Final report

Review of the Postgraduate Research Experience Questionnaire (PREQ)

Ali Radloff
Darren Matthews
Yan Bibby
Daniel Edwards

Australian Council *for* Educational Research

October 2017

ACER

Acknowledgements

The authors acknowledge the contributions of a number of people to this project. We would like to thank the Department of Education and Training - in particular Phil Aungles and Sam Pietsch, The QILT Working Group, The Social Research Centre - in particular Lisa Bolton, the numerous stakeholders, academics and professional staff across the university sector, our focus group participants and the research graduates who completed the pilot PREQ.

We would also like to make special reference to the project advisory group, who offered guidance and advice throughout the project. Members of this group were: Sara Rowlley (The Australian National University), Sue Mikilewicz (University of South Australia), Lucy Johnson (Newcastle University), Mike Teece (Universities Australia) and Conor King (Innovative Research Universities).

Table of Contents

Acknowledgements ii
Executive summary 6
Overview 8
Background and contexts 8
HDR training in Australia 8
About the PREQ 10
Project methodology 12
Phase 1 12
Phase 2 14
Review of literature and current practice and trends 16
Overview 16
The HDR population 16
Trends in HDR training 18
Measuring the HDR experience 20
The PREQ as an indicator of the contemporary HDR student experience 23
Findings from Phase 1 27
Statistical analyses 27
Stakeholder consultations 27
Options for the redevelopment of the PREQ 30
Findings from Phase 2 32
Development of revised PREQ instrument 32
Statistical analyses of pilot results 38
Stakeholder consultations 38
Recommendations for future PREQ 39
References 41
Appendix A: Consultation questions from Phase 1 45
Overview 45
About the PREQ 45
Consultation questions 46
Appendix B: Psychometric analyses of current PREQ 49
Overview 49
Appendix 1: Cohort Item Summaries 59
Appendix 2: EFA Results 63
Appendix 3: CFA Results 64
Appendix C: Pilot PREQ instrument development 65

Appendix D: Pilot PREQ instrument....70
Appendix E: Psychometric analyses of pilot PREQ....72
Appendix 1: Cohort Item Summary....87
Appendix 2: EFA results....89
Appendix 3: CFA results....90
Appendix F: Comparison of current and recommended PREQ instrument....92

Table of Figures and Tables

Table 1: Description of PREQ scales....11
Table 2: PREQ items and scales....11
Table 3: List of universities that participated in the PREQ pilot fieldwork....15
Table 4: Measurement of the contemporary HDR student experience....25
Table 5: Researcher Development Framework....34
Table 6: Current PREQ Items....45
Table 7: Data received and included in analyses....49
Table 8: Student background characteristics as percentage....49
Table 9: Correlations among latent scales in CFA model....53
Table 10: Pairs of Items with correlations greater than 0.75....54
Table 11: Items falling outside confidence bands of DIF analyses....55
Table 12: Significant Effect from the SEM Modelling....58
Table 13: 2014 cohort item summary....59
Table 14: 2015 cohort item summary....60
Table 15: 2016 cohort item summary....61
Table 16: Loadings for seven-factor Exploratory Model....63
Table 17: Unstandardised and standardised loadings for six-factor Confirmatory Model....64
Table 18: Mapping of survey items onto Researcher Development Framework....65
Table 19: Summary of AQF learning outcomes for HDR graduates....69
Table 20: Student background characteristics as percentage....72
Table 21: Correlations among latent scales in CFA model....76
Table 22: Pairs of Items with correlations greater than 0.75....77
Table 23: Items falling outside confidence bands of DIF analyses....80
Table 24: Significant effect from the SEM modelling....83
Table 25: Correlations between PREQ Skill Development scale and foundation skills items....85
Table 26: 2017 cohort item summary....87
Table 27: Loadings for seven-factor Exploratory Model....89
Table 28: Unstandardised and standardised loadings for seven-factor Confirmatory Model....90
Table 29: Unstandardised and standardised loadings for seven-factor Confirmatory Model (includes GFOUND06 item)....91
Table 30: Current and proposed PREQ instrument....92

Figure 1: Domestic and international HDR enrolments, numbers, 2001 to 2015....9
Figure 2: Domestic and international HDR enrolments, per cent, 2001 to 2015....9
Figure 3: Response patterns across 2014, 2015 and 2016 PREQ items....51
Figure 4: Item Characteristic Curves for Items PREQ25 and PREQ27 for the 2016 Data....52
Figure 5: Eigenvalues Graphs of 28 Items from EFA Analysis....53
Figure 6: Differential Item Functioning by demographic and contextual groups....55
Figure 7: SEM Model....57

