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Higher Degree Research at Australian Universities: Responding to Diversity in Engineering and Information Technology

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BACKGROUND

There is increasing enrolment of international students in the Engineering and Information Technology disciplines and anecdotal evidence of a need for additional understanding and support for these students and their supervisors due to differences both in academic and social cultures. While there is a growing literature on supervisory styles and guidelines on effective supervision, there is little on discipline-specific, cross-cultural supervision responding to the growing diversity. In this paper, we report findings from a study of Engineering and Information technology Higher Degree Research (HDR) students and supervision in three Australian universities.

PURPOSE

The aim was to assess perceptions of students and supervisors of factors influencing success that are particular to international or culturally and linguistically diverse (CaLD) HDR students in Engineering and Information technology.

DESIGN/METHOD

Online survey and qualitative data was collected from international and CaLD HDR students and supervisors at the three universities. Bayesian network analysis, inferential statistics, and qualitative analysis provided the main findings.

RESULTS

Survey results indicate that both students and supervisors are positive about their experiences, and do not see language or culture as particularly problematic. The survey results also reveal strong consistency between the perceptions of students and supervisors on most factors influencing success. Qualitative analysis of critical supervision incidents has provided rich data that could help improve support services.

CONCLUSIONS

In contrast with anecdotal evidence, HDR completion data from the three universities reveal that international students, on average, complete in shorter time periods than domestic students. The analysis suggests that success is linked to a complex set of factors involving the student, supervision, the institution and broader community.

KEYWORDS

Higher Degree Research, Engineering, Information Technology, supervision.

Introduction

International (Int) students make up a substantial proportion of Higher Degree Research (HDR) enrolments in Engineering and Information Technology in Australia (AEI, 2010; Dobson, 2010; King, 2008). Anecdotal evidence from Australian Engineering schools has indicated concerns stemming from the rising participation by these students, many of whom are from culturally and/or linguistically diverse (CaLD) backgrounds. This study was motivated by anecdotal evidence suggesting that cultural and linguistic differences influence the students' studies. Some supervisors suggested that international students require 'high maintenance'; that supervision workloads are higher and that many have 'inferior' prior research training. There was also anecdotal evidence that supervisors may resist taking on supervision of Int-CaLD students.

In contrast to these perceptions, unpublished completion data contained in records from the three participating institutions has revealed that international students may be more successful than domestic students as shown in Table 1 (note that the majority of HDR students are enrolled in PhD degree studies, and also that there are slight organisational differences in discipline aggregation). This data is not easily accessible, even to academics. Appreciating this data, and also the complexity of factors that influence student outcomes could change perceptions and help academics respond effectively to the increasing diversity of student demographics.

This paper reports findings from a study to investigate factors that may influence HDR student success, specifically in the Engineering and Information technology (IT) disciplines. Students and supervisors from University of Western Australia (UWA), Queensland University of Technology (QUT) and Curtin University (Curtin) participated in the study.

Table 1: Number of doctoral completions and mean-time to completion in Engineering and Computing: 2003-2008. (See Appendix for data sources).

UWA	Total number of completions (EFTSL)	% of cohort	Mean-time to completion
Domestic	217	73.4	4.31
International	78.5	26.6	4.09
QUT			
Domestic	423	79	3.9
International	112	21	3.6
Curtin			
Domestic	264	55.2	NA
International	214	44.8	NA

As they progress, HDR students transition from being dependent on direction and support for their study to become independent researchers with substantial discipline knowledge. They are expected to demonstrate independent, systematic and critical thinking at a very high level for an intensive study. There is also an expectation that graduates at this level are able to 'develop, adapt and implement research methodologies' (AQFC, 2011, p 61).

On the other hand, HDR successful completions are highly dependent upon the quality of supervision. The experiences and outcomes of studies are significantly related to the 'quality' of the supervision provided (McCulloch, 2010, p 175). In practice, this is reflected in the development of professional supervision training programs for supervisors and through the introduction of accreditation of supervisors at some universities such as Queensland University of Technology.

