COOPERATIVE RESEARCH CENTRES ASSOCIATION

The CRC Contribution to Research Training

Report of a Scoping Study for the Cooperative Research Centres Association

cshe centre for the study of higher education

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December 2012

978-0-9874649-0-3

The CRC Contribution to Research Training: Report of a Scoping Study for the Cooperative Research Centres Association was prepared for the Cooperative Research Centres Association by the Centre for the Study of Higher Education at the University of Melbourne.

Recommended attribution:

Palmer, N. (2012). *The CRC Contribution to Research Training*. Canberra, Australia: Cooperative Research Centres Association.

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Contents

Acknowledgements

This scoping study was commissioned by the CRC Association to investigate the definition and measurement of the CRC contribution to research training. The author would like to thank the many individuals whose insight has been invaluable in compiling this report.

Thanks goes to the education managers of the CRC program who invest significant efforts in supporting CRC-engaged research higher degree candidates. Thanks also to Sid Bourke and Rachael Pitt for providing expert advice and to Joe Luca, Trish Wolski and Sarah Booth of the Best Practice Framework project team.

Special thanks goes to the CRC Branch of the Department of Industry, Innovation, Science, Research and Tertiary Education for their assistance and support for the scoping study. Thanks also to the CRC members and interested stakeholders who have assisted in the preparation of this report.

Acronyms and key terms

Advisor/ Graduate Advisor	The terms supervisor, advisor and graduate advisor are used interchangeably in this report to refer to any member of a candidate's graduate advisory panel.
Candidate	The terms *student* and *candidate* are used interchangeably in this report to refer to someone currently enrolled in a research higher degree.
CRC	Cooperative Research Centre.
CRC Research Candidate	Research higher degree students who work on CRC activities and who are regarded as part of the CRC.
Research education	The terms *research training* and *research education* are used interchangeably in this report. While CRCs engage in a broad range of research education activities, for the purposes of this report research education is understood as efforts directed to supporting the attainment of research higher degrees and related activities.
Research higher degree (RHD or HDR)	Research masters and research doctoral degree programs as per levels 9 and 10 of the Australian Qualifications Framework (AQF). While many coursework programs do have a significant research component they fall outside of the scope of this report.
Research training	See *Research education.*
Student	See *candidate*.
Supervisor	See *advisor/graduate advisor.*

Foreword

One of the most satisfying aspects of being involved with Australia's Cooperative Research Centres is undoubtedly working with postgraduate students. CRCs have the freedom and flexibility to go beyond a basic level of research training. We can organise industry involvement and supervision to support a broader outlook than the typical research degree experience. Postgraduates challenge established researchers to look at problems in different ways. They remind us of why we do research - to make a difference - whether that difference is increasing our wealth, restoring our environment or improving our wellbeing.

Training postgraduates is also one of the most important jobs that CRC researchers do. Australia ranks very low among the OECD countries in terms of PhD-level researchers working in industry. Any action we can take to improve the interaction of academia and industry is to be applauded. Postgraduate exchange and training across industry and universities is one of the best things we can do. It can improve the process and relevance of research as well as break down cultural barriers. Inevitably, researchers find their work more exciting, more fun and more satisfying when they can see it having an impact.

The skills needed for working in industry and for working in academia often differ. But that doesn't mean that clever people can't learn both, or at least become familiar with both. Cooperative Research Centres are able to offer the opportunity to postgraduate researchers to become familiar with the skills needed to work in industry, as well as familiar with differences across culture and context. Indeed, a surprisingly large number of postgraduate researchers have already worked in industry and are upgrading their research skills with the intention of returning to industry. This is one of the reasons we can't offer a "one size fits all" model for postgraduate development. We must offer personalised programs that best suit the individual.

In this report, author Nigel Palmer has tracked down the completion rates of CRC-trained postgraduates as one means of measuring success. They compare well with Australia's best Universities. Nigel has also begun to flesh out what it means to provide "good" postgraduate training in an industry-focussed setting. The Cooperative Research Centres Association hopes to take this work forward to ensure that every CRC is providing the best possible training and opportunities for its postgraduate students. We know that by doing so, they will make a decades-long impact on their sector.

Tony Peacock
Cooperative Research Centres Association
December 2012

Executive Summary

This report summarises findings from a scoping study conducted for the Cooperative Research Centres Association (CRCA) by the Centre for the Study of Higher Education. The purpose of the scoping study is to inform the research training activities of Cooperative Research Centres (CRCs). While previous studies have focussed on the outcomes supported by the CRC research training activities, the focus of this report is on the inputs and processes invested by Cooperative Research Centres in supporting quality research education outcomes, and the measures of performance in which they are reflected. Findings from the scoping study reflect a diverse range of research training activities supported by CRCs.

Key findings include:

- Supporting quality research education in partnership with universities is among the **central objectives** of the CRC program;
- CRCs are the **12th largest provider of research training nationally** by overall research student load;
- In partnership with universities, CRCs represent the **9th largest provider of doctoral completions** overall;
- When compared with universities **CRCs rank 8th nationally in supporting doctoral completions**; and
- When compared with university groups, CRCs perform **among the best nationally in supporting doctoral completions**, second only to the Group of Eight.

Findings from this study are intended to inform the collection and dissemination of information on CRC research training activities, assist in identifying markers for distinctiveness in the CRC contribution to research education, inform related benchmarking activities and inform recommendations for future development.

Key areas highlighted for future development include:

- Improved metrics to reflect the CRC contribution to research training;
- Improved data collection around CRC research training activities;
- Possible improvements to the Management Data Questionnaire (MDQ); and
- Improved resource sharing among member CRCs.

The report is structured as follows:

- **Section 1: The CRC program and research education** summarises developments to date around the CRC contribution to research training in research, policy and practice;
- **Section 2: Measures of quality and scale in research training** summarises available measures for the CRC contribution to research training, and opportunities for future development;
- **Section 3: Markers for quality and distinctiveness** outlines broad domains for research education, and provides an overview of CRC research education activity and areas where CRCs are able to make a distinctive contribution; and
- **Section 4: Strategies for sustainability and opportunities for future development** outlines opportunities for future development.

1 The CRC program and research education

CRCs set the benchmark for research cooperation in Australia. As user-driven centres for collaborative research, CRCs make an important contribution to Australia's innovation capacity through bringing stakeholders together to address applied problems. The CRC program was established with the aim of supporting a long-term approach to investment in research through strategic partnerships with industry. As of 2010 there were 42 CRCs engaged with over 370 partner organisations both large and small. Many more Australian firms have been engaged with CRCs over the life of the program.

Research education represents an important part of a long-term approach to building and sustaining research capacity, and has featured as an important part of the CRC program since its inception. Central to this has been the role of CRCs in engaging research higher degree students as partners in collaborative research. CRCs support the development of 'industry ready' research graduates through providing opportunities for engagement and collaboration with government, business and community sector partners in the course of a research degree. In 2008 the CRCA estimated that roughly 1,500 PhD candidates were engaged with CRCs at that time (CRCA, 2008, p.5). Findings from a 2010 study suggest that depending on scale it would be realistic to expect something in the order of 50 RHD successful graduates over the lifetime of a single CRC (Montagu, 2010).

The CRCA have determined that adding value to the research student experience for candidates engaged with CRCs should feature among the priorities of the Association, and that member CRCs could benefit from additional resources in this area. To this end the CRCA have commissioned a scoping study with the aims of enhancing, supporting and informing member CRC efforts in supporting a quality research training experience.

Findings from this study are intended to inform the collection and dissemination of information on CRC research training activities, assist in identifying markers for distinctiveness in the CRC contribution to research education, and inform recommendations for future development. While previous studies have focussed on the outcomes supported by the CRC research training activities, the focus of this report is on the inputs and processes invested by Cooperative Research Centres in supporting quality research education outcomes. Findings from this scoping study are also intended to inform future CRC benchmarking activities in this area.

A general view on the nature and extent of the CRC contribution to research training may depend on who you ask. From a university perspective, CRCs may be regarded as an additional add-on for some of their research students. From a CRC perspective however, it often seems that CRC-engaged research candidates are regarded as the CRC's research students, with the university contribution being more administrative than practical in nature. In truth of course the nature and extent of the CRC contribution to research training will vary on a case-by-case basis, with research students typically seeking out the resources and support that best suit them and the needs of their project. The challenge for CRCs however is in demonstrating the contribution they make to research training, as part of their broader education and research activities.

1.1 Developments in research, policy and practice

There has been a range of developments relevant to the research training activities of CRCs over the life of the program. These broadly fall across research, policy and practice, as outlined below.

1.1.1 Policy

Research training featured prominently among the founding objectives for the CRC program, and this emphasis continues to be reflected in program objectives and through CRC selection criteria through the 1990s, as summarised below.

Table 1 CRC Education and Training Program Objectives and Selection Criteria 1991 – 2006

<table>
<tr><th></th><th>1991</th><th>1992</th><th>1996</th><th>2000-2002</th><th>'04-</th></tr>
<tr><td>Objectives</td><td colspan="3">To stimulate education and training, particularly in graduate programs, through the active involvement of researchers from outside the higher education system in educational activities, and graduate students in major research programs.</td><td>To enhance the value to Australia of graduate researchers.</td><td rowspan="2">(No specific reference)</td></tr>
<tr><td>Criteria</td><td></td><td>The existence of challenging educational programs which benefit from the overall size and orientation of the Centre, and address identified market needs.</td><td>The development of leading innovative education and training activities that meet industry sector needs and enhance the employment prospects of graduates.</td><td rowspan="2">The proposed CRC has a well developed graduate education and training program oriented to research user and industry needs. The education and training program will demonstrably enhance the employment prospects and the value of the graduates of the program in the industry and user environment.</td></tr>
<tr><td></td><td colspan="3">The extent to which researchers from throughout the Centre are involved in education programs, particularly postgraduate programs.</td></tr>
</table>

From *Collaborating to a Purpose* (2008, p.24).

Revisions in 2000 refocussed CRC program objectives and criteria on the value of graduates to industry. Specific reference to research education in program objectives and criteria was dropped altogether from 2004, leaving only the requirement that CRCs engage at least one university as a research partner in order to meet their research training requirements (DIISR, 2010b).

Despite this apparent change in emphasis, reviews of the program have continued to emphasise the importance of the CRC program's research education role in developing Australia's innovation capacity, and in facilitating end user engagement in and uptake of the benefits of applied research. The O'Kane review for example clearly identified PhD graduates as an important means through which the benefits of research collaboration may be conveyed, and proposed a greater emphasis on end-user focussed education (especially at PhD level) through partnerships with universities, other research agencies and end-user groups (Recommendation 2, O'Kane, 2008, pp.xv-xvi).

While the selection process for CRCs currently includes accounting for the quality of the educational program by peer review, those criteria do not provide for how that quality might be judged. CRCs are currently required to engage at least one university as a research partner in order to meet their research training requirements (DIISR, 2010b). Beyond that the only formal requirements are in regard to annual reporting activities. The O'Kane review recommended the development of common metrics for evaluation and comparison across all CRCs, and that these also include metrics on research education. The implication here is that minimum levels of

acceptable performance in research training might also feature among threshold requirements for CRC program funding (recommendation 7.4, O'Kane, 2008, p.xx).

CRCs have maintained research education as a priority, with many centres devoting considerable resources to the development and improvement of the experience and outcomes of CRC engaged candidates. CRC research training to date has been supported by affiliated universities' RHD program policies, procedures and development initiatives. There has been preliminary engagement across CRCs on strategies to capitalise and build on these strengths, however opportunities exist for developing a clearer view of the commonalities and strengths across CRCs for supporting industry-engaged research higher degrees. Given that CRCs play a leading role in supporting industry-engaged research higher degrees, there may also be opportunities for CRCs to inform broader efforts in the development of Australia's research workforce capacity in this area.

1.1.2 Research

A series of research initiatives were engaged through the 2000's into the experiences and outcomes of research higher degree students engaged with CRCs (Manathunga, Pitt & Critchley, 2005; Manathunga, Pitt & Critchley, 2009; Pitt, Cox & Manathunga, 2010a, 2010b; Morris, Pitt & Manathunga, 2011), and into the role of industry links in research training more broadly (Harman, 2002, 2004; Harman, 2008). Findings from these research initiatives have broadly affirmed the role of CRCs in supporting industry-engaged research higher degrees, and the need for strategies to ensure that CRCs serve to add value to the research training experience for individual candidates.

Significant efforts have been made to date to evaluate the distinctiveness of CRC RHDs, in terms of CRC research student characteristic, and based on evidence of their satisfaction and of outcomes. Important contributions to this area include the following:

- *The Research Training Experiences of Doctoral Students Linked to Australian Cooperative Research Centres* (Harman, 2002);
- *Producing 'industry-ready' doctorates: Australian Cooperative Research Centre approaches to doctoral education* (Harman, 2004);
- *Challenging traditional research training culture: Industry-oriented doctoral programs in Australian Cooperative Research Centres* (Harman, 2008);
- *Australia's future research leaders: Are they coming from CRCs?* (Manathunga, Pitt & Critchley, 2005);
- *Students' experiences of supervision in academic and industry settings: results of an Australian study* (Morris, Pitt & Manathunga, 2011);
- *Cooperative Research Centre PhD graduates* (Pitt, Cox & Manathunga, 2010a);
- *Gender differences of PhD graduates 5- to 10-years post-PhD* (Pitt, Cox & Manathunga, 2010b).

A 2010 survey of current and former research students with the Irrigation Futures CRC found that students report their engagement with a CRC as adding between 50 and 100 per cent additional value over and above that provided by their university (Montagu, 2010). Unpacking what supports this perceived 'value add' however remains an challenge – one that would not only help

CRCs in demonstrating their contribution to research training, but also in monitoring and supporting improvements in quality over time.

Findings to date have provided important insight into some of the distinctive characteristics of CRC-engaged research higher degrees, comparisons between CRC and non-CRC engaged research candidates and a preliminary view of comparative outcomes. Noting results from pilot studies available at the time, the O'Kane review highlighted the need for further research into the research training environment supported by CRCs (O'Kane, 2008, p.66). Opportunities exist to build on this research in providing a clearer picture of the defining characteristics of CRC-engaged research degrees, and to more clearly identify indicators through which the quality and success of CRC-RHDs may be reflected and improved.

1.1.3 Practice

The CRC program was established as a means of encouraging collaboration in research between universities and industry. While it is clear that CRCs are able to support an innovative environment for research education, it is less clear how evidence for this may be sought and performance demonstrated. While it is also clear that research training with CRCs offers many benefits, it is less clear how evenly these benefits feature across CRCs or how the benefits of research training with CRCs may be communicated more broadly.