Figure 8: Response patterns across 2014, 2015, 2016 and 2017 PREQ items....74
Figure 9: Item Characteristic Curves for Items PREQP01 of the 2017 Data....75
Figure 10: Eigenvalues graph of Items from EFA Analysis 76
Figure 11: Path diagram of CFA analysis based on pilot PREQ data....77
Figure 12: Response option distributions....79
Figure 13: Item DIF by respondent subgroup....81
Figure 14: SEM Model....82
Figure 15: Path diagram of CFA analysis based on pilot PREQ data (includes GFOUND06 item)....84

Executive summary

A review of the Postgraduate Research Experience Questionnaire (PREQ) was conducted by the Australian Council for Educational Research (ACER) on behalf of the Commonwealth Department of Education and Training. The PREQ was developed in 1999 to collect information on core aspects of the HDR experience, and is currently administered as part of the Graduate Outcomes Survey (GOS) which is conducted with recent graduates from Australian higher education institutions. The PREQ currently provides information to government, universities and other stakeholders that help inform improvements to the quality of HDR training.

This project was conducted in two phases. Phase 1 of the project aimed to review the existing PREQ instrument to determine whether it is still appropriate for measuring the experience of higher degree by research (HDR) students in Australian higher education, and whether it is meeting the needs of data users. Phase 2 of the project involved the redevelopment, testing and piloting of a revised PREQ instrument. The results from both phases of the PREQ review are provided in this report.

Phase 1 of the PREQ review involved a review of literature and current practice and trends, statistical analyses, and a series of stakeholder consultations. The review of literature explored the latest research into the experience of postgraduate research students in Australia and internationally, and how HDR candidates' experience and satisfaction is being measured, and the review of current practice and trends focused on trends in HDR enrolment and candidate characteristics, and national and international practice in measuring HDR candidates' experience and satisfaction. The review reported that the numbers and diversity of HDR candidates are increasing, and the diversity of career paths has also been increasing. It also noted that there have been many changes in recent years in the focus of HDR training. There has been a shift from the production of a thesis as the goal of HDR training to the goal being the development of well-rounded research skills. There has also been increasing emphasis on the development of employability skills and industry engagement.

A series of statistical analyses were conducted during Phase 1 of the review to determine the psychometric properties of the current PREQ instrument. These included exploratory analyses and psychometric analyses that investigated the reliability and quality of the current PREQ items and scales. Overall, the analyses indicated that the PREQ items and scales were satisfactory.

A number of stakeholders in the Australian higher education sector who are involved in research and practice relating to HDR candidates' experience or are familiar with the PREQ were consulted as part of phase one of the PREQ review. Stakeholders were invited to contribute to the project by providing feedback to a number of consultation questions via email or participating in a short telephone interview.

When asked about how the HDR cohort has changed in recent years, stakeholders noted that candidates were becoming more diverse in terms of their demographics and work and life experience. Stakeholders noted that HDR programs have an increased focus on professional development and the development of industry skills.

There was mixed feedback from stakeholders about their use of the PREQ results, with many universities reporting that they do use the findings, but often in a limited way. The main reasons given for not using the results more extensively included low response numbers and rates, which makes the data difficult to analyse at a disciplinary level.

Overall, most stakeholders indicated that the PREQ included some useful information, but that the items were a bit out-of-date and focused on older models of HDR candidature and the areas that they measured were a bit narrow to be appropriate for measuring the more contemporary HDR experience. Stakeholders indicated that there were some gaps in terms of the areas measured in the PREQ, these included industry engagement and the development of transferable and employability skills, among others. Other feedback from stakeholders focused on ways to improve the way in which PREQ results are reported, and considering the possibility of a survey of current HDR candidates.

Based on the findings from the review of literature and current practice and trends and the findings from the stakeholder consultation, a number of options for the redevelopment of the PREQ were raised. Based on feedback from the Department, the PREQ Review Advisory Panel and stakeholder consultations, the option that was pursued in Phase 2 focused on redeveloping the instrument to include questions relating to industry engagement and the development of broader generic skills and employability skills.

Phase 2 of the PREQ review involved the development of a revised PREQ instrument, a pilot of the revised PREQ instrument, statistical analyses, and further stakeholder consultations. The instrument development was underpinned by a conceptual framework which was informed by national and international research into HDR candidates' experience and satisfaction and findings from Phase 1. New and revised items were drafted to measure industry engagement and skills development, and these items were revised based on feedback from the Department, the PREQ Review Advisory Panel and following cognitive testing with current and recent HDR candidates.