While there is emerging literature on discipline-specific approaches to supervision (see for example, Bruce, 2008), largely, perspectives on supervision are general and anchored in the role of the supervisor in the supervision process. Depending on the objectives of the studies, a

wide-ranging list of roles are found such as director, facilitator, adviser, teacher, guide, critic, freedom-giver, supporter, friend, manager, mentor, gatekeeper, organiser, nurturer, coach, sponsor, educator and more which form the basis of most models on supervision (Delany 2008; Lee 2007; Manathunga, 2009; Pearson and Kayrooz, 2005; Zhao, 2010).

The 'role theory' (Walford, 1981), underpinning these perspectives has its limitations as it reduces supervision to a relationship between two individuals. In reality, HDR studies intersect with the social and cultural lives of the supervisor and the student in the academic community and the wider society in which they work. To integrate these elements within research training frameworks, some researchers for example, Cullen et al (1994) have proposed models that detail and explain the complexities of a supervisory relationship.

However, to date, research that specifically addresses supervision issues related to the diversity that Int-CaLD, HDR students present is scarce in the Engineering and IT disciplines. Literature on diversity in the HDR sector has indicated significant additional challenges faced by students with backgrounds different from the prevailing Anglo-European majority in Australia. Many Int-CaLD students come from countries where English is a second language and may be accustomed to a more authoritarian academic hierarchy. Adjustment to the different Australian social, cultural, and academic environments could be disorientating as it may be 'unpredictable and uncertain' (Taranuraksakul and Hall, 2011) leading to degrees of unease with interactions, processes, and modes of study, depending on the personal circumstances of the students.

Research also shows that cultural, linguistic and academic differences may influence students' progress. Cultural differences may affect communication between students and their supervisors, students and other students, or with students in the larger community (Marcus and Gould, 2000). Linguistic challenges can include the need for fluency in a specific academic genre or discipline to present orally in seminars and at conferences, as well as the requirement to interact appropriately with colleagues and others. Differences may include expectations regarding student and teacher/supervisor roles and responsibilities, learning style differences, discipline-specific skills expectations, or even different understandings of approaches to research for example in terms of how it is done (Garcia- Perez and Ayers, 2012) and the requirements for different types of research degrees (Briguglio and Howe, 2006).

Students may also find it difficult to adapt to the local research culture as a result of a lack of familiarity with social conventions, discipline-specific genres of writing or working, and assumed rules of communication. For example, some students may struggle to ask questions comfortably, communicate effectively with their supervisors, or have difficulty understanding Australian approaches to time and self-directed learning (Cahill, 1997). These issues can be compounded when a student is required to interact with a supervisor who may also be from a non Anglo-European background (but different from the student's). Therefore, the primary objective of this study has been to identify key factors which may influence supervision, of Int-CaLD HDR students, particular to the Engineering and IT disciplines.

A mixed methods approach was taken for this study. Data from documents and focus groups in the initial phase of the study helped to identify factors to include in two on-line surveys that were developed to allow data collection from larger populations of students and supervisors. Complex systems analysis (discussed below) of the survey data provided a complementary framework and comparison of the results could provide a more reliable foundation to understand which factors ultimately have most influence on student success. Further qualitative analysis based on the initial focus groups, interviews and comments from the surveys provided an understanding of the wider research environment and factors that may influence success.

This paper presents the preliminary results of the supervisor surveys and qualitative data analysis that could be of value in Engineering and IT HDR education programmes. Results of the student survey have been presented in earlier publications (Gudimetla et al 2010 and

Woodman et al, 2011). More detailed findings and analyses will appear in forthcoming publications.

Survey Data and Analysis

Two online survey instruments were developed to collect data from students and supervisors respectively. These were based on a pilot student survey, data from focus group discussions with students and supervisors, documentary evidence, and relevant literature (see Gudimetla et al, 2010; Woodman et al, 2011). The focus group discussions helped to identify discipline-specific factors which were included in the surveys.