Every CRC is required to secure a commitment from at least one Australian university to guarantee supervisory arrangements for research students associated with the Centre (for which funding is provided from the CRC). The O'Kane review noted that from the university perspective there was considerable prestige in being associated with a successful CRC bid, and that CRCs were considered a good source of additional funding for supervision, and for PhD scholarships (O'Kane, 2008, p.35). As a condition of this partnership, the university must guarantee to provide supervision for PhD students associated with the Centre, and be 'continually vigilant in ensuring the research training experience for students is comprehensive and in line with industry and educational needs' (O'Kane, 2008, p.xvii).

The extent to which CRCs supplement the 'core' research training for CRC engaged RHDs provided by universities remains unclear. It may well be that it is the students themselves that determine this balance, seeking out the resources and support that best suit them and the nature of their research. Rather than seek to establish the exact nature of the arrangements one way or the other, it perhaps makes sense to review the nature and characteristics of CRC education programs, and the way these 'map' with research higher degree programs supported by universities. A more comprehensive evidence base in this area will assist in demonstrating strengths in the CRC research training environment, as well as identify opportunities for future improvement.

1.2 Key challenges

The CRC program is now in its 21st year. It should be possible to determine whether a CRC-engaged research education experience makes a demonstrable difference for research graduates over and above that supported by other research training opportunities. It should be possible to develop and communicate a coherent view of the nature of the CRC research training environment and its relative merits. While significant insight has been gained through developments in research, policy and practice to date, additional resources are needed to inform planning and development of the research education activities of CRCs.

2 Measures of quality and scale in research training

The report on the development of the Australian Government's *Research Workforce Strategy* noted that CRCs have been a leader in collaborative research training for some time, supporting the development of a broad suite of skills and promoting engagement with industry and other research end-users (DIISR, 2011c, p.23). The CRC program is frequently commended for making a unique contribution to research training through supporting industry engagement, and on the available evidence this certainly seems to be the case. Beyond industry engagement however the CRC contribution to research training has received relatively little attention to date.

The principal means of government support for research training in Australia is known as the Research Training Scheme (or RTS). Through the RTS higher education providers receive Commonwealth funding for each domestic research higher degree candidate. Aims of the scheme include supporting quality, efficiency and effectiveness in research training and responsiveness to the needs of both the labour market and of students (Other Grants Guidelines (Research), 2010, p.11). On the face of it, these aims seem compatible with what CRCs do, and arguably do well in the area of research training. One way of demonstrating the CRC contribution to research training is to apply the same criteria for quality and performance as used in evaluating and comparing university providers.

Enrolment metrics support the basic measures in evaluating the efficiency and effectiveness of research training provision. Research degree completion rates have been a prominent indicator for performance in research training for some time (Linke, 1991; West, 1998; Kemp, 1999b, 1999a; Martin, 1999). Other measures used include total enrolments, degree completions and full-time equivalent student load. These basic measures combine to provide other indicators, such as student attrition and rates and times for student completion. The Australian Government is currently undertaking a review of the RTS, including ways in which quality in research training may be measured and encouraged (DIISR, 2011b). Among challenges for the current review of the RTS is to define what quality in research training is and how it can be measured and encouraged. These questions are cast in a particular light given a recent shift away from a fitness-for-purpose approach to quality assurance to one premised on standards and the assessment of risk (Palmer, 2012b). It is timely then to consider the potential application of similar measures for quality and performance in the CRC context, as these are also currently under review in the case of universities.

CRCs report annually on their performance and progress as part of their program requirements. The Management Data Questionnaire (MDQ) is currently the principal means for collecting information on the activities of CRCs program-wide. The MDQ includes survey items relevant to a range of education-related activities. Current MDQ items relevant to CRC research training activities include:[1]

- The equivalent full-time student load (EFTSL) of students;
- The number (headcount) of commencing students; and
- The number (headcount) of course completions.

[1] DIISR (2011). Annual Report Guidelines. Canberra, Australia: Department of Industry, Innovation, Science and Research (DIISR). Relevant items from the MDQ are included here as Appendix II.

Indicators for quality and performance in the CRC contribution to research training are useful both in demonstrating the value of this contribution and in benchmarking CRCs against university providers. To do this effectively CRCs need to be able to use a reliable set of indicators that are comparable both between CRCs and between CRCs and university providers. This section outlines each of the standard enrolment measures, and their potential application in the case of CRCs. The subsequent section outlines a broader range of aspects with a more direct focus on enhancing quality and sustainability in research training provision.

2.1 Student load

Total student load is a measure of scale in student enrolments. Student load data summarise enrolments counted on a full-time equivalent basis. Student load differs from enrolment measures that count numbers of students in summarising all student enrolments based on the proportion of a typical full time enrolment for a given course of study. There are two different ways student load is generally used. The first is to summarise the proportion of program enrolment for groups of students at a particular point in time (total student load). The second is to describe degree program enrolment time for each individual student (referred to in the case of research students as full-time equivalent candidature time, or simply candidature time).

2.1.1 Total student load

Total CRC research student load in 2010 was 1,270 (FTE), making the CRC program the twelfth largest research training provider for that year based on reported full time equivalent student load, as outlined in Table 2 below.[2]

Table 2 Research student load (2010): CRC program with 15 largest university providers

Rank	Provider	Research Doctorate	Research Masters	Total RHD load
1	The University of Sydney	2,831	642	3,473
2	The University of Melbourne	2,727	493	3,220
3	The University of Queensland	2,683	293	2,976
4	Monash University	2,368	500	2,868
5	The University of New South Wales	2,420	404	2,824
6	The Australian National University	1,804	93	1,897
7	The University of Western Australia	1,434	187	1,621
8	The University of Adelaide	1,255	145	1,400
9	Queensland University of Technology	1,071	277	1,348
10	Curtin University of Technology	1,114	185	1,299
11	Macquarie University	1,229	61	1,290
	CRC Program	**1,219**	**51**	**1,270**
12	RMIT University	1,004	173	1,177
13	University of Wollongong	928	169	1,097
14	Griffith University	988	82	1,070
15	La Trobe University	927	130	1,057

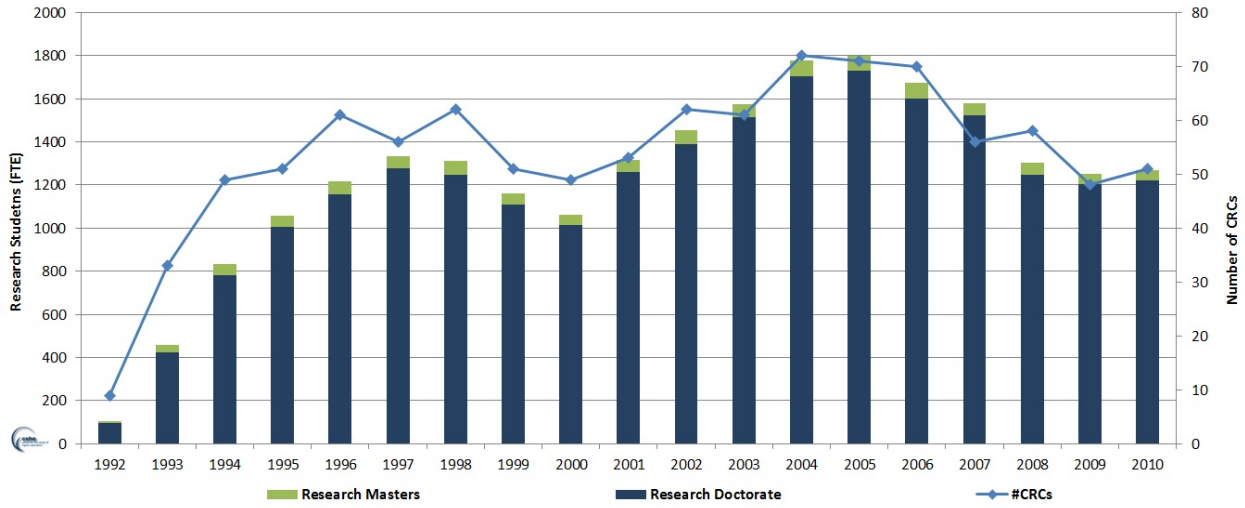
Sources: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), DIISR and *Students 2010 (full year), Selected Higher Education Statistics* (DEEWR, 2011).

Total CRC student load has varied over the life of the program from 103 FTE in 1992 to 1,798 FTE in 2005, as reflected in Figure 1 below. While total CRC student load appears to vary over the life of the program, much of this variation is accounted for by changes in the number of CRCs

[2] CRC's support research candidates in partnership with university providers, therefore CRC student load may be counted twice in comparisons such as the one outlined in Table 2 above.

participating in the program. To illustrate this the number of active CRCs each year is also outlined in Figure 1.

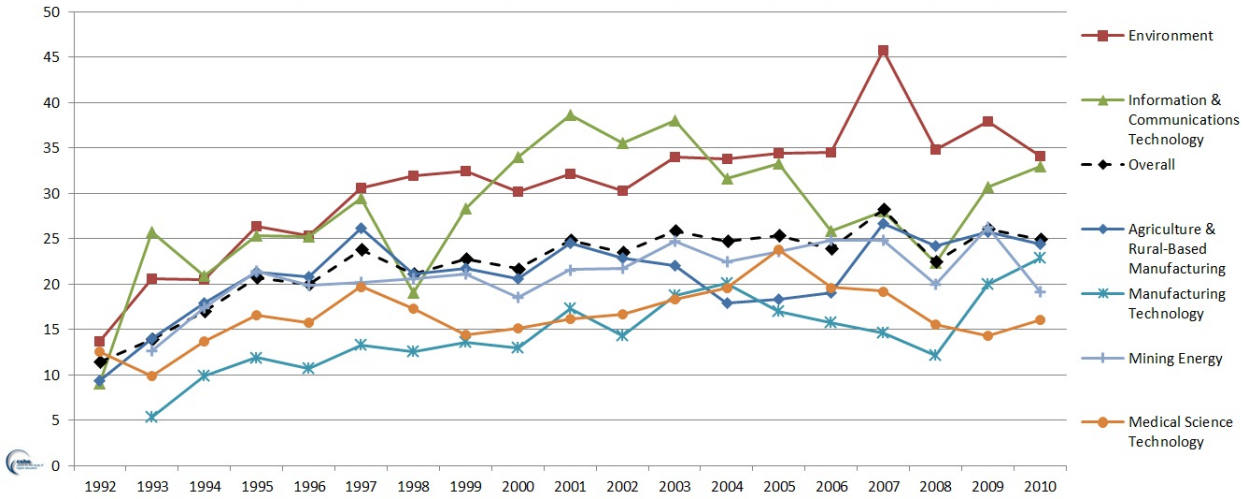
Figure 1 Research Higher Degree Students Engaged with CRCs (full time equivalent) 1992-2010



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

The average number of candidates per CRC by student load in 2010 was 25, and overall this average has remained fairly stable at roughly 24-25 FTE research candidates per CRC since the late 1990s. The average number of research higher degree students per CRC is outlined in Figure 2 below, grouped by sector.

Figure 2 Average Research Higher Degree Student load (FTE) per CRC by Sector



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

Total student load summarises the proportion of a typical full time enrolment recorded for groups of students at a particular point in time. These are typically expressed as full time equivalent (FTE) enrolments. This means for example that a student load of 100 reported as of a census date summarises the proportion of full time enrolment recorded for 100 students or more. If all students enrolled in this example were full time, then there would be 100 students enrolled for a total student load of 100 FTE. If however at that point in time 20% of student load was accounted for by candidates studying part time at 0.5 FTE, then a total student load of 100 would summarise the proportion of full time enrolment for 120 students (80 full-time and 40 recorded at 0.5 FTE). Student load data therefore have the effect of 'masking' trends in part time enrolment, and

should be used with care, particularly in the case of research higher degree students. Full time equivalent enrolments provide an indication of the scale of activity in research training, and to a lesser extent the resources required to support that activity. Caution should also then be used when using FTE data to estimate resource requirements, as resources are often allocated or used on a per-candidate rather than per-FTE basis.

2.1.2 Full time equivalent candidature time

The second commonly used FTE measure is full time equivalent candidature time. Per-student FTE enrolment data is typically used to track the allocation and use of enrolment entitlement (typically referred to as Equivalent Full-Time Student Load (EFTSL)). It is also used to reflect the time taken to complete a course of study. Research on patterns in the part-time enrolment of research doctoral candidates shows that nearly half of all domestic research candidates may be enrolled part-time in any given semester, with trends varying from 31% in engineering to 75% in education (Palmer, 2011a). Individual students' enrolment status is also less of a static category than many may assume, as research higher degree students actively use variation in enrolment status over time in completing their degree (Pearson et al., 2008). A study of PhD candidates by Bourke et al. found that almost one third of completing candidates reported a mix of periods of full and part time enrolment in completing their degree with the remainder either entirely full-time (55%) or entirely part-time (14%) (Bourke et al., 2005, p.8).

Full time equivalent candidature time (also referred to as candidacy time (Bourke et al., 2005)) is a more accurate basis for evaluating and comparing completion times than measures like elapsed calendar time to completion (a simple measure derived through subtracting the date of commencement from a census date or date of completion). This is due to the variation noted above in part-time enrolment patterns for research higher degree candidates (see also Bourke et al., 2005; Pearson et al., 2008; Palmer, 2011b). Bourke et al.'s analysis of attrition and completion for research doctoral candidates was clear in recommending what they refer to as candidacy time as the most reliable and accurate measure for evaluating and comparing completion rates and time to completion. Their study arrived at a mean PhD candidacy time of 7.4 semesters (3.7 years on a two-semester basis) compared with a median elapsed 'calendar' time to completion of 8.8 semesters (4.4 years) (Bourke et al., 2005, p.8). Their study also found that part-time candidates actually make more efficient use of candidature time than their full-time colleagues. The findings from Bourke et al. in a sense point to an inverse relationship between speed and efficiency in research higher degrees. Candidates enrolled mostly full-time will very likely finish earlier, but make less efficient use of candidature time than candidates predominantly enrolled part time.

