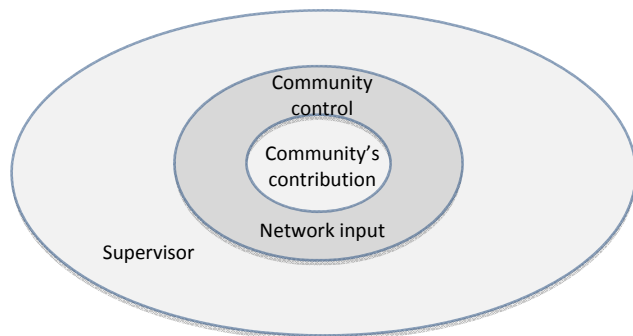
## FORMING PRODUCTIVE COMMUNITIES

When teaching research students is thought of as forming productive communities, supervisors draw key stakeholders together into an active network of contributors to the research endeavour.

*you create a bidirectional flow whereby you have a team or this organization has a very dense network in itself. You have all these dots, but all these dots are very well connected. I want that there is a maximum density in this network. (I12-2)*

Supervisors –

- **Direct attention towards:** community's contribution.
- **Consider the following aspects relevant to supervision:** networks (of students, supervisors and industry partners) in order to introduce alternative points of view; multiple interactions; communication; exploration of possibilities; relinquishment of central control.
- **Are less likely to consider:** supervisor's goals.
- **See supervision from:** the research community's perspective (of students, supervisors and industry partners).



**Figure 10. Forming productive communities**

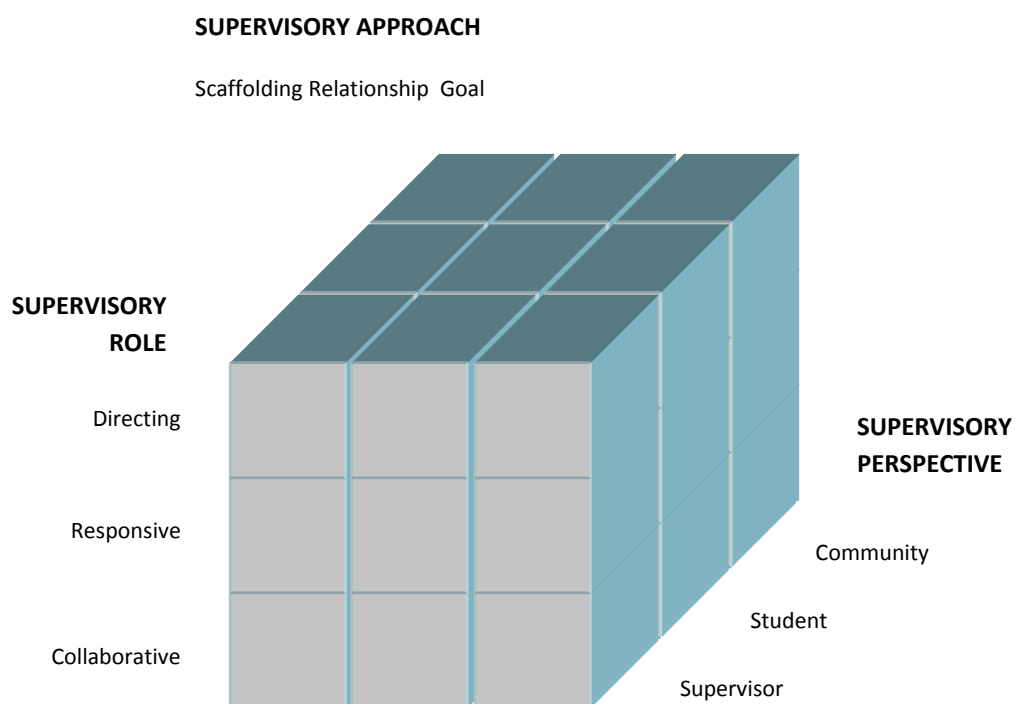
#### IV. HOW MIGHT THE ELEMENTS OF THE FRAMEWORK INTERRELATE?

Key elements of the framework may be interrelated, suggesting that different roles, approaches and perspectives work together in different combinations to influence our supervisory practices.

Everything can map against everything else.

For example, three aspects of the contributing elements may be represented together as in Figure 11:

- the supervisory approach on the horizontal axis (scaffolding, relationship and direction-setting, section 3.1);
- supervisory role on the vertical axis (directing, responsive and collaborative, section 3.5); and
- supervisory perspective on the third axis (supervisor, student and community, section 3.7).



**Figure 11. Interrelationship of some elements contributing to supervision pedagogy**

Examples of what might happen in practice when these elements combine in particular ways are shown in the sections below.