The student survey involved 228 Int-CaLD HDR students in Engineering and IT at the three participating universities who completed the student survey. The main source countries were China, Malaysia, Iran, India, Indonesia and Sri Lanka. Demographic data included age, gender, country of birth, length of residence in Australia, course information, previous experience at an Australian university, level of previous education, and study mode (part-time or full-time). Likert scale responses provided perceptions on supervisors' expertise, interest shown in student, availability, guidance, research support, language and communication skills support, social interactions and willingness to discuss personal issues. Further items on the survey examined perceptions on assistance in understanding the local research environment, research culture, the socio-economic and national implications of their research, and student and supervisor obligations.

The supervisor survey was completed by 69 supervisors from the three universities. The supervisor survey contained ten items which were identical to those on the student surveys, as well as including items of similar or relevant issues. Demographic data included educational background, gender, country of birth, length of residence in Australia, cultural background, language background, previous experience at an Australian university, educational background and international experience, employment experience, and field of expertise. Other items included the number of HDRs (Int-CaLD and non-Int-CaLD) supervised and completed. Again, Likert scale responses provided perceptions on supervisory style, student and supervisor obligations, cross-cultural supervision issues and benefits, successful student behavioural attributes, differences in support needs for Int-CaLD students, impact of Int-CALD HDR supervision, supervisors' own research, and institutional support. The data from both student and supervisor surveys was analysed using descriptive statistics, principal components analysis (PCA), linear regression, and Bayesian Network analysis.

Principal components analysis (PCA) is a method for combining a set of variables into a combined score (also often called an index). Linear regression was used to examine the relationship between the students' personal attributes and their attitudes to supervision (student survey), and supervisors' personal attributes and their attitudes to supervision and student success (supervisor survey). The attitudes were considered as the response and the personal attributes were fitted as possible predictors of the response. The aim was to identify personal attributes that significantly impacted on the students' attitudes to the supervisor, and vice versa. A Bayesian Network (BN) can be used to graphically represent and then examine the relationship between an outcome of interest and the (possibly many, interacting) variables that influence this outcome. It is a common method for modelling complex systems, so is a natural model for attitudinal surveys (Mengersen et al, 2012 provide details). A complex systems model obtained from the supervisor survey analysis is shown in Figure 1 and illustrates the range of factors examined during the study.

A comparison between the student and supervisor responses revealed strong positive correlations between supervisors and students perceptions on most issues. However, students had higher expectations concerning support from their supervisors on areas of personal and extracurricular issues than the supervisors, who tended to focus on academic matters. Both students and supervisors expressed satisfaction with each other and support from their institutions (see Mengersen et al, 2012 for details). This close alignment complements the completion data from documentary evidence in Table 1.