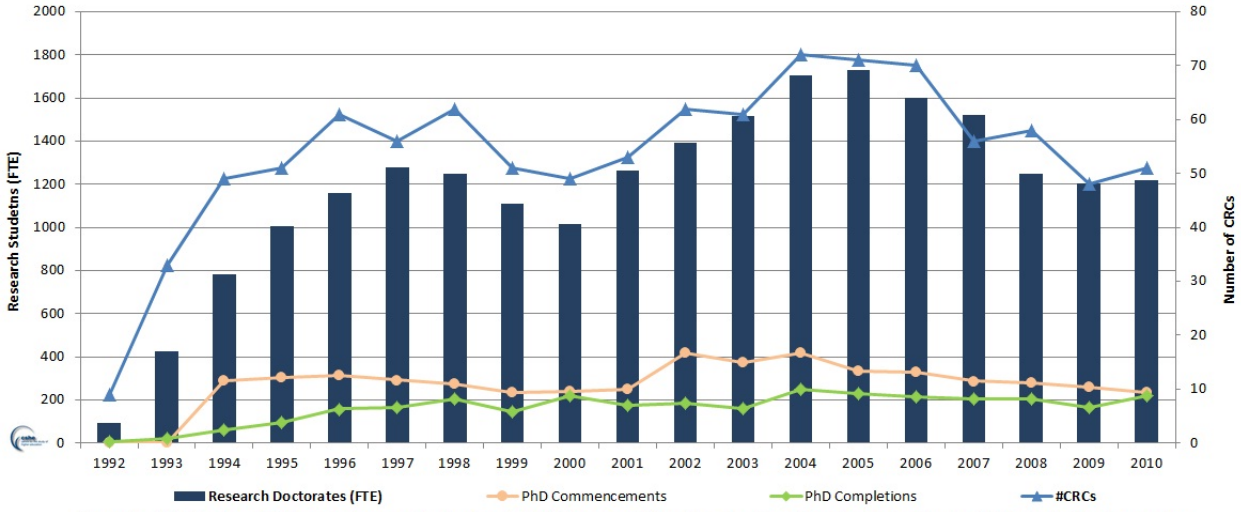
While an analysis along the lines of that outlined by Bourke et al. would represent good practice in the collection and reporting of accurate time to completion data, this is not currently possible based on the information collected for CRC-engaged research candidates (either through the MDQ or otherwise). While valuable in more accurately determining the completion rates and times, collecting information of this kind would not be a straightforward matter. It would require each CRC compiling cumulative FTE candidature time for each candidate, possibly accompanied by an anonymous unique student identifier in each case. One alternative would be formalising arrangements for requesting and compiling FTE candidate data from each candidate's university provider. This may also require additional measures to ensure the information compiled was collected and reported consistently.

2.2 Total student enrolments

Total student enrolments are the closest indication of a student 'head count' available through commonly used enrolment metrics. Total student enrolments capture the number of students regardless of their enrolment status. While all CRCs would know the 'head count' for the research candidates they engage, there is currently no program-wide data readily available on the total number of research candidates engaged with CRCs. Summarising total student enrolments each year would provide a more complete record of enrolment patterns for CRC engaged research candidates, and also allow crude measures for attrition and completion to be derived from the dataset collected through the MDQ (see below).

2.3 Doctoral commencements and completions

Figure 3 CRC PhD Students: Commencements, Completions and FTE Load



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

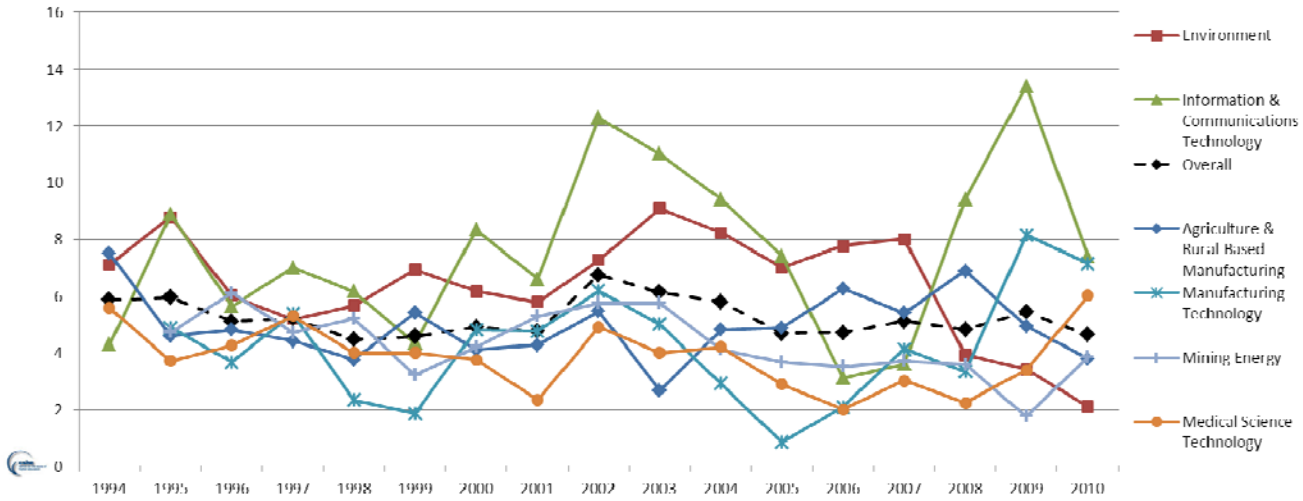
Commencements, completions and FTE load for CRC-engaged research doctoral candidates are summarised in Figure 3 above, along with the total number of active CRCs participating in the program each year. While completion rates and times for research masters candidates are as important as those for doctoral candidates, the following section deals specifically with CRC-engaged doctoral candidates given the parameters particular to this group and the level of relevant information available.

2.3.1 Commencements

Commencing students are typically identified by means of data element #328 of the Australian Government's Higher Education Data Collection guidelines. 'Commencement' is here understood as the date a candidate first consumes student load in a course of study (DEEWR, 2011a, p.16). Commencing status for annual reporting purposes therefore should only be attributed to candidates for the year that occurs.

On average 300 doctoral students have commenced as a CRC engaged research candidate each year since 1994, as outlined in Figure 3. While there is some variation in the overall number of commencements, average commencements per CRC have remained stable at around 5 doctoral commencements per year per CRC since 1994. Doctoral commencements per CRC by sector are outlined in Figure 4 below.

Figure 4 Average Annual Research Doctoral Commencements per CRC by Sector



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

There are specific considerations when using commencements data collected through the Management Data Questionnaire (MDQ). Item 4.1.2 of the current MDQ surveys CRCs each year on the '[n]umber (headcount) of new doctorate by research students who commenced their course during the reporting period' (DIISR, 2011a, p.24).[3] While item 4.1.2 clearly refers to course commencement, there is a risk that this item might pick up responses indicating the number of students in their commencing year with the CRC who may already be continuing students based on their enrolment with their home institution. While the available data does not reflect significant error here, the difference is important: counting continuing students as commencing (even though they may be new to the CRC) confounds the data on CRC commencements and for calendar time to completion calculations.

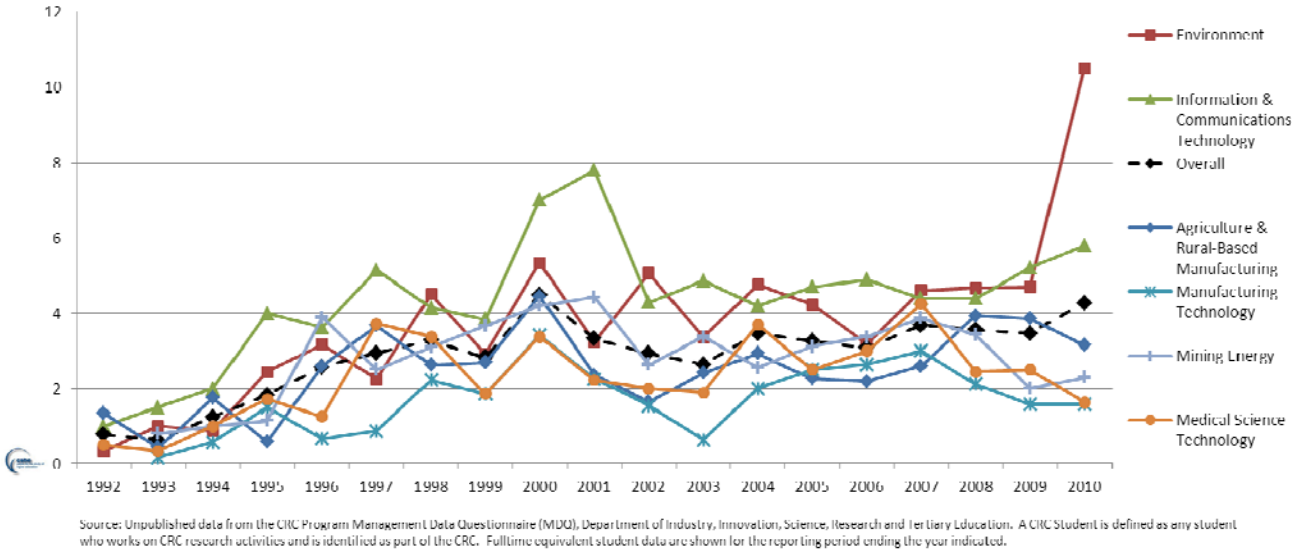
Possible steps for managing the risk of error for this item include providing clearer context instructions on the MDQ form, or replacing the existing item with two: one that collects information on candidates newly engaged with the CRC that are commencing and another for candidates that are continuing in their current course of study (but newly engaged with the CRC). Data collected on new commencing candidates would remain comparable with data collected through this and comparable items in previous iterations of the MDQ. The inclusion of an item on new continuing students would assist in clarifying the existing item as well as providing additional insight into the characteristics of CRC engaged research candidates as well as the pathways students follow in becoming involved with CRCs.

2.3.2 Completions

Degree completions are typically indicated through data element #355 of the Australian Government's Higher Education Data Collection guidelines. 'Completion' is here understood as having successfully completed all requirements for award of a degree (DEEWR, 2011a, p.30).

[3] This item is repeated for masters by research candidates as item 4.2.2.

Figure 5 Average Annual Research Doctoral Completions per CRC by Sector



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

The number of PhD completions for CRC engaged research candidates is illustrated in Figure 3. On average 193 doctoral candidates have completed as a CRC engaged research candidate each year since 1996. While there is some variation in the overall number of completions, the average number of completions per CRC has remained fairly stable at 3 doctoral completions per CRC each year over the life of the program. Doctoral completions per CRC by sector are outlined in Figure 5 above.

Table 3 Research doctoral completions (2010): CRC program with 15 largest university providers

Rank	Provider	Research Doctorate	% of all PhD completions
1	The University of Sydney	573	9%
2	The University of Melbourne	566	9%
3	The University of Queensland	474	8%
4	The University of New South Wales	471	8%
5	Monash University	424	7%
6	The Australian National University	301	5%
7	The University of Adelaide	272	4%
8	The University of Western Australia	235	4%
	CRC Program	**218**	**4%**
9	Queensland University of Technology	206	3%
10	University of Tasmania	178	3%
11	Curtin University of Technology	169	3%
12	Macquarie University	166	3%
13	University of South Australia	159	3%
14	Griffith University	157	3%
15	RMIT University	143	2%

Sources: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), DIISR and *Students 2010 (full year), Selected Higher Education Statistics* (DEEWR, 2011).

Overall the CRC program ranked as the ninth largest provider for doctoral completions in 2010, and was the largest source of doctoral graduates outside of the Group of Eight universities (as outlined in Table 3 above).[4] Based on this alone it is clear that the CRC program makes a

[4] CRC's support research candidates in partnership with university providers, therefore CRC student completions may be counted twice in comparisons such as the one outlined in Table 3 above.

substantial contribution to research education in Australia, supporting 4% of all PhD completions in Australia for 2010.

As with commencements, there are considerations in regard to collecting and reporting completions data that are worth keeping in mind. 'Completion' can sometimes be an ambiguous term, used to refer to a range of enrolment events including:

1. Submitting a thesis for examination;
2. The final date of enrolment;
3. Receipt of examination reports recommending degree conferral;
4. Satisfaction of all requirements for conferral of a degree; and
5. Degree recorded as conferred by the education provider.

It can take a year or more to pass between steps 1 and 5 outlined above. Typically steps 1 and 2 coincide as under current provisions candidates cease to be considered as enrolled once they submit their thesis for examination. Steps 3 and 4 also typically coincide: receipt of examination reports recommending degree conferral (step 3) is typically taken to indicate completion through satisfying all of the academic requirements of the degree program (however some providers may have their own requirements in addition to this). While representing the final stage in the process for students, degree conferral is rarely used as a completion indicator for performance measurement purposes.

CRC's are currently surveyed on degree completions each year through the Management Data Questionnaire (MDQ). Item 4.1.3 of the current MDQ asks CRCs to indicate the '[n]umber (headcount) of doctorate by research course completions during the reporting period' (DIISR, 2011a, p.24).[5] While item 4.1.3 of the current MDQ clearly refers to course completions, it may still allow undue scope for interpretation in potentially referring to any of steps 1 through 5 above. While there is no evidence of significant error on the available data, it may be worth clarifying the terms currently used for these items in the MDQ, to help ensure that CRC-engaged research degree completions are recorded and reported so they are comparable with those recorded for university providers.

2.4 Completion rates

Variation in enrolment status, mobility between providers, use of intermission and longer calendar times to completion combine to make standard measures for completion and attrition less reliable in the case of research higher degree candidates (Bourke et al., 2005; Palmer, 2011b). 'Crude' calculations for research degree time to completion are problematic, particularly when relying on completion rates derived from calendar year participation data. The most accurate measures for research degree completion rates and times involve tracking each research student's elapsed candidature time, ideally with the help of a unique student identifier for tracking individual candidate progress and outcomes over time. In the absence of data of this kind, ratios of completions to commencements are proposed here as the most effective alternative measure which makes the best use of available data. While not intended to reflect completion rates per se, they do offer a broad indication of the productivity and outcomes associated with research training efforts over time.

[5] This is repeated as item 4.2.3 for masters by research candidates.

2.4.1 Standard measures for completion

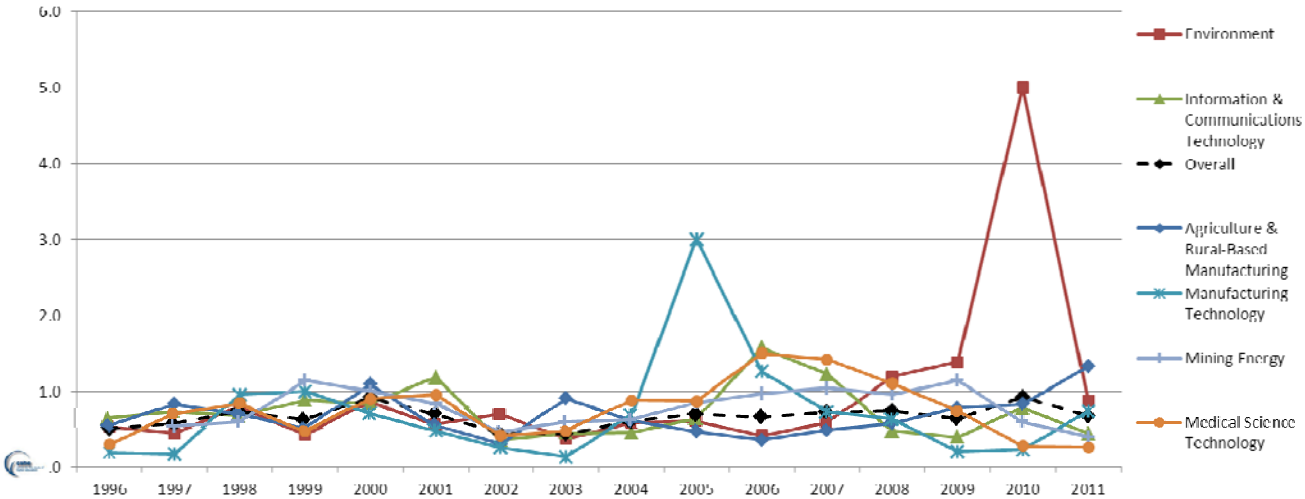
Deriving accurate completion rates for research students is tricky at the best of times. Data on 'crude' attrition for all research students is confounded by a range of factors including variability in enrolment status (including periods of intermission and part-time enrolment), longer calendar times to degree completion and a higher incidence of student mobility within and between institutions (Palmer, 2010c). 'Crude' annual attrition is typically derived as the proportion of students who commence a course in year (x) who neither complete nor return in year (x + 1) (Linke, 1991; DEEWR, 2011b). To calculate this you need access to reliable data on commencements for the current year, completions from the previous year, and the number of continuing (or non-commencing) students for the current year.