#### 4.1 MAPPING FRAMEWORK ELEMENTS

In this section we show examples of the different practices which might occur if aspects of the framework are mapped against supervisory roles. The relationship between elements of the framework can be mapped in various ways, including:

- Types of groups mapped against supervisory roles
- Approaches mapped against supervisory roles
- Strategies mapped against supervisory roles
- Learning outcomes mapped against supervisory roles.

## TYPES OF GROUPS MAPPED AGAINST SUPERVISORY ROLES

What might happen when particular supervisory roles are adopted in different types of group supervision settings? Examples of practices which may result are shown in Table 9. The horizontal axis represents the type of group employed, that is the number of supervisors and students interacting simultaneously together (see section 3.2). The vertical axis represents the supervisor's role, that is the type of interaction the supervisor has with the student, from directing to collaborative (see section 3.5). The examples are illustrations of what might happen at the points of intersection.

**Table 9. Types of groups and roles**

|               |   |   |  |
|---------------|---|---|--|
| Collaborative | <i>Supervisor and student write a paper together.</i>                       | <i>Supervisors and students work in mixed teams on a project.</i>   | <i>Students and supervisors work together to critique project progress</i>                                   |
| Responsive    | <i>Supervisor shows the student a lab technique they are not mastering.</i> | <i>Supervisor identifies student need in small group and uses large group to provide efficient instruction<br/>Supervisors identified individual needs in large group and arranges small group meetings as required</i> | <i>Supervisors monitor student progress for weaknesses, as the students present their work to the group.</i> |
| Directing     | <i>Supervisor devises a research plan for the student.</i>                  | <i>Supervisor devises plan in small group and uses large group as a forum to monitor progress and provide feedback</i>  | <i>Supervisors assign reading lists and require student reports to the group.</i>                            |
|               | Small group – individual student and one supervisor                         | Mixed – both small and large group  | Large group – many students and many supervisors   |

## APPROACHES MAPPED AGAINST SUPERVISORY ROLES

What might happen if supervisors adopt different roles (section 3.5) whilst using the same approach (section 3.1) to supervision?

Table 10 shows examples of how students and supervisors might interact.

**Table 10. Approaches and roles**

| <b>Approach</b>      | <b>Directing</b>  | <b>Responsive</b>  | <b>Collaborative</b>  |
|----------------------|---|--|---|
| 1. Scaffolding       | Supervisor conceptualises the project as a sequence of related tasks.             | Supervisor refers to formal requirements to respond to student needs.<br>Supervisor refers to establish techniques, in light of student ability. | Supervisor and student plan own strategy to meet project goals. |
| 2. Relationship      | Supervisor and student meet frequently to monitor and negotiate student progress. | Supervisor seeks insight into student needs and makes individual responses to those needs.   | Supervisor and student form a close, productive partnership.    |
| 3. Direction-setting | Supervisor requires the student to pursue the supervisor's agenda.                | Supervisor prompts the student to consider the objectives of the project, as needed.   | Supervisor and student work towards mutually agreed targets.    |

## STRATEGIES MAPPED AGAINST SUPERVISORY ROLES

What might happen if supervisors adopt different roles (section 3.5) whilst using the same strategy (section 3.2) for supervision?

Table 11 shows examples of how students and supervisors might interact.

**Table 11. Strategies and roles**

| <b>Strategy</b>                    | <b>Directing</b>   | <b>Responsive</b>  | <b>Collaborative</b>  |
|------------------------------------|--|--|---|
| A. Creating groups                 | Supervisors and students meet regularly and student input is assessed by the supervisors.                                  | Supervisor holds a seminar on a special topic when they identify a need in their students.                                   | Supervisors and students meet to identify needs and offer solutions.  |
| B. Creating structure              | Supervisor establishes clear expectations about responsibilities.  | Supervisor reviews student work e.g. monthly plan, TOC.  | Supervisor and student devise a research plan together.   |
| C. Generating outputs              | Supervisor requires reports, papers, articles and ultimately a thesis, with specific outputs at specific times.            | Supervisor seeks opportunities which will advance the student in areas of need e.g. conferences at a realistic level.        | Supervisor and student agree on joint outputs and work towards them together.   |
| D. Creating space                  | Supervisor plans down-time for the student.  | Supervisor withholds an answer, so the student can discover it.  | Supervisor and student talk around a wide range of interests to discover each other's contributions.                              |
| E. Establishing collaboration      | Supervisor assigns the student to a research team, comprised of other students.  | Supervisor introduces student to industry and other partners, according to student interests.                                | Supervisor and student establish a working relationship, with give and take on both sides. Supervisor and student learn together. |
| F. Focusing on the big picture     | Supervisor conceptualises the research as a contribution to society.   | Supervisor discusses student's career aspirations and project goals with the student and their influence on the candidature. | Supervisor's and student's strengths and weaknesses are acknowledged as influencers of the candidature.                           |
| G. Negotiating expectations        | Supervisor expresses their expectations clearly e.g. "it is your thesis". Supervisor only accepts high-quality candidates. | Supervisor identifies student expectations and responds to them.   | Supervisor and student discuss their mutual expectations.   |
| H. Pursuing established programmes | Supervisor manages students so they pursue the supervisor's established agenda.  | Supervisor perceives student interest in established programs and directs their attention to them.                           | Supervisor and student have established common interests which they pursue as a team.   |



## LEARNING OUTCOMES MAPPED AGAINST SUPERVISORY ROLES

What might happen if supervisors adopt different roles (section 3.5) whilst striving for the same learning outcomes (section 3.3) to supervision?