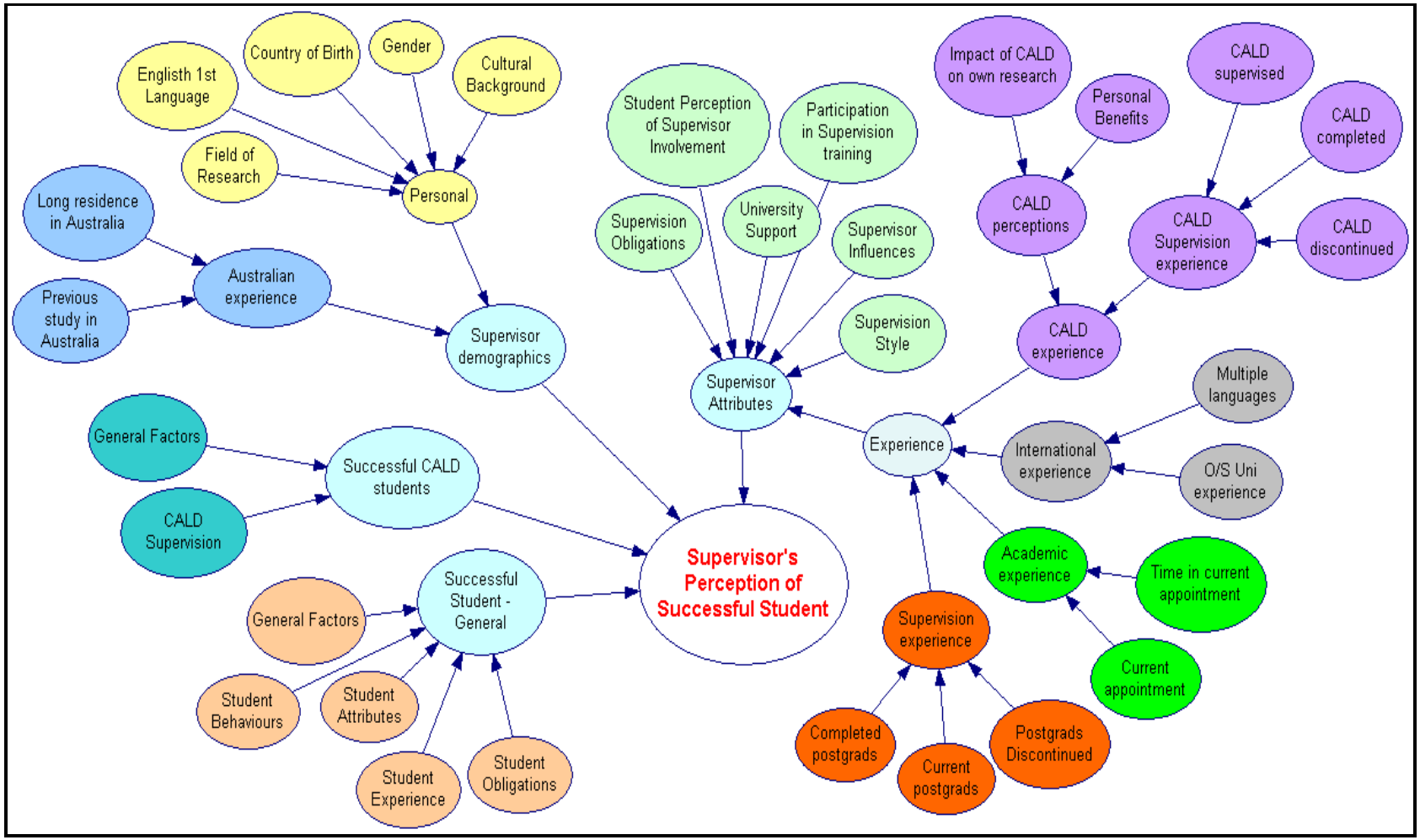

Figure 1.Complex systems model for supervisor survey

Qualitative Data and Analysis

The qualitative analysis conducted for the project was based on three data sources: transcripts from focus groups of students and supervisors in the initial phase; comments made by the 228 participants and 69 participants on the online student and supervisor surveys; and interviews on critical incidents with 12 supervisors in the last phase of the project.

NVivo software was used to organise and analyse the unstructured data. The data was coded on 36 emerging themes relating to the supervisory relationship. The themes were arranged and classified in four sets: 'student', 'supervisor', 'university/faculty' and 'other'. These themes provide the elements of the schematic illustration of the HDR learning environment shown in Figure 2 below.