The continuing student component is derived from total enrolments for the current year minus the number of candidates commencing their degree in the current year. Notwithstanding other methodological considerations noted in this section, the principal challenge for CRCs in deriving accurate attrition rates on this measure is the lack of program-wide data on total student numbers for each year. While program-wide data for student load is collected as part of CRC annual reporting through the MDQ, this is not the case for the total number of students. As noted earlier, the MDQ only surveys for the number (headcount) of commencing students, the number (headcount) of course completions and the equivalent full-time student load (EFTSL) of students. The current MDQ data cannot be used for deriving standard measures for attrition or completion rates as total enrolments are not collected, and calculations using student load alone would be confounded by variations in enrolment status.

2.4.2 Alternative completion rate measures

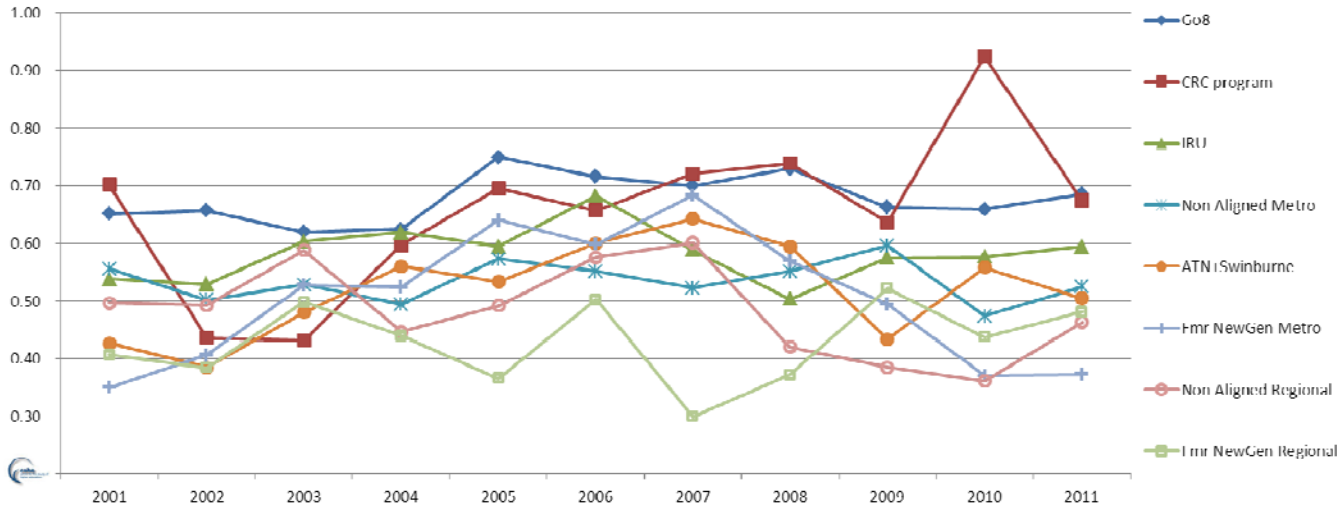
Alternative approaches in determining completion rates include deriving a simple annual ratio of completions to commencements (Access Economics, 2010, p.48), and averaging an annual ratio of completions to commencements over time (Pechenkina, Kowal & Paradies, 2011, pp.60-63). Annual (or 'simple') ratios of research doctoral completions to commencements for CRCs are outlined in Figure 6 below, with comparisons including doctoral completions and commencements for groups of university providers shown in Figure 7.

Figure 6 Simple Ratio of Annual CRC Research Doctoral Completions to Commencements by Sector



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Fulltime equivalent student data are shown for the reporting period ending the year indicated.

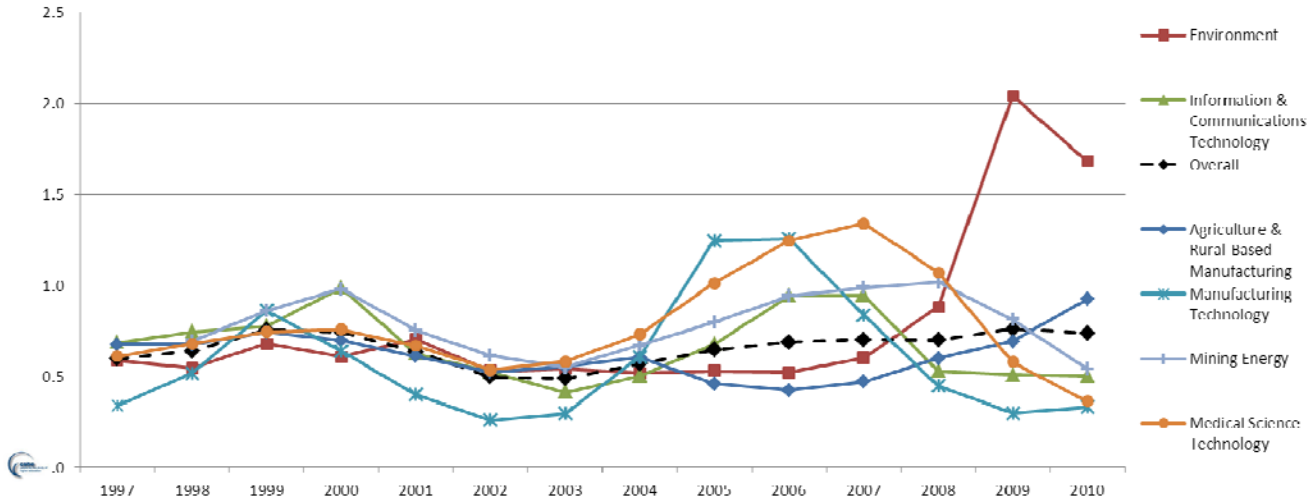
Figure 7 Simple Ratio of Annual Research Doctoral Completions to Commencements by Provider Group



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ) and *Selected Higher Education Statistics (Students)* for the relevant year, Department of Industry, Innovation, Science, Research and Tertiary Education. Provider groups defined as per *Applications, Offers and Acceptances* (DEEWR, 2011).

While annual ratios do provide an indication of completions relative to commencements, they also reflect changes in year-on-year trends for both measures. This means that annual ratios of completions to commencements can be as much a reflection of supply and demand as they are of efficiency and effectiveness in supporting research degree completions, and can serve to highlight inconsistencies rather than provide a suitable overall means of comparison. They also cannot be taken to directly reflect completion *rates* for research degree cohorts, as research degrees typically take longer than one year to complete.

Figure 8 Ratio of CRC Doctoral Completions to Commencements by Sector (3 year moving average)

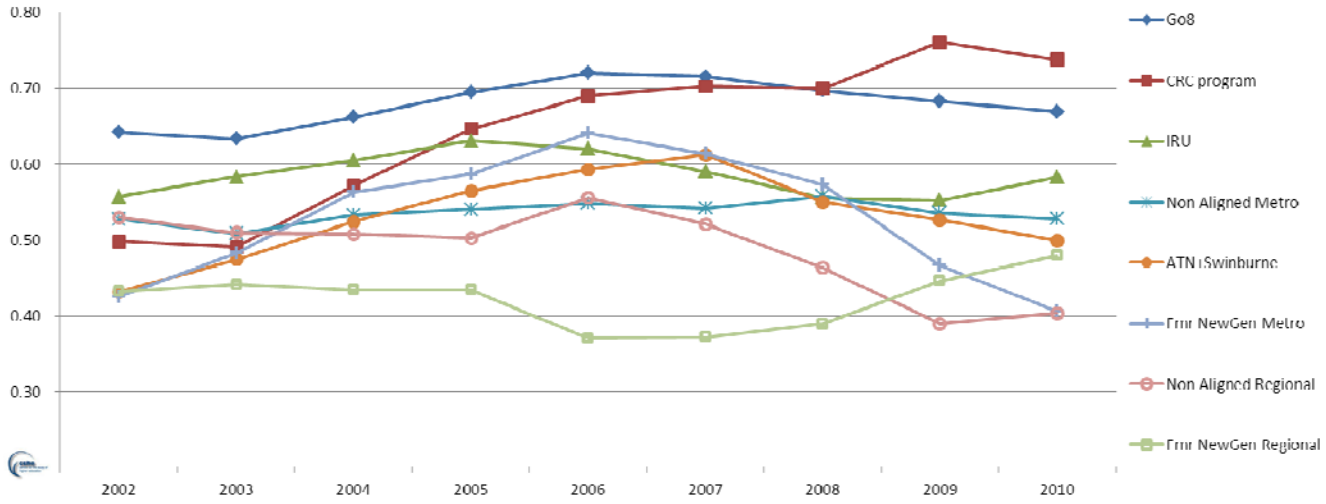


Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ), Department of Industry, Innovation, Science, Research and Tertiary Education. A CRC Student is defined as any student who works on CRC research activities and is identified as part of the CRC. Student data are shown for the reporting period ending the year indicated.

Another alternative means of reflecting research doctoral completions relative to commencements is to use a moving average to capture enrolment trends in a way that is less sensitive to year-on-year variation. A three-year moving average can be used to illustrate the ratio of CRC research doctoral completions to commencements. Figure 8 above shows the effect of using a 3-year moving average to help account for year-on-year fluctuations in completions and commencements data for CRC-engaged research doctoral candidates (summarised here by sector). Figure 9 below shows the same analysis for comparisons between research doctoral commencements and completions for the CRC program and university provider groups. It is

important to note in these comparisons that while a 3 year moving average has been used to help mitigate the effect of year-on-year variations in commencements and completions, this is not intended to reflect cohort completion rates.

Figure 9 Ratio of Research Doctoral Completions to Commencements by Provider Group (3 Year Moving Average)



Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ) and *Selected Higher Education Statistics (Students)* for the relevant year, Department of Industry, Innovation, Science, Research and Tertiary Education. Provider groups defined as per *Applications, Offers and Acceptances* (DEEWR, 2011).

Comparisons of completion to commencement ratios between the CRC program and university provider groups in Figure 7 and Figure 9 shows the performance of CRCs in supporting degree completions for research doctoral candidates. The average 'simple' ratio of annual completions to commencements for the CRC program overall was 0.66 (for both the 2001-2011 and 1996-2011 comparison timeframes), ranking second behind the Group of Eight university providers at 0.68. While it is not normally appropriate to report averages of averages, for the sake of comparison the overall average of annual 3 year moving average ratios for the CRC program was 0.64, again ranking second behind the Group of Eight university providers at 0.68. CRCs performed slightly better over a 1997 to 2011 timeframe, with an average of 0.66.[6]

Table 4 Completion ratio measures for research doctoral candidates

	Three year moving average ratio of research doctoral completions to commencements 2002-2010	Ratio of total overall research doctoral completions to commencements 2001-2011	Average simple ratio of annual research doctoral completions to commencements 2001-2011	% of all PhD completions 2001-2011
Go8	68%	68%	68%	55.6%
CRC program	**64%**	**64%**	**66%**	*3.8%**
IRU	59%	58%	58%	12.0%
Non Aligned Metro	54%	53%	53%	9.5%
ATN+Swinburne	53%	52%	52%	13.6%
Fmr NewGen Metro	53%	49%	50%	4.7%
Non Uni Providers	50%	48%	54%	0.3%
Non Aligned Regional	49%	48%	48%	2.1%
Fmr NewGen Regional	42%	42%	43%	2.2%
National	61%	60%	60%	

Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ) and *Selected Higher Education Statistics (Students)* for the relevant year, Department of Industry, Innovation, Science, Research and Tertiary Education. Ratios are expressed as percentages. Provider groups defined as per *Applications, Offers and Acceptances* (DEEWR, 2011). * CRCs support research training in partnership with universities, therefore this percentage is independent to the provider share represented here.

[6] CRCs support research training in partnership with universities, therefore commencements and completions for university providers will be counted with CRC data, and vice versa.

Finally, perhaps the most straightforward reflection of completions relative to commencements is to simply divide the sum of all completions over an extended duration by the sum of commencements for the same period. While this would fail to capture cohort effects at the beginning and end of the duration of comparison, it would summarise the full enrolment history for candidates who both commenced and completed within the comparison duration. While this comparison would not reflect variation over time, it would allow a basic means of comparison between research training environments in broad terms. A summary of indicators discussed in this section appears in Table 4 above and Table 5 below.

Table 5 Comparison of completion ratio measures for top 10 university providers

	Three year moving average ratio of research doctoral completions to commencements 2002-2010	Ratio of total overall research doctoral completions to commencements 2001-2011	Average simple ratio of annual research doctoral completions to commencements
University of New South Wales	77%	74%	75%
University of Western Sydney	75%	66%	72%
University of Queensland	75%	73%	74%
University of Melbourne	73%	74%	74%
Flinders University	66%	64%	65%
University of Sydney	65%	66%	66%
University of Tasmania	65%	65%	66%
CRC Program	**64%**	**64%**	**66%**
University of Western Australia	64%	63%	64%
Monash University	63%	62%	63%
Australian National University	62%	62%	63%

Source: Unpublished data from the CRC Program Management Data Questionnaire (MDQ) and *Selected Higher Education Statistics (Students)* for the relevant year, Department of Industry, Innovation, Science, Research and Tertiary Education. Ratios are expressed as percentages. Only university providers reporting data since 2001 were included for comparison.

Data for overall national research doctoral completion ratios summarised here align well with findings from an earlier study on postgraduate completion rates by Martin et al. The Martin study derived estimated research doctoral completion rates in the range of 60.3 to 65.2 per cent, depending on the analysis used (Martin, 1999, p.16). The three-year moving average completion ratio data also align well with cohort studies of completion rates for specific providers, in the case of Bills (2003) and Bourke et al. (2005, p.13). The Bills study arrived at a research doctoral completion rate for a 1994-2002 cohort of 46 per cent compared with a three-year moving average completion ratio in 2003 of 47 per cent for the same provider. While there does appear to be some alignment, further research would need to be done to test the degree to which completion ratios of the kind derived here match with measures for completion used elsewhere (Linke, 1991; Martin, 1999; Bourke et al., 2005). By comparison, calculating completion ratios in this way has the benefit of being less demanding on the data requirements necessary to perform the calculations, and more to the point less prone to reporting errors, particularly those common for reported numbers of commencing and continuing students.