Table 12 shows examples of how students and supervisors might interact.

**Table 12. Learning outcomes and roles**

| Learning outcomes   | Directing  | Responsive   | Collaborative  |
|---|--|--|--|
| 1. Topic expertise  | Supervisor chooses the topic and imparts their insights.   | Supervisor helps students discover their passion.  | Supervisor and student pursue a topic of mutual interest and contribute equally.           |
| 2. How to get resources                                   | Supervisor chooses the literature and monitors student's understanding. Supervisor assesses the logic of student's insights. | Supervisor supports the student as they navigate unsteadily.   | Supervisor looks to student to discover new literature and see new connections.            |
| 3. Independence   | Supervisor designs student experiences to compel autonomous action.  | Supervisor encourages student initiatives as they occur.   | Supervisor and student fulfil responsibilities interdependently.                           |
| 4. Contributing to society                                | Supervisor refers to ethics committee requirements.  | Supervisor discusses ethical implications of research with student.  | Supervisor and student are attentive to the ethical implications of the project.           |
| 5. Teamwork skills and membership in a research community | Supervisor organises research group around a common topic and requires joint work, to a defined timeline.                    | Supervisor is alert to teamwork possibilities but lets the student choose whether to engage or not. Supervisor monitors progress against a timeline. | Supervisor and student form a productive team.   |
| 6. Publishing   | Supervisor sets the goal of the number of publications and rank of journals/conferences.                                     | Supervisor suggests publishing opportunities and edits student's work extensively.   | Supervisor and student write and conceptualise together.                                   |
| 7. Developing as a professional                           | Supervisor presents the implications in society of holding doctoral qualifications.  | Supervisor offers experiences related to the student's career interests.   | Supervisor and student work together on activities relevant to the student's career goals. |

## V. A LONGER VERSION OF THE FRAMEWORK IN SUMMARY FORM

The following table presents most of the elements in summary form.

**Table 13. A framework for thinking about supervision as pedagogy in the technology disciplines (long version)**

| Pedagogies   |                                   | Supervisors' approaches  | Sample learning outcomes   | Supervisors see research as  | Supervisors see students learning to research as   | Supervisors' related roles | Curriculum frames   |
|--|-----------------------------------|--|--|--|--|----------------------------|---------------------|
| Supervisors see teaching research students as  | Attention directed towards        |  |  |  |  |                            |                     |
| <b>Upholding academic standards</b><br><i>Meeting the discipline and institutional communities' expectations</i> | Established academic standards    | <ul style="list-style-type: none"> <li>• Scaffolding</li> <li>• Direction-setting</li> </ul> | <ul style="list-style-type: none"> <li>• to be hard workers</li> <li>• quality publications</li> <li>• topic expertise</li> </ul>  | <b>Substantial</b><br><i>Working rigorously on difficult problems, resulting in important breakthroughs</i><br>Substantial ideas, tackling difficult problems, finding solutions, arriving at an informed view, sound methodology, 'good' results, rigor, hard work, disciplining the mind, intensive. | <b>Accepting constraints</b><br><i>Disciplined application of basic skills to new areas</i><br>Developing habits, applying basic skills, methods and tools (to new problems), disciplining the mind, applying a high work ethic, grasping fundamentals, constructing an argument, interrogating existing research, seeking out resources, structuring any topic. | Manager                    | Academic discipline |
| <b>Imparting academic expertise</b><br><i>Conveying expertise in research processes</i>                          | Supervisor's knowledge and skills | <ul style="list-style-type: none"> <li>• Scaffolding</li> <li>• Relationship</li> </ul>      | <ul style="list-style-type: none"> <li>• project management</li> <li>• ability to write academically</li> <li>• how to do a literature review</li> <li>• technical skills</li> </ul> | <b>Investigative</b><br><i>Strategic, evidence-based problem solving</i><br>Problem-solving techniques, persistent, systematic, strategies for understanding, obtaining relevant resources, evidence-based.  | <b>Being apprenticed</b><br><i>Imitating a master</i><br>Imitation, apprenticeship, following a model, walking alongside a researcher (initially), following expert advice, understanding process and standards.   | Manager                    | Competency          |