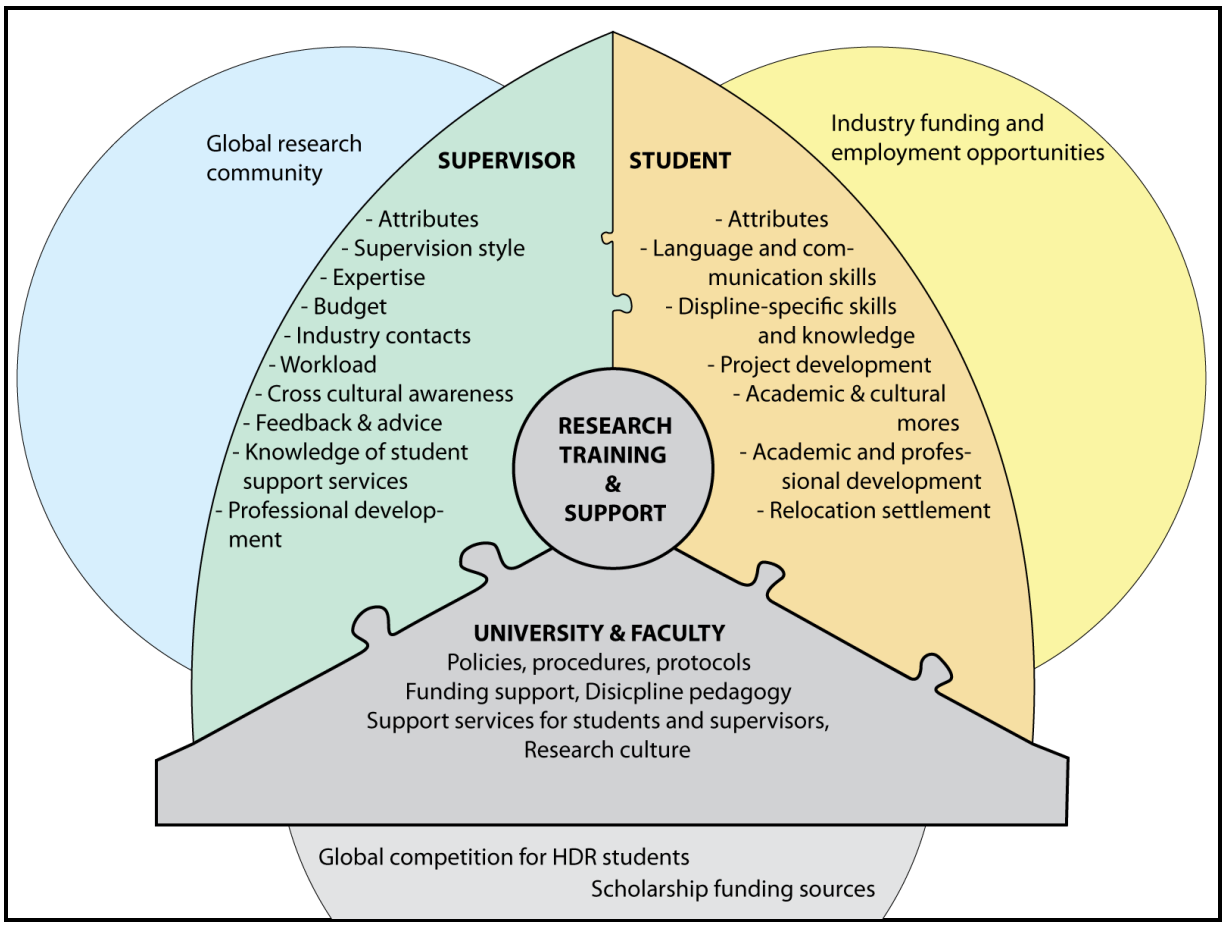

Figure 2: The higher degree research learning environment

General qualitative findings

Supporting the survey findings, the results of the qualitative analysis suggest that supervisor attributes, expertise, budget, industry contacts, workloads, feedback and advice, professional development, knowledge of student support services, professional development and cross-cultural awareness are relevant in the supervisory relationship. For example, in terms of attributes, students would prefer to have supervisors who are:

> *"not dictatorial, and willing to help even when discussing personal problems" (student quote).*

The supervisory style can be crucial in sustaining a lasting supervisor-student relationship:

> *"I give my students much more freedom to decide the direction of their research. Some students have changed from other supervisors and told me this" (supervisor quote).*

In terms of cultural awareness, the analysis reveals that most supervisors are attentive to cultural differences and use that awareness in strengthening the student-supervisor relationship as this quote indicates. Here the supervisor drawing from his own experience as an Int-CaLD student in Australia, shares the cultural norms of deference of his culture and indicates how he uses that to strengthen his supervision:

> *"I was so distressed being asked to call a senior academic with grey hair (by his first name), represents not only a fatherly figure in my culture,...And I give a lot of importance to that especially when I'm counseling…"(supervisor quote).*

On the part of the student too, personal attributes are important for success in HDR research. As one supervisor describes, a successful HDR student is one who is capable of

> *"independent thinking and analysis, who is self-motivated and has a genuine interest in research" (supervisor quote).*

Language and communication stand out as particularly essential in the initial stage of the candidature:

> *"In spite of obtaining the required scores for the IELTS examination, they do spend a lot of time during the initial months struggling to understand and learn language skills…" (supervisor quote).*

This validates the supervisor survey findings where nearly 85% of supervisors indicated the need to advise Int-CaLD HDR students on how to improve their linguistic skills was important. Further, 55% indicated that recommending language development programs was significant.