It should be noted here that there would be many variables accounting for variance in the comparisons illustrated above. These would include variation in enrolment status, the proportion of international candidates, disciplinary variation and other demographic factors, just to name a few. As noted earlier, the key to reporting accurate completion rates and times for research higher degree candidates lies in recording and reporting elapsed candidature time. Addressing poor completion rates and times (and demonstrating good performance) means addressing inefficient use of full time equivalent candidature time, not simply variation in elapsed calendar years to completion. The comparisons above are an accurate overall comparison of commencements and completions between CRCs in various sectors, and between CRCs and university providers of research training. On these measures, CRCs compare very well.

3 Markers for quality and distinctiveness

The leading role played by the CRC program in supporting collaborative, end-user engaged environments for research candidates was highlighted in the development of the Australian Government's *Research Workforce Strategy*. CRCs were identified as a leader in supporting the development of both 'soft' or generic skills and innovation capabilities through research training programs, supporting candidate productivity in a wide range of employment contexts (DIISR, 2011c, p.25). A 2010 survey of current and former research candidates with the Irrigation Futures CRC found that students report their engagement with a CRC as adding between 50 and 100 per cent additional value over and above that provided by their university (Montagu, 2010). While it is clear that CRCs support a distinctive industry-engaged research training experience and are able to support an innovative environment for research education, it is less clear how evidence for this may be sought, performance demonstrated and improvement sustained. While it is also clear that research training with CRCs offers many benefits, it is less clear how evenly these benefits feature across CRCs, or how the specific benefits of a CRC research training environment might be identified and communicated. Unpacking what supports this perceived 'value add' remains a challenge. Describing this picture more fully would not only assist CRCs in demonstrating their contribution to research training, but also CRC efforts in monitoring and supporting improvements in quality over time.

3.1 Establishing domains of activity and dimensions for good practice

CRCs support a quality research training environment in partnership with universities. The extent to which CRCs supplement the 'core' research training provided by university partners remains unclear. It may well be that it is the students themselves that determine their own balance in each case, seeking out the resources and support that best suit them and the nature of their research. Rather than seek to establish the exact nature of the arrangements one way or the other, or attempt to gauge their relative impact based on student satisfaction measures, it perhaps makes sense to review the nature and characteristics of CRC education programs, and the way these 'map' with good practice identified in the research higher degree programs supported by universities. A more comprehensive evidence base in this area will assist in demonstrating strengths in the CRC research training environment, as well as identifying opportunities for future improvement.

3.1.1 CRC research education in practice

Previous reviews of the CRC contribution to research training have emphasised different aspects of that contribution. For example, Harman (2002, 2004) compared satisfaction measures for CRC and non-CRC graduates. Similarly Pitt et al. (2010a) and Manathunga et al. (2005) compared samples of CRC and non-CRC graduates. Morris et al. (2011) compared similar measures for enrolled candidates in industry settings. The emphasis of these studies overall was on comparing the research education outcomes of CRC with non-CRC students. Relatively speaking there has been less emphasis to date on the inputs and processes associated the CRC contribution to research training.

From a program perspective, the principal stakeholders in the inputs and processes associated with the CRC contribution to research training aside from the candidates themselves are the education managers for individual CRCs. Workshops conducted with CRC education managers as

part of the scoping study identified a range of strengths to the CRC research training environment, including:[7]

- Research topics clearly focussed on an end point developed in collaboration with industry;
- The relevance of CRC-engaged research topics to 'real world' problems in a 'state of the art' industry context;
- Access to 'industry standard' infrastructure and resources for research;
- Exposure to a broad range of discipline areas;
- Networking opportunities directly with industry partners;
- Opportunities to get a 'head start' on a graduate role with industry;
- The sense of community and collegiality typical of CRCs;
- Access to expert non-academic advisors, including from industry, government and non-profit sectors, and access to industry mentors in addition to the supervisory panel;
- Professional development opportunities in areas outside traditional 'generic skills' training;
- That CRCs support research graduates that are truly 'industry ready'; and
- The opportunity to be 'part of something bigger'.

The investment made by CRCs in supporting these benefits were highlighted in workshops with CRC education managers. These included scholarships with 'topped up' stipend duration and value, structured peer network engagement activities, industry networking initiatives, structured and semi-structured academic and professional development activities and frameworks for providing industry supervisory arrangements. Some of these are unique to CRCs, while others are comparable to examples of the research training environment found in universities (Palmer, 2012a) and other research agencies (Morris, Pitt & Manathunga, 2011).

While there are strengths to the CRC research training environment, there are also opportunities for improvement. Challenges identified in workshops with CRC education managers included:

- The issue of realistic FTE completion times (with three years considered too short);
- Challenges around student recruitment;
- Challenges around supervisor recruitment; and
- Challenges in tracking graduates and measuring and evaluating graduate pathways and outcomes.

Opportunities for improvement have also been highlighted through previous research in this area. While CRC engaged research students surveyed in 2000 reported significantly higher satisfaction in the areas of resources, supervision, research culture, research environment and general support (Harman, 2002), a comparable survey in 2005 found that CRC-engaged research candidates were less satisfied overall with their research training experience (Manathunga, Pitt & Critchley, 2005). More broadly it has been suggested that the CRC program would benefit from improved consistency and transparency in monitoring of the quality and performance of CRC research training activities (O'Kane, 2008).

[7] Activities conducted as part of the scoping study are outlined in Appendix I.

3.1.2 Frameworks for good practice

Despite the relatively un-structured learning environment for research higher degrees, there is a fairly stable set of identifiable 'ingredients' unique to the research training environment that are instrumental in supporting successful outcomes. It is generally agreed that supervision, resources, administrative and support services, a collegial environment and opportunities for skills and professional development are the principal 'ingredients' for a quality research training environment (QAA, 2004; The Council of Deans and Directors of Graduate Studies in Australia, 2008; CHE, 2010; Palmer, 2010a; Palmer, 2010b; Booth & Frappell, 2011; GCA, 2011; Group of Eight Deans of Graduate Studies, 2011; Luca, 2011; QAA, 2012).

Particular domains of activity have emerged to broadly describe aspects of the research training environment that are salient for both students and institutions, and potentially useful in supporting successful outcomes and in reflecting quality (as outlined in Table 6 below).

Table 6 Dimensionality in Research Training

Dimension	Aspect
Infrastructure and resources for research	Infrastructure, equipment, facilities and resources provided to support research, appropriate to enabling successful and timely completion.
Supervision and examination	Quality in supervision, and of the examination process.
Skills and professional development	Opportunities for personal and professional development, including the development of skills and professional capabilities.
Collegiality and intellectual climate	An open, collegial and productive learning environment, with support for doing and learning about research.
Administrative, student support and QA policies, programs and strategies	Administrative and student support services and programs. Policies, programs and strategies to promote and assure quality and to manage risk.

Source: *Dimensionality in Research Education* (Palmer, 2012a)

Increasing attention on the part of stakeholders in research training has been given to developing frameworks to describe how good practice may be defined, measured and encouraged. Significant steps have already been made towards developing guidelines for good practice that are specific to the CRC research training environment. In 2011 Dimond and Sarre published *Guidelines for the Balanced Scientist Program*, based on the Invasive Animals CRC Balanced Scientist PhD Program in Research Leadership and Management. The candidate development focus of the *Balanced Scientist Program* in many ways reflects aspects of a similar exercise underway in the UK. The Vitae *Research Development Framework* is a professional development framework for planning, promoting and supporting the personal, professional and career development of researchers in higher education (Vitae, 2011). A comparison of *Balanced Scientist Model* and the *Researcher Development Framework* is included here as Appendix VII.

The UK's Quality Assurance Agency for Higher Education (QAA) has also recently revised its code of practice for assuring and enhancing quality in postgraduate research programs. The revised code includes 'indicators of sound practice'. These are intended to assist higher education providers in demonstrating that they are meeting expectations for quality and performance in postgraduate research, and are intended to help higher education providers reflect on and develop their regulations, procedures and practices to demonstrate that these expectations are being met (QAA, 2012).[8]

[8] A summary of areas where indicators of sound practice were identified is included as Appendix IV.

A national *Good Practice Framework* is also currently under development by The Council of Deans and Directors of Graduate Studies in Australia (DDoGS). The DDoGS framework captures good practice dimensions and components found in the QAA code and in comparable frameworks and guidelines (including the previous 2008 DDoGS *Framework for Best Practice*). The new DDOGS framework focuses on sharing good practice principles, processes and quality assurance strategies relevant to salient aspects of the research training experience, and from a provider perspective, the key program elements that are useful in supporting quality research training outcomes (Luca, 2011).[9] The framework is still under development, and is yet to be adopted as an agreed framework for good practice. Once in place, the framework is likely to inform development of the Australian Government's standards for research training, as part of those described for higher education research, and the potential development and use of indicators for quality and performance for research training in the future (DIISR, 2011b). While still in the development stage, the draft DDoGS *Good Practice Framework* outlines dimensions with associated components and quality assurance processes which largely 'map' with existing frameworks and guidelines. These are referred to in the following section along with other relevant guidelines to help guide discussion around demonstrating the CRC contribution to research training in particular areas, and to assist in future capacity building. Comparison in this context is also intended to help inform the development process for the draft *Good Practice Framework*.

3.2 Infrastructure and resources for research

Table 7 Research training cost domains identified by Deloitte Access Economics

Direct Costs (potentially costed per candidate)		Indirect Costs (shared services)	
Broad	**Detailed**	**Broad**	**Detailed**
Supervisor costs	• Supervisor salaries and on-costs	**Central services**	• Counselling services • Student services • Career advice services • Graduate studies office services • Research office services • Gym, sporting facilities • Conference facilities • Other central services
Candidate work environment	• IT equipment • Office supplies • Library support, journal and database subscription • Insurance	**Generic skills development**	• Presentation/communication skills • Research skills • IP skills • Writing skills • Ethics, legal responsibilities • Other generic training
Research project costs	• Lab equipment • Data acquisition • Field trips • Access to external equipment/facilities • Access to other testing/analysis services	**Maintenance costs**	• Maintenance costs of equipment and facilities • Cleaning • Security • Utility costs • General library services • Broader IT infrastructure
Other direct costs	• Conference registration fees • Travel & accom. for conferences • Printing and publication costs • Seminars related to field of research • Targeted professional development • Examination costs • Other direct costs	**Other indirect costs**	• Legal fees • Publication costs not directly attributable to research training (e.g. photocopying etc.) • Office supplies • Health and safety expenses • Other indirect costs

Source: Deloitte Access Economics (2011, pp.41-42)

The Australian Government's Research Workforce Strategy identified the human and physical resources that support research as among the most important capabilities that underpin

[9] A summary of research training quality dimensions and components identified in the draft *Good Practice Framework* is included as Appendix IV.

innovation (DIISR, 2011c, p.31). In 2011 the Department of Industry, Innovation, Science and Research (DIISR) commissioned a report on the full cost of research training in Australian universities. The cost domains identified by Deloitte Access Economics reflect many of the inputs invested by institutions in support of a quality research training environment, particularly those that support the physical and financial resources necessary for supporting a quality research environment. Areas identified by Deloitte Access Economics (2011) as either direct or indirect costs of research training are outlined in Table 7 above.

3.2.1 Minimum resource standards

The resources available to each candidate to support the conduct and dissemination of research in a university supported research training environment are typically spelt out in an institution-wide *statement of minimum resources* policy (Palmer, 2010a). These largely apply to the candidate work environment, but also refer to research project cost and other direct costs associated with the conduct and dissemination of research. Policies typically describe each candidate's minimum resource entitlements, with area-specific policies applying where resource provision is over-and-above the institution-wide minimum standard.[10] The draft *Good Practice Framework* guidelines recommend that research candidates only be offered a place where resources adequate to their research and candidature are available. These include the infrastructure and consumables necessary for the conduct and dissemination of quality research, and for the attainment of the desired graduate attributes (Luca & Wolski, 2012). The framework also recommends that minimum standards for the resources available be clearly specified in an institution-wide policy (Luca & Wolski, 2012).

While the infrastructure and resources CRC-engaged research candidates would have access to are typically at or above the industry standard, there are currently no strategies in place for monitoring or assuring the minimum standards of facilities and resources for CRC-engaged research candidates program-wide. Individual CRCs would typically have their own research infrastructure policies and guidelines, potentially supplementing those in place at the partner university. There is however scope to review the possibility that CRCs might adopt their own set of minimum resource standards for CRC-engaged research candidates, either on an individual level or program-wide.

3.2.2 Candidate administered project funding

Table 8 Estimated annual research training direct costs

Cost item	*Discipline / field of education*	*cost per candidate ($)*
Laboratory equipment and consumables, reagents	Science and Technology (Molecular Biology), Health (Medicine), ITRI*	$5 - 15k
Data acquisition	Business and Law; Health	$1k
Survey Costs	Business and Law; Health (Psychology, Population Health)	$1 - 2k
Field trips	Life and Environmental Sciences (LES)	$5 - 10k
Access to external equipment and/or facilities	ITRI, Science & Tech	$5 - 10k
Access to testing/analysis services (not included above)	ITRI, Science & Tech, Medicine	$5 - 10k
Travel for Data Acquisition	Health (Population Health)	$5 - 10k
Animal Laboratory	Life and Environmental Sciences (LES), Health (Medicine)	$5- 10k

[10] Useful examples of good practice can be found at JCU (James Cook University Academic Board, 2011), UNE (Academic Board Higher Degree Research Committee, 2010) and Newcastle (The University of Newcastle, 2010).

Source: Deloitte Access Economics (2011, p.55)

The cost domains identified in Table 7 reflect the inputs invested by institutions in support of a quality research training environment. Estimated costs per candidate for some of the components identified above offer additional insight into the typical resource requirements of each research higher degree candidate. Case study findings from the Deloitte Access Economics study are summarised in Table 8 above by broad discipline area. These findings were consistent with a second case study conducted for the report, where the average annual direct cost per candidate (excluding academic supervision) was $5,160 (with comparable variation by discipline area) (Deloitte Access Economics, 2011, p.56).

The Deloitte Access Economics report found that a significant proportion of the direct costs for research were managed through a discretionary spending budget managed by each candidate (Deloitte Access Economics, 2011, p.56). Most universities make a minimum level of funding available to research students for the kind of consumables, fieldwork, lab or research costs identified as research project costs and other direct costs identified in Table 7 and Table 8. Guidelines for the use of discretionary research budgets typically also extend to include costs associated with the dissemination of research, including travel and attendance at conferences (Palmer, 2010a, pp.30-32).