| Pedagogies   |                            | Supervisors' approaches   | Sample learning outcomes   | Supervisors see research as   | Supervisors see students learning to research as   | Supervisors' related roles | Curriculum frames  |
|--|----------------------------|---|--|---|--|----------------------------|--------------------|
| Supervisors see teaching research students as  | Attention directed towards |   |  |   |  |                            |                    |
| <b>Promoting learning to research</b><br><i>Meeting students' learning needs</i>                         | Students' learning needs   | <ul style="list-style-type: none"> <li>Scaffolding</li> <li>Relationship</li> </ul> | <ul style="list-style-type: none"> <li>how to become an expert</li> <li>reflection skills</li> <li>developing study habits</li> </ul>                      | <b>Meaning-making</b><br><i>Seeking meaning through the synthesis of complex data or knowledge</i><br>Gaining insight, finding solutions to problems.                 | <b>Journeying</b><br><i>Self-discovery by trial and error, towards independence</i><br>Working into the project, learning about self, discovery by trial and error, learning to choose focus, stumbling journey (with excellent hindsight), climbing by yourself (with encouragement and guidance), developing independence, being self-starting and self-monitoring, linking broad and deep knowledge, tolerating rejection and learning from it, learning to choose which advice to listen to. | Coach                      | Learning to learn  |
| <b>Promoting the supervisor's development</b><br><i>Pursuing the supervisor's established objectives</i> | Supervisor's agenda        | <ul style="list-style-type: none"> <li>Direction-setting</li> </ul>                 | <ul style="list-style-type: none"> <li>join an established research team</li> <li>enter supervisor's projects</li> </ul>                                   | <b>Deepening</b><br><i>Increasing self awareness through an iterative process</i><br>Iterative, narrowing focus, deepening self, understanding your own contribution. | <b>Focussing</b><br><i>Pursuing mature, world-class expertise</i><br>Pursuing a passion, aiming to be the world's expert, developing into a mature researcher and colleague, embodying research, internal processes, shouldering responsibility for the research, 'hitting a gear'.  | Director                   |                    |
| <b>Enabling student development</b><br><i>Seeking students' academic and professional maturity</i>       | Student maturity           | <ul style="list-style-type: none"> <li>Relationship</li> </ul>                      | <ul style="list-style-type: none"> <li>leadership skills</li> <li>an independent, mature researcher</li> <li>ability to question the status quo</li> </ul> |   |  | Nurturer                   | Personal relevance |

| Pedagogies  |                            | Supervisors' approaches   | Sample learning outcomes   | Supervisors see research as  | Supervisors see students learning to research as   | Supervisors' related roles | Curriculum frames |
|---|----------------------------|---|--|--|--|----------------------------|-------------------|
| Supervisors see teaching research students as   | Attention directed towards |   |  |  |  |                            |                   |
| <b>Contributing to society</b><br><i>Having social impact</i>                                 | Society's needs            | <ul style="list-style-type: none"> <li>Direction-setting</li> <li>Relationship</li> </ul> | <ul style="list-style-type: none"> <li>to develop substantial and innovative solutions</li> </ul>  | <b>Productive</b><br><i>Usefully satisfying a range of stakeholders</i><br>Useful to industry, satisfying stakeholders, commercial value.  | <b>Contributing</b><br><i>Exploring positive impact on others</i><br>Coming to understand the impact of research on society. | Partner                    | Social impact     |
| <b>Venturing into unexplored territory</b><br><i>Discovering the research agenda together</i> | New frontiers              | <ul style="list-style-type: none"> <li>Direction-setting</li> <li>Relationship</li> </ul> | <ul style="list-style-type: none"> <li>creation of innovative systems</li> <li>employ out-of-the-box thinking</li> </ul>   | <b>Explorative</b><br><i>Following speculative leads which challenge norms</i><br>Newness, following leads, thinking outside the square, big risks leading to big steps, exploring esoteric thoughts, asking big questions, questioning norms. | <b>Stretching</b><br><i>Being stretched into new areas</i><br>Expanding into new areas, big changes, cutting edge.           | Colleague                  |                   |
| <b>Drawing upon student expertise</b><br><i>Building from existing student abilities</i>      | Student's contribution     | <ul style="list-style-type: none"> <li>Relationship</li> </ul>                            | <ul style="list-style-type: none"> <li>become the world expert</li> <li>teach the supervisor</li> </ul>  |  |  | Guide                      | Collaborative     |
| <b>Forming productive communities</b><br><i>Drawing key stakeholders together</i>             | Community's contribution   | <ul style="list-style-type: none"> <li>Direction-setting</li> <li>Relationship</li> </ul> | <ul style="list-style-type: none"> <li>to develop an international network</li> <li>membership in a research community</li> <li>work across discipline boundaries</li> </ul> | Colleague  |  |                            |                   |

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