Discipline-specific skills and knowledge emerged as highly relevant to what contributes to success. As many supervisors pointed out in both interviews and surveys, inadequate background knowledge and preparation for research work can delay completions, however this is not seen as a problem specific to Int-CaLD students. Other factors include project development, academic and cultural mores and academic professional development. Additional factors outside of the academic relationship pertaining to relocating to Australia were also noted. For instance, students may have to be informed about housing, schools for their children and other family related issues, as well as religious needs:

> *"…if you have Islamic students, you have to understand what Ramadan is all about and that team social events need to be sensitive to their dietary differences..." (supervisor quote).*

Influential factors in the environment included policies, procedures and protocols, discipline-specific pedagogical resources, funding support and support services. Several supervisors commented on the need for adequate testing and technical facilities for research purposes. These types of factors strongly influence the supervisory relationship, defining its structure and giving financial support. The 'other' dimension revealed exogenous elements such as international research networks, industry and scholarship funding, and global competition for HDR students driving a quality agenda. These validating factors identified in the qualitative analysis help to substantiate the findings of the quantitative survey analysis.

Critical Incident Findings

Although the majority of findings in the large study indicate that the overall perceptions of Int-CaLD students is positive, when asked about specific incidents through critical incident interviews with mostly principal supervisors in the last phase of the project, a number of areas of potential difficulty were identified. The interviews explored challenging episodes that supervisors may encounter and yielded narratives on actual supervisor interventions. The

episodes were related both to students being of a CaLD background, as well as their international student status. Research disciplines included heat transfer, material science, civil, structural and mechanical engineering, mathematics and network security. Most of the incidents occurred in mid to late candidacy. Several were related to levels of English language proficiency compounded by weaknesses in background discipline knowledge and research skills; however social concerns were also presented. Narratives covered hygiene issues, disagreements with principal supervisors, relationship problems, ill-health and family financial responsibilities. Weaknesses in assessment for admission were cited; particularly for students on some foreign government scholarships as in some cases students:

> *"…are not really selected according to merit exactly and this was not picked up in the vetting process" (supervisor quote).*

Such students may not have the foundational knowledge in the specific discipline and a lot more has to be invested to bring the student up to mark to develop a project. The supervisors have provided solutions for the issues they have encountered and given further suggestions for improvement. For example, in a case where the student has little foundational knowledge, this supervisor suggested a more stringent process of admission at the HDR level to resolve such issues:

> *"…have some benchmarks against which to evaluate the student. Then at the personal level you could ask them to submit a thesis, or ask for their publications…" (supervisor quote).*

This rich source of data will be used to develop learning resources to help supervisors to improve their supervision knowledge base.

Conclusions and Implications

The results of this study provide encouraging outcomes for postgraduate research coordinators and deans of Engineering and IT. In contrast to anecdotal perceptions, Int-CaLD HDR students appear to be at least, if not more, successful than their domestic counterparts, perhaps partly due to higher financial investment and expectations and/or support systems available to these group of students at universities in Australia.

Both quantitative and qualitative analyses have yielded a comprehensive overview of the complex range of factors influencing success. The study finds that Int-CaLD students may require some different types of supervision support, and uncovers some of the challenges faced by these students and their supervisors, particularly in Engineering and IT. The study provides insights into how to respond to the growing student diversity in these disciplines.

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Appendix – Data Sources for Completions in Table 1

University of Western Australia, Review of Graduate Research Training, (2010) provided data for the School of Engineering, Computing and Mathematics, UWA, 2003-2008. Queensland University of Technology, Corporate Reports (2011) provided data for Faculty of Science and Engineering (and its predecessor Faculties of Science, Information Technology, Science and Technology, and Built Environment and Engineering), QUT, 2003-2008. Curtin University, Internal Sources, (2011) provided data for Faculty of Science and Engineering, Curtin University, 2003 – 2008.

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