Financial support for the direct costs associated with the conduct and dissemination of research are identified in what is currently dimension seven of the draft *Good Practice* Framework (Luca & Wolski, 2012). Guidelines for the Balanced Scientist program also describe the provision of an *operational fund*, where financial resources are made available to candidates to support direct project costs (Dimond & Sarre, 2011, p.13). These entitlements are typically provided over and above those available from the partner university (where conditions would vary by provider). Guidelines for the *Balanced Scientist Program* recommend that candidates develop a fully costed project proposal at commencement which is used as the basis for the allocation of operational funds from the CRC. The guidelines also recommend that a professional development plan for activities such as short courses, workshops, field days, seminars, conferences, and relevant industry placements also be prepared by each candidate at commencement, in consultation with their advisory panel. Together these provide a framework for candidates to manage the costs and resources associated with their own research. There is scope to explore the extent to which comparable arrangements are in place for CRCs program-wide.

3.3 Scholarships and stipends

The Australian Postgraduate Award (APA) is the benchmark living allowance stipend scheme for research higher degrees in Australia. Provisions for the majority of scholarships provided by institutions are tied in one way or another to the APA conditions of award. These include the APA stipend rate (which for 2012 is $23,728 for full-time and $12,898 for part-time candidates), and duration (currently 42 months FTE inclusive of the 6 month extension) (DIISR, 2010a).

CRC funded scholarships make a significant contribution to the overall pool of scholarships available to support Australian research higher degrees.[11] Resources and support provided to CRC affiliated research students include scholarships, often with 'topped up' stipend duration and value: top-up scholarships in various forms are a prominent feature of the CRC research training

[11] The exact proportion of overall scholarships funded by CRCs is difficult to establish, as there is currently no national reporting of overall scholarship holding.

environment. Some CRCs provide an additional six months or one year of stipend funding to allow candidates to make the most of the full range of professional development opportunities available to them through the CRC research education program.

The draft *Good Practice Framework* recommends that the provision of scholarships be monitored by an appropriate committee responsible for higher degrees, and governed by a clear set of policies and procedures (Luca & Wolski, 2012). These include:

- A clear set of transparent criteria for determining eligibility for and award of scholarships;
- Transparent policy and procedures for the allocation and administration of research scholarships;
- A clear statement of all scholarship entitlements and conditions; and
- Regular review of all relevant policies and procedures to ensure transparency, equity of opportunity and alignment with government or other scholarship provider conditions.

Opportunities exist for developing a clearer picture of the scholarship and stipend offerings supported by CRCs, in terms of their number, rate and conditions of award. Opportunities also exist for the development of a clear set of criteria and conditions for CRC funded scholarships, either at the CRC level or program-wide.

3.4 Supervision and research advisory arrangements

The draft *Good Practice Framework* recommends that research candidates have access to a graduate advisory team with an appropriate mix of expertise in the relevant discipline(s), research methods, and supervisory skills and experience. Each graduate advisory team should include a main advisor as a clearly identified point of contact, with co-supervisory arrangements tailored to candidates' interests and needs and the requirements of their chosen research (Luca & Wolski, 2012).

A broader range of stakeholders are typically involved with each CRC-engaged research candidate's project than would be the case with a more traditional university-based degree program. Each research student engaged with a CRC will typically have a panel with at least one advisor from their university, one from the CRC and one from an industry partner. Guidelines for the *Balanced Scientist Program* recommend that each CRC-engaged research candidate have a research advisory panel containing a primary, university-based research advisor and at least one other that is industry-based (Dimond & Sarre, 2011, p.9).

The draft *Good Practice Framework* also recommends that eligibility criteria be applied for prospective supervisors before approving supervisory arrangements, and the rights and responsibilities of both students and supervisors should be clearly defined and readily available. Supervisors should have access to ongoing professional development and support as part of the research degree program (Luca & Wolski, 2012). In line with this, guidelines for the *Balanced Scientist Program* include a structured process for identifying and matching PhD projects with suitable university and industry based supervisors (Dimond & Sarre, 2011, p.5). Opportunities exist to gain a clearer picture of the research advisory arrangements typical of CRCs, and the extent to which there are common aspects to research degree supervision and advice program-wide.

3.5 Skills and professional development

The draft *Good Practice Framework* recommends that academic and professional development opportunities be available to assist candidates in completing their program and progress in their chosen field. It recommends that academic and professional development needs be identified early in candidature, through agreement between the candidate and their advisory panel (Luca & Wolski, 2012). Areas addressed should reflect each candidate's interests and needs and the requirements of their research, and should include:

- Research skill development;
- Transferable skill development;
- Interdisciplinary experience; and
- International engagement.

Support should also be available to assist candidates in developing both academic and non-academic careers, including career development advice, assistance in developing their CV and opportunities to engage with peers, employers and alumni relevant to their discipline area (Luca & Wolski, 2012). The *Balanced Scientist Program* guidelines very much reflect the aims outlined in the *Good Practice Framework*, but are also informed by the aim of supporting the development of skills and experience in a broader range of areas than typical research degree experience might allow. These areas include research leadership and management, stakeholder and community engagement, project management, innovation and development, effective communication, media awareness and business and entrepreneurial skills (Dimond & Sarre, 2011). The program aims to support a range of outcomes for research candidates, including:

- Professional development through direct industry engagement;
- Mapping research efforts with industry priorities; and
- Building professional networks in their field.

Initiatives like the *Balanced Scientist Program* highlight the kind of approach taken to professional development by CRCs. Areas highlighted in workshops conducted for the scoping study with CRC education managers include leading teams, presentation skills and niche areas like preparing policy papers, professional, strategic and vocational skills, and industry focussed knowledge, networks and contacts. Communication, team leadership and project management feature as prominent themes among the professional development activities supported by CRCs. Others include research design and analysis, financial management, policy, planning and community involvement.

The *Balanced Scientist Program* recommends as a guideline that candidates devote 80 days to professional development activities outside of their immediate area of research over four years, recommending that 40 days be given to structured professional development activities, and 40 to semi-structured and unstructured 'experiential' professional development activities (Cumming & Kiley, 2009; Dimond & Sarre, 2011). The guidelines also recommend that a professional development plan be established at commencement, with a log maintained recording professional development activities engaged in throughout the degree. Opportunities exist to more clearly describe the unique resource-focussed approach adopted by CRCs in supporting skills and professional development, and to describe the extent to which characteristics of this approach are shared by CRCs program-wide. Among challenges here will be demonstrating quality and performance in an area characterised by diversity in content and approach. It may

well be the case that this can best be demonstrated in the framework elements that support these activities, rather than comparing lists of professional development activities per se.

3.6 Collegiality and intellectual climate

The draft *Good Practice Framework* recommends that candidates have opportunities to engage with a dynamic and inclusive culture of research scholarship, with formal and informal opportunities for engaging with other researchers, academic peers and with industry, with regular feedback and review of the scope and effectiveness of the opportunities available (Luca & Wolski, 2012). Postgraduates consistently report collegiality in particular as an important aspect of a positive research training experience (Palmer, 2010b; Jonas & Croker, 2012).

Industry engagement clearly emerged as a prominent characteristic of the CRC research training environment in workshops conducted as part of the scoping study, and in all the other available evidence, including the annual reports of individual CRCs. Industry engagement in the CRC environment includes both government and non-government organisations. CRCs support a broad range of industry focussed collegiality and network building activities, including conferences, meetings and networking events, all of which typically involve a range of industry partners. Among the most prominent strengths identified in this area were CRC capabilities for facilitating industry networks, and the positive impact of access to industry mentors.

CRC Industry mentors are typically experienced industry stakeholders who are available to offer advice to candidates on an ongoing basis without formally being part of the supervisory team (Montagu, 2010, p.17). The role of the industry mentor is typically understood as offering opportunities and advice over and above what is already be available through formal supervisory arrangements. The impact of industry mentors was among the factors evaluated in a 2010 study of research candidates with the Irrigation Futures CRC (Montagu, 2010). While having an industry mentor did not seem to influence students' perception of the CRC contribution to their research training experience in the Montagu study, candidates with industry mentors did report producing 2.5 times more conference publications than those without (2010, p.9). Sixty-three per cent of respondents to the Montagu study indicated they had had an industry mentor, highlighting the important role played by industry mentors in the research training activities of CRCs. Among recommendations in the Montagu study were to develop a more active industry mentoring program to assist the one-third of students who reported not having an industry mentor, and for CRCs to review the mentoring and support available to candidates located off-campus (Montagu, 2010, pp.17-18).

A broad range of activities in support of collegiality and a positive and productive intellectual climate were identified in workshops with CRC education managers, and in the annual reports published for individual CRCs. The diversity of activities in this area was comparable to that found for the skills and professional development activities supported by CRCs. Given the diversity of activities in this area, it may be that an outcomes measure along the lines of the intellectual climate subscale of the *Postgraduate Research Experience Questionnaire (PREQ)*, possibly modified to better reflect industry engagement, may be the most appropriate means of demonstrating quality and distinctiveness in this area.[12] Broader opportunities also exist to provide a clearer picture of the program elements that support the collegiality-building activities of CRCs, and the extent to which common themes may be identified program-wide.

[12] Current items for the *Postgraduate Research Experience Questionnaire (PREQ)* are included here as Appendix IV.

4 Strategies for sustainability and opportunities for future development

Supporting research education in partnership with universities has been among the core aims of the CRC program since its inception. Unique opportunities are supported through this partnership, leading to valuable outcomes through a distinctive research training environment. CRCs make a distinctive contribution in this partnership, through industry standard facilities and resources, advisory arrangements closely linked with industry, unique professional development opportunities and a distinctive intellectual climate. By themselves each of these dimensions represent a valuable supplement to the overall research training experience supported in partnership with universities. In addition to these, administrative and process-related aspects of the research training environment also represent an important dimension of the research training experience. These are particularly important if CRCs are to effectively demonstrate their overall contribution to research training and support improvements over time, both at the program level and at the level of individual CRCs.

In workshops conducted for the scoping study, issues raised by CRC education managers on how to demonstrate the quality of the CRC contribution to research training, and to improve their ability to successfully sustain those over time, include the following:

- Improved availability of data;
- Being able to benchmark with universities on research candidate completion rates and times;
- Opportunities to solicit '360 degree' feedback from stakeholders;
- Recognition of the investments made around research education activity (including both financial and human resources);
- Being able to have clear and agreed definitions for key points of comparison program-wide;
- Being able to compare student satisfaction results with those of university providers;
- Opportunities to share research education resources with other CRCs; and
- Review the MDQ for relevance to the activities and outcomes associated with CRCs.

Many of the issues raised centred around quality assurance and quality enhancement activities, and strategies in support of managing risk associated with research education activities. Strategies for assuring quality and identifying and managing risk include anticipating, identifying, managing and accounting for any difficulties or shortcomings that may arise, and specifically accounting for any potential downside risk associated with the unique RHD environment in CRCs. Opportunities identified for improvement included a common resourcing strategy for CRC research higher degrees, CRC-specific policies and procedures (either CRC-specific or program-wide), improved data collection and reporting activities and the possible development and application of minimum standards for specific areas.

4.1 Quality assurance and CRC research training partner arrangements with universities

CRCs support research training in partnership with university providers. CRC efforts to date have been largely focussed on offering a distinctive research training environment to supplement the 'core' research training activities of university providers. However, there is evidence that CRCs also have a role to play in helping to support the quality of the overall research training experience of candidates, and are often quite active in supplementing aspects that might otherwise be considered in the sphere of activity governed by the partner provider (Montagu, 2010, p.16).

The intersection of research training responsibilities between CRCs and university providers represents an area of risk. The risks here are salient for each of the stakeholders involved – for CRCs, universities and industry partners alike, and especially from the perspective of individual candidates. The stakes in research higher degrees for research candidates themselves are particularly high (Palmer, 2011b). The costs of attrition for industry partners and research training providers include the investment in recruiting, engaging and resourcing candidates as partners in research. For candidates themselves the cost is typically much higher, in opportunities forgone and in the prior investments made to get them within reach of doctoral level of attainment.

Two broad opportunities exist for CRCs to assure the quality of the research training environment they support in a more holistic and comprehensive manner. The first is to employ the same benchmarks and threshold requirements employed by university providers in research training. These would be guided by the same frameworks for good practice as used by university providers, such as that currently under development by the Australian Council Deans and Directors of Graduate Studies (DDoGS).[13]

The second opportunity would be to include a set of specific threshold requirements for research training provision as part of a formal agreement between CRCs and the university partners they engage with in supporting their research education activities. To be effective such arrangements would require CRCs only entering into research training support agreements where university providers meet or exceed a set of clearly specified requirements, with provisions to include exceptions on a case-by-case basis. In practice both opportunities are open to CRCs – in both improving and enhancing the CRC contribution to research training, and in only engaging the university partners that meet or exceed a clear set of threshold criteria for research training governance, services and support.

4.2 Developing and sharing information and resources

Improved means of sharing information and resources were identified as a priority by CRC education managers in workshops conducted for the scoping study. Areas where scope for improvement was identified were in the program-wide data collected and reported for CRCs, and in the development and sharing of resources for good practice, potentially through the CRCA website.

[13] A summary of draft dimensions and components from the framework currently under development are included here as Appendix IV.

4.2.1 Data for CRC candidate characteristics

Harman (2002) found a roughly even gender balance among CRC research candidates, with 20% studying part-time and 15% being international students. Subsequent studies have to varying degrees reflected a similar picture, however in each case the data have been collected through survey responses, sometimes including both candidates and graduates, rather than through census measures or through more comprehensive sampling of current candidates. Opportunities exist to provide a clearer picture of the characteristics of CRC-engaged research candidates through more systematic means. Most CRCs would already have access to the basic enrolment characteristics for the research candidates they engage, however there is currently no structured means of compiling and reporting this information program-wide.

Table 9 Possible Higher Education Student Data Collection Elements for use by CRCs

Element No.	Element Name
306	Higher Education Provider code
310	Course of study type code
314	Date of birth
315	Gender code
328	Course commencement date
330	Type of attendance code
339	Equivalent full-time student unit load
358	Citizen/resident indicator
461	Field of education code
487	Scholarship type code
493	Highest educational attainment prior to commencement

Source: *Higher Education Data Collection Element Dictionary* (DEEWR, 2011a)

One way of supporting both availability and consistency in student data collected and reported for CRC-engaged research candidates would be for CRCs to adopt the same data elements used by university providers. A list of possible data elements is included in Table 9 above as a starting point for considering the student characteristic data which could be collected for CRC-engaged research candidates. Information for these elements could be collected and compiled by CRCs directly, or requested from university partners on a regular basis. As with any data collection and reporting exercise, the benefits of collecting and reporting additional student data would need to be weighed against the costs (see also section 4.2.2 below).

4.2.2 Benchmarking and 'good practice' resources for member CRCs

Another area identified as a priority by CRC education managers in workshops conducted for the scoping study was in the development and sharing of resources for good practice, potentially through the CRCA website. It was noted that while there was scope to review the information collected as part of the annual reporting process, that there were also opportunities to improve on the information available through benchmarking activities, where these might also serve to highlight useful examples of good practice. Benchmarking and review of CRC activities and resources for research education might include such areas as:

- Enrolment metrics for CRC-engaged research candidates;
- Research infrastructure, resources and project funding available to candidates;
- Scholarship and stipend support;
- Supervision and research advisory arrangements;
- Skills and professional development activities;
- Initiatives in support of collegiality and a positive and productive intellectual climate;

- Specific policies, procedures and resources in areas like IP management; and
- The general policies and procedures that inform and support the broader range of CRC research education activities.

Outcomes from benchmarking activities should ideally form part of a 'living document' or online resource available for member CRCs. There may also be opportunities for developing a broader range of 'good practice' resources, ideally available to member CRCs through the CRCA website. Following findings from Montagu (2010) and input from CRC education managers, strategic considerations for CRCs in research training that might also be addressed through such an initiative include:

- Arrangements for off-campus students;
- Maximising opportunities for engagement with industry mentors and industry engagement more broadly;
- Ensuring efficient and effective use of support measures such as scholarships and stipends; and
- Perceptions of the CRC research climate.

Some reservations were expressed in workshops conducted for the scoping study regarding the potential proliferation of benchmarking activities. Disadvantages identified include the potential for duplication of effort, adding to what may already be an excessive reporting and compliance load, and the risk of considerable additional effort being required for questionable additional benefit. It was also noted that benchmarking with the aim of duplicating the research education contribution of partner universities may be of questionable additional value. Concerns were also raised about the methodology employed by some benchmarking initiatives. On the positive side, benchmarking activities that were practice-focussed, and that supported the availability and use of common resources, practical strategies and examples of good practice were valued over those which may simply add to paperwork being circulated on an annual basis. As with any data collection and reporting exercise, the benefits of expanding the data collection and reporting activities of CRCs would need to be weighed against the costs, including the time, financial and human resources invested in doing so.

4.3 Conclusion

Cooperative Research Centres (CRCs) are a key 'bridge builder' between research organisations and research end-users. They achieve this through building long-term strategic collaborations in research. Research higher degree students play a central role in building and sustaining these links, both through their contribution through research, through the stakeholders they bring together in cementing research partnerships, and actively through the ongoing engagement candidates and graduates pursue following their time as researchers with CRCs.

The O'Kane report affirmed the need for further research into the CRC research training environment (O'Kane, 2008, p.66). The CRCA recognises that the responsible management of risk plays an important role in innovation. Providing scope for innovation and outcomes that are both valued and valuable means taking chances within the bounds of what is possible. This means meeting and exceeding expectations through balancing pursuit of the novel or original within the bounds of what is practical and achievable. The same holds for research higher degrees.

There are clear development opportunities around the research education activities of CRCs, both in the immediate and longer term. At a minimum pursuit of these opportunities would serve to demonstrate the distinctiveness of CRCs and inform their activities in this area. Broader opportunities exist through development in this area in the medium to longer term.

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Appendices

Appendix I The scoping study

Aims

The broad aims of the scoping study are to:

- Identify a set of guiding questions for future development in the area of CRC RHDs;
- Identify and review available metrics in which the quality and distinctiveness of the CRC RHD environment may be reflected;
- Identify preliminary dimensions and criteria by which CRCs may be able to benchmark their RHD activities and share resources; and
- Identify development opportunities in the research education activities of CRCs.

Activities

The principal activities proposed for the scoping study including compiling available evidence, stakeholder consultation and summarising key issues, gaps and opportunities for future development.

Summarise key issues, gaps and opportunities for future development

Identify strategies for improving the quality and availability of key data on CRC RHDs, including basic demographics of RHD students engaged with CRCs, enrolment status and field of study. The scoping study will also provide a preliminary summary of recommended target setting, performance metrics and key dimensions for benchmarking, reporting and for further investigation and development.

Stakeholder consultation

A series of workshops were hosted on issues around the research training contribution of smaller-scale research training providers, and issues specific to the CRC contribution to research training. These included the following:

- Research Training in Less Research Intensive Environments, University of Canberra, November 2011;
- CRCA Education Managers Meeting, Perth, November 2011;
- *Collaborating with Postgraduates: The CRC Contribution to Research Training*. Paper presented at the Collaborate Innovate: 2012 CRCA National Conference; and
- *Improving Postgraduate Completion Rates: The CRC Contribution to Research Training*. Workshop conducted at the Collaborate Innovate: 2012 CRCA National Conference.

Good Practice Appraisal Tool

A good practice appraisal tool was developed for the scoping study as a companion document to the scoping study final report. The appraisal tool was tailored to internal stakeholders as a vehicle for continued development around the CRC contribution to research training.

Appendix II Extracts from the Management Data Questionnaire (MDQ)

Items from the current version of the MDQ relevant to the research training activities of CRC are included below (source: DIISR, 2011a, pp.23-27). Emphasis has been added in order to highlight definitions and key terms. Items relevant to coursework postgraduates engaged with CRCs and other CRC educational activity are not included here.

4.1 Doctorate by research students

- Data must only relate to the CRC's activities, as specified in the Commonwealth Agreement.
- **Course completions**: The successful completion of all the academic requirements of a course which includes any required attendance, assignments, examinations, assessments, dissertations, practical experience and work experience in industry.
- **EFTSL:** Equivalent full-time student load (EFTSL) or full-time equivalent (FTE) is a measure of the study load, for a year, of a student undertaking a course of study on a full-time basis, as used by the DEEWR Higher Education Information Management System (HEIMS).
- Include: Only students who work on CRC activities and who are regarded as part of the CRC.
- Include: Doctorate by research degrees (course for which at least two-thirds of the student load is required as research work).

4.1.1 Equivalent full-time student load (EFTSL) of students working for their doctorate by research during the reporting period: 0

4.1.2 Number (headcount) of new doctorate by research students who commenced their course during the reporting period: 0

4.1.3 Number (headcount) of doctorate by research course completions during the reporting period: 0

4.2 Masters by research students

- Data must only relate to the CRC's activities, as specified in the Commonwealth Agreement.
- **Course completions**: The successful completion of all the academic requirements of a course which includes any required attendance, assignments, examinations, assessments, dissertations, practical experience and work experience in industry.
- **EFTSL:** Equivalent full-time student load (EFTSL) or full-time equivalent (FTE) is a measure of the study load, for a year, of a student undertaking a course of study on a full-time basis, as used by the DEEWR Higher Education Information Management System (HEIMS).
- Include: Only students who work on CRC activities and who are regarded as part of the CRC.
- Include: Masters by research students (course for which at least two-thirds of the student load is required as research work).

4.2.1 Equivalent full-time student load (EFTSL) of students working for their masters by research during the reporting period: 0

4.2.2 Number (headcount) of new masters by research students who commenced their course during the reporting period: 0

4.2.3 Number (headcount) of masters by research course completions during the reporting period: 0

…

4.4 Supervision of higher degree by research students

- Data must only relate to the CRC's activities, as specified in the Commonwealth Agreement.
- **Non-university staff member**: A person employed by the CRC or a participant, other than a university, for more than 50% of his or her time.
- Include: Supervision of doctorate by research and masters by research students who work on CRC activities and who are regarded as part of the CRC.

4.4.1 Number (headcount) of university staff members involved in formal supervision of higher degree by research students reported in questions 4.1.1 and 4.2.1 during the reporting period: 0

4.4.2 Number (headcount) of non-university staff members involved in formal supervision (e.g. second supervisor) of higher degree by research students reported in questions 4.1.1 and 4.2.1 during the reporting period: 0

…

4.6 Graduate employment destination after completing postgraduate qualifications

- Data must only relate to the CRC's activities, as specified in the Commonwealth Agreement.
- **End-user**: A person, organisation, industry or community capable of deploying the research outputs of a CRC, whether they are participants in the CRC or not.
- **Course completions**: The successful completion of all the academic requirements of a course which includes any required attendance, assignments, examinations, assessments, dissertations, practical experience and work experience in industry.
- Include: Only graduates who worked on CRC activities and who were regarded as part of the CRC.
- Exclude: Students who did not complete their formal postgraduate qualification.

4.6.1 Number of doctorate by research graduates taking up employment with end-users during the reporting period: 0

4.6.2 Number of masters by research graduates taking up employment with end-users during the reporting period: 0

4.6.3 Number of other postgraduates taking up employment with end-users during the reporting period: 0

Appendix III University Groupings

University Type	
Group of Eight Member Universities (Go8)	**Former New Generation Member Universities - Metropolitan**
Monash University	Australian Catholic University
The Australian National University	Edith Cowan University
The University of Adelaide	University of Canberra
The University of Melbourne	University of the Sunshine Coast
The University of New South Wales	University of Western Sydney
The University of Queensland	Victoria University
The University of Sydney	
The University of Western Australia	
Innovative Research Member Universities (IRU)	**Former New Generation Member Universities - Regional**
Flinders University of South Australia	Central Queensland University
Griffith University	Southern Cross University
James Cook University	University of Ballarat
La Trobe University	University of Southern Queensland
Murdoch University	
The University of Newcastle	
Universities of Technology (ATN members plus Swinburne)	**Non Aligned Metropolitan Universities**
Curtin University of Technology	Bond University
Queensland University of Technology	Deakin University
RMIT University	Macquarie University
Swinburne University of Technology	The University of Notre Dame Australia
University of South Australia	University of Tasmania
University of Technology, Sydney	University of Wollongong
	Non Aligned Regional Universities
	Batchelor Institute of Indigenous Tertiary Education
	Charles Darwin University
	Charles Sturt University
	The University of New England

From *Undergraduate Applications, Offers and Acceptances*, 2010. Department of Education, Employment and Workplace Relations (DEEWR) 2011.

Appendix IV The Postgraduate Research Experience Questionnaire (PREQ)

Table 10 Items from the Postgraduate Research Experience Questionnaire (PREQ)

Scale	Label	Item
Supervision	PREQ01	Supervision was available when I needed it
	PREQ07	My supervisor/s made a real effort to understand difficulties I faced
	PREQ13	My supervisor/s provided additional information relevant to my topic
	PREQ17	I was given good guidance in topic selection and refinement
	PREQ21	My supervisor/s provided helpful feedback on my progress
	PREQ24	I received good guidance in my literature search
Intellectual Climate	PREQ05	The department provided opportunities for social contact with other postgraduate students
	PREQ09	I was integrated into the department's community
	PREQ16	The department provided opportunities for me to become involved in the broader research culture
	PREQ22	A good seminar program for postgraduate students was provided
	PREQ23	The research ambience in the department or faculty stimulated my work
Skill Development	PREQ06	My research further developed my problem-solving skills
	PREQ10	I learned to develop my ideas and present them in my written work
	PREQ14	My research sharpened my analytic skills
	PREQ20	Doing my research helped me to develop my ability to plan my own work
	PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems
Infrastructure	PREQ03	I had access to a suitable working space
	PREQ08	I had good access to the technical support I needed
	PREQ12	I was able to organise good access to necessary equipment
	PREQ18	I had good access to computing facilities and services
	PREQ27	There was appropriate financial support for research activities
Thesis Examination	PREQ02	The thesis examination process was fair
	PREQ15	I was satisfied with the thesis examination process
	PREQ25	The examination of my thesis was completed in a reasonable time
Goals and Expectations	PREQ04	I developed an understanding of the standard of work expected
	PREQ11	I understood the required standard for the thesis
	PREQ19	I understood the requirements of thesis examination
Overall Satisfaction	PREQ28	Overall, I was satisfied with the quality of my higher degree research experience

Source: *Postgraduate Research Experience 2010: A Report of the Postgraduate Research Experience Questionnaire* (GCA, 2011)

Appendix V QAA Indicators of Sound Practice

Table 11 Indicators of sound practice in assuring and enhancing the quality of research degrees

Indicator	Areas where indicators of sound practice were identified
Indicator 1	Develop, implement and review regulations and codes of practice relating to research degrees that are clear and readily available to research students and staff.
Indicator 2	
Indicator 3	Monitor internal and external indicators that reflect the context in which research degrees are being offered.
Indicator 4	Accept appropriately qualified and prepared research students into a quality environment that provides support for doing and learning about research based on admissions procedures that are clear, consistently applied and demonstrate equality of opportunity.
Indicator 5	
Indicator 6	
Indicator 7	Clearly define and communicate the responsibilities and entitlements of students and supervisors, and provide students with sufficient information to enable them to begin their studies with an understanding of the environment in which they will be working.
Indicator 8	
Indicator 11	
Indicator 9	Appoint supervisors as part of a team (with one main supervisor as a clearly identified point of contact) with the appropriate skills, subject knowledge and sufficient time to effectively support and encourage research students, and to monitor their progress effectively.
Indicator 10	
Indicator 12	
Indicator 13	Put in place clearly defined mechanisms for monitoring and supporting research student progress, including formal and explicit reviews of progress at different stages. Research students, supervisors and other relevant staff are made aware of progress monitoring mechanisms, including the importance of keeping appropriate records of the outcomes of meetings and related activities.
Indicator 14	Ensure research students have appropriate opportunities for developing research, personal and professional skills, with development needs jointly agreed early in the project.
Indicator 15	Higher education providers put in place mechanisms to collect, review and respond as appropriate to evaluations from those concerned with research degrees, including individual research students and groups of research students or their representatives. Evaluations are considered openly and constructively and the results are communicated appropriately.
Indicator 16	Higher education providers that are research degree awarding bodies use criteria for assessing research degrees that enable them to define their academic standards and the achievements of their graduates. The criteria used to assess research degrees are clear and readily available to research students, staff and examiners.
Indicator 17	Research degree final assessment procedures are clear and are operated rigorously, fairly and consistently. They include input from an external examiner and are carried out to a reasonable timescale. Assessment procedures are communicated clearly to research students, supervisors and examiners.
Indicator 18	Higher education providers put in place and promote independent and formal procedures for dealing with complaints and appeals that are fair, clear to all concerned, robust, and applied consistently. The acceptable grounds for complaints and appeals are clearly defined.

Source: *UK Quality Code for Higher Education Chapter B11: Research Degrees* (QAA, 2012) [14]

[14] The full version of the code is available at http://www.qaa.ac.uk/Publications/InformationAndGuidance/Pages/quality-code-B11.aspx.

Appendix VI Areas addressed in the draft *Good Practice Framework for Research Training*

An edited summary based on the broad areas addressed through dimensions and components of the draft *Good Practice Framework* is included below. As of the time of writing the framework is still under development, and is yet to be proposed or adopted as a framework for good practice. The summary below and dimensions and components referred to elsewhere in this report are therefore included as a general guide only, as the detail outlined below may differ substantially from the final version of the *Good Practice Framework*.

1: RHD Governance

An effective governance framework for research training assures and enhances the quality of research degree programs, monitors performance and compliance and manages risk associated with research higher degrees. Components of an effective governance framework include:

- RHD Committee oversight and review;
- RHD Policies and procedures;
- Provisions for RHD candidate representation and informed participation; and
- Procedures for handling grievances and appeals.

2: Research Degree Program Overview

A research degree program is typically accompanied by a clear statement of purpose, outlining aims for the program against which quality and performance may be evaluated. These typically describe in broad terms the desirable outcomes associated with the program, and in some cases the inputs and processes associated with these. These typically include a clear statement of program outcomes and provisions for monitoring, review and continuous improvement (including mechanisms for candidate feedback).

3: Selection, Admission and Orientation

Clear, accurate, consistent and accessible information on selection and admission provides appropriate disclosure for current and prospective candidates, can assist in recruitment and are important in managing risk. Components include:

- Provision of information at initial enquiry;
- Clearly described entry pathways;
- Provisions for transfer and advanced standing;
- Transparent criteria and procedures for selection, offer, admission and enrolment; and
- Strategies and procedures for matching candidates with projects, supervision, facilities and resources.

4: Supervision

Research candidates should have access to a graduate advisory team with an appropriate mix of expertise in the relevant discipline(s), research methods, and supervisory skills and experience. Each graduate advisory team should include a main advisor as a clearly identified point of contact, with co-supervisory arrangements tailored to candidates' interests and needs and the requirements of their chosen research. Eligibility criteria should be applied for prospective supervisors before approving supervisory arrangements, and the rights and responsibilities of supervisors should be clearly defined and readily available. Supervisors should have access to ongoing professional development and support as part of the research degree program.

5: Candidature agreements

Clear and detailed information on all features and requirements of the research degree is made available to candidates at or prior to commencement, including the rights and responsibilities of both candidates and supervisors. Other provisions outlined at commencement include access to the resources necessary for the conduct of quality research, academic and professional objectives for the degree and requirements for maintaining satisfactory progress. Arrangements should also be made clear for the ongoing provision of information, guidance and support, and for regular review of progress relative to the objectives and requirements of the research project. These elements may be described through policies, procedures and conditions of enrolment, but may also feature as part of a clearly stated agreement or agreements between the candidate and the provider which may be varied over time.

6: Responsible Conduct of Research

Research training programs should be supported by clear policies, procedures and guidelines that promote academic integrity, ethical scholarship and the responsible conduct of research. These should be accompanied resources on the responsible management of intellectual property and related issues tailored to both supervisors and candidates, and clear strategies for managing both opportunities and risks through the conduct of research. Examples include accessible policy and resources on:

- Intellectual property;
- Academic integrity;
- Conflict of interest;
- Responsible authorship;
- Attribution and citation practices; and
- Collection and storage of data.

7: Support for Candidates and for a Quality Research Environment

RHD candidates should have access to resources appropriate to their research project and sufficient to support timely completion of a quality degree. They should also have access to services and support in attaining the desired graduate outcomes, and for assisting them in the challenges they must navigate in completing their degree. Examples include the appropriate physical, financial, administrative, academic, counselling and disability support services. They also include strategies for supporting a collegial environment for the conduct of research, and one that is engaging, culturally sensitive, locally and globally relevant and supportive of diversity.

Scholarships

The provision of scholarships should be monitored by the appropriate higher degrees committee, and governed by a clear set of policies and procedures. These should include:

- A clear set of transparent criteria for determining eligibility for and award of scholarships;
- Transparent policy and procedures for the allocation and administration of research scholarships;
- A clear statement of all scholarship entitlements and conditions; and
- Regular review of all relevant policies and procedures to ensure transparency, equity of opportunity and alignment with government or other scholarship provider conditions.

Facilities, resources and support for the conduct and dissemination of research

Research candidates should only be offered a place where resources adequate to their research and candidature are available. These include the infrastructure and consumables necessary for the conduct, dissemination and examination of the research project, and for the attainment of the desired graduate attributes.

Minimum standards for the resources available should be clearly specified in an institution-wide policy (with area-specific policies where facilities and resources are provided above this standard). Resource provision should be benchmarked against the standards described in *Minimum Resources for Postgraduate Study* (2010), and include the following:

- Appropriate access to facilities, and lab space where required;
- Appropriate sole-use work-space, filing and storage facilities and correspondence address;
- IT facilities and support, including software appropriate to the research project;
- Photocopier, printer, telephone, and scanner access as appropriate to the research project;
- Support for consumables necessary for the conduct of research;
- Support for travel, accommodation and registration costs associated with the conduct and dissemination of research (including conference travel and field work); and
- Financial support for the direct costs associated with the conduct and dissemination of research (with a budget for the direct costs of research established at or prior to commencement).

A collegial research environment

Candidates should have opportunities to engage with a dynamic and inclusive culture of research scholarship, with formal and informal opportunities for engaging with other researchers, academic peers and with industry, with regular feedback and review of the scope and effectiveness of the opportunities available.

Support services

Candidates should have access to a range of personal, professional and academic support services, with clear information on these readily accessible. Access to these services should extend the full duration of candidature, including the period between submission of the thesis and conferral of the degree. These should include:

- Information and advice on academic policies and procedures and how they affect them;
- Access to counselling and student welfare services;
- Access to academic development services;
- Access to career development and advice services;
- Access to specialised support and advice tailored to particular groups;
- Access to sources of information and advice independent to the supervisory team, and where possible independent to the provider for the degree; and
- Opportunities to engage with other research candidates through independent groups or associations of postgraduates, as a valuable avenue for collegiality and peer support.

8: Professional Development

Academic and professional development opportunities should be available to assist candidates in completing their program and progress in their chosen field. Academic and professional development needs are identified early in each students candidature through agreement between the candidate and their advisory panel. Areas addressed should reflect each candidate's interests and needs and the requirements of their research, and should include:

- Research skill development;
- Transferable skill development;
- Interdisciplinary experience; and
- International engagement.

9: Supporting Career Progression

Support should be available to assist candidates in developing both academic and non-academic careers.

- Career development advice;
- Assistance in developing a Curriculum Vitae (CV) and Portfolio; and
- Opportunities to engage with peers, employers and alumni relevant to the candidate's discipline area.

10: Examination

Clear advice on the examination process should be available to candidates and staff. Steps in the examination process should include the following.

Pre-submission Review

Examination processes should ensure that successful candidates merit award of their degree, and work submitted for examination is required to be of an international standard.

Appointment of Examiners

The examination process should avoid conflicts of interest. Examiners should be appointed based on a clear set of criteria and their competency must meet international standards relevant to the discipline. Examiners must be external, independent and hold a degree at the level they are examining or higher, unless in exceptional circumstances.

Examination of Thesis

Examination of the thesis should be based on a clear set of criteria available to both candidates and staff. Appropriate processes should be in place for managing divergent examination reports and allow opportunity for appeal. The examination process should avoid unnecessary delays and candidates should be kept informed of progress.

Conferral of Award

Conferral of the degree certifies that the candidate has AQF and other requirements for the award of the degree. Based on the examination results, conferral of the degree is approved by the senior committee responsible for academic governance.

Appendix VII Template program elements based on the CRC *Balanced Scientist Program*

The template program aims and outcomes included here are based on *Guidelines for the Balanced Scientist Program* (Dimond & Sarre, 2011, p.4). These are included as a guide only, and further consultation should be undertaken before arriving at an agreed set of program outcomes either within or across CRCs. Further comparison with example program outcome statements for university providers of research training is strongly recommended.

Template program aims

Our aim is to provide comprehensive training and development programs for postgraduate candidates that result in highly-skilled graduates with a broad knowledge of issues applicable to their discipline and experience in industry settings relevant to their area of expertise.

Our goal is to produce graduates that can move between industry and academia providing the vital links between these critical components of the infrastructure of Australasia. Graduates from this program attain a Certificate in Research Leadership and Management and will be, we hope, more attractive to employers and able to make a contribution to their field of research beyond that which would have been possible with conventional, thesis-only based training.

Traditional PhD programs aim to have candidates learn to conceive, plan and carry to completion a substantial piece of original research in a specialised area of academic study, under the supervision of a professional in the field. In so doing, the candidate is expected to extend their chosen field of study by contributing to knowledge in that field or by reworking existing knowledge to provide new insights.

An additional central objective of this program is to prepare graduates for leadership roles in industry. This is accomplished by providing leadership, management, business and entrepreneurial skills, in addition to the sound research training designed to improve the knowledge base upon which research decisions rest. These additional educational opportunities are accommodated by funding candidates into a fourth year of study.

In this way, graduates of this program will be fully equipped with the knowledge and skills to take up key positions in research and industry. These individuals will likely become key players in the future of research and this training program will have prepared them for this challenge.

Template program outcomes

Given the aims of the program, we expect candidates to achieve learning outcomes beyond that seen in standard thesis-based training. We outline these below in relation to the Balanced Scientist Model.

Self

Candidates will be able to express knowledge, novel ideas and opinions in their professional field, both orally and in written form, with confidence and clarity. Candidates will demonstrate advanced knowledge and professional competence in the principles and practices of project management and have the skills to be flexible and responsive to the broad range of situations that confront them in a whole-of-life context.

Team

Candidates will have the capacity to work effectively in a team environment and will have the knowledge to initiate and participate in professional collaborations. Candidates will be able to provide constructive feedback to peers and to be able to receive and evaluate constructive criticism from peers in their professional field.

Science

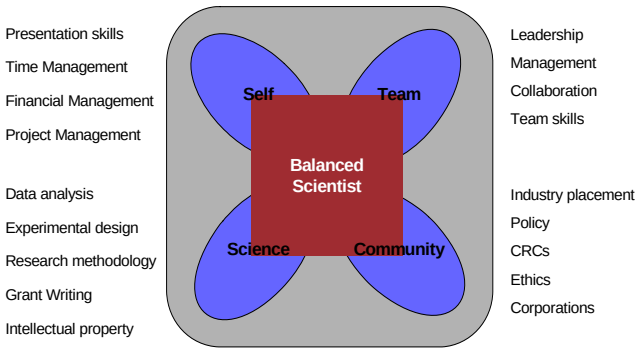
Candidates will be able to design and implement a research program, inclusive of budget, research proposal, research ethics application and timeline to completion. Candidates will be able to express a problem in statistical terms; summarise data graphically and statistically, and conduct appropriate statistical analyses relevant to their professional field. Candidates will be able to identify intellectual property rights and comprehend the commercialisation of research process for both their own, and other organisations.

Community

Candidates will have a comprehensive understanding of the organisational and management structure of Cooperative Research Centres. Candidates will have a critical understanding and knowledge of research ethics and obligations including the preparation of applications for ethics boards where appropriate.

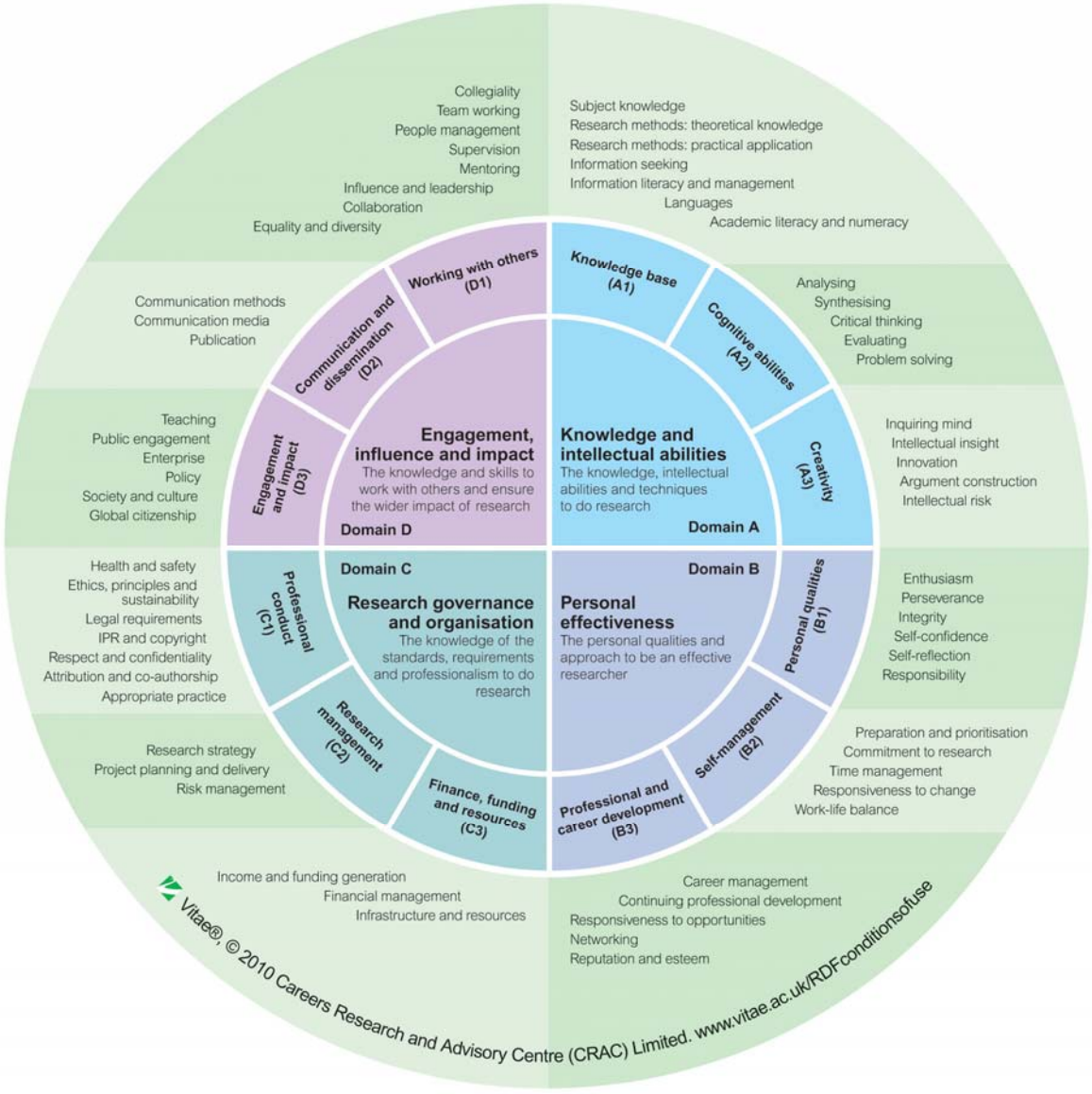
Appendix VIII Comparison of the CRC *Balanced Scientist Model* and the Vitae *Researcher Development Framework*

Figure 10 The *Balanced Scientist Model*



Source: *Guidelines for the Balanced Scientist Program* (Dimond & Sarre, 2011)

Figure 11 The *Researcher Development Framework*



Source: *Researcher Development Framework* (Vitae, 2011)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