The revised PREQ instrument was piloted with recent HDR graduates as part of the Graduate Outcomes Survey fieldwork that was conducted in May and June 2017 by the Social Research Centre. A total of 20 universities chose to participate in the pilot, and 1,131 recent graduates received the revised PREQ instrument. A total of 630 graduates completed the revised PREQ instrument.

Following the pilot fieldwork, a series of statistical analyses were conducted to determine the psychometric properties of the revised PREQ instrument. These included exploratory analyses and psychometric analyses that investigated the reliability and quality of the revised PREQ items and scales. Overall, the analyses indicated that the revised PREQ items and scales performed satisfactorily.

Building on the feedback provided by stakeholders during Phase 1, more specific feedback on the content of the revised PREQ instrument was sought from stakeholders in the Australian higher education sector. Feedback was sought from the PREQ Review Advisory Panel as well as more broadly from Deans of Graduate Research.

Overall the feedback suggested that the revised PREQ instrument was robust, useful and well-written and that most stakeholders were comfortable with the proposed changes to the PREQ instrument. Most feedback provided related to the wording of items that were part of the current PREQ, rather than focused on the newly developed or revised items. Some stakeholders expressed concerns with the inclusion of items measuring industry engagement, as they may not be relevant to all HDR graduates. Other feedback identified some potential further gaps in the measurement of the revised PREQ, and other feedback indicated that it would be helpful to provide some definitions of key terms used in the PREQ.

Recommendations for future administrations of the PREQ were developed based on the findings from both Phase 1 and Phase 2 of the PREQ review. The main recommendation was to retain the new and revised items included in the revised PREQ instrument in future administrations of the PREQ.

Overview

The Commonwealth Department of Education and Training (the Department) engaged the services of the Australian Council for Educational Research (ACER) to review the current Postgraduate Research Experience Questionnaire (PREQ) and potentially revise and redevelop the PREQ items and scales.

This project was conducted in two phases. Phase 1 aimed to review the existing PREQ to determine whether it is still appropriate for measuring the experience of higher degree by research (HDR) students in Australian higher education, and whether it is meeting the needs of data users. Phase 2 involved the development of an updated PREQ instrument, and testing and piloting of the updated instrument.

This report provides a summary of the findings resulting from both phases of the PREQ review. It first includes an overview of the project, including a brief overview of the relevant background and contexts to the PREQ review, and an overview of the methodology used during both phases to undertake the review. The report then includes a literature review and review of current practice and trends, followed by an overview of the findings from Phase 1 of the PREQ review, and provides a summary of the statistical properties of the current PREQ items and scales, findings from initial stakeholder consultations, and proposed options for the redevelopment of the PREQ. The report then provides an overview of the findings from Phase 2 of the PREQ review, including details about the item construction, cognitive testing and pilot process, statistical analyses of the pilot PREQ instrument, and findings from further stakeholder consultations relating to the pilot PREQ instrument. The final section of the report draws together all the findings from the PREQ review to provide recommendations for future deployments of the PREQ.

Background and contexts

HDR training in Australia

Ensuring Australia's HDR training system provides quality research training is important for Australia's position as a leading knowledge economy. Over the past decade, the Australian government has invested substantially in HDR training, and it is important to understand whether HDR training is equipping graduates with the high-level research skills that they need to innovate and succeed in academia and industry.

In 2015, more than 60,000 candidates were enrolled in HDR training in Australia (DET, 2017a). As shown in Figure 1, over the past decade enrolments have increased by 50 per cent. This increase in candidates enrolling in HDR training, has been driven – at least in part – by recent changes in policy that have aimed to make HDR training more accessible to candidates, increase international enrolments and encourage universities to train more candidates (Larkins, 2011).

Over this period, the diversity of the HDR candidate cohort has also increased. Figure 2 shows that the proportion of international students enrolled in Australian HDR courses has more than doubled from 14 per cent in 2001 to 32 per cent in 2015. Among domestic HDR candidates, around 40 per cent are currently enrolled part-time, and around 90 per cent are internal students (DET, 2017a).

HDR training completions have also increased rapidly over recent years. In 2001, just over 5,300 candidates completed their HDR training, and in 2015, this number had almost doubled to around 10,000 completions (DET, 2016a). There has also been a decrease in the number and proportion of candidates completing a masters by research, while at the same time the numbers completing doctorates by research have increased (DET, 2016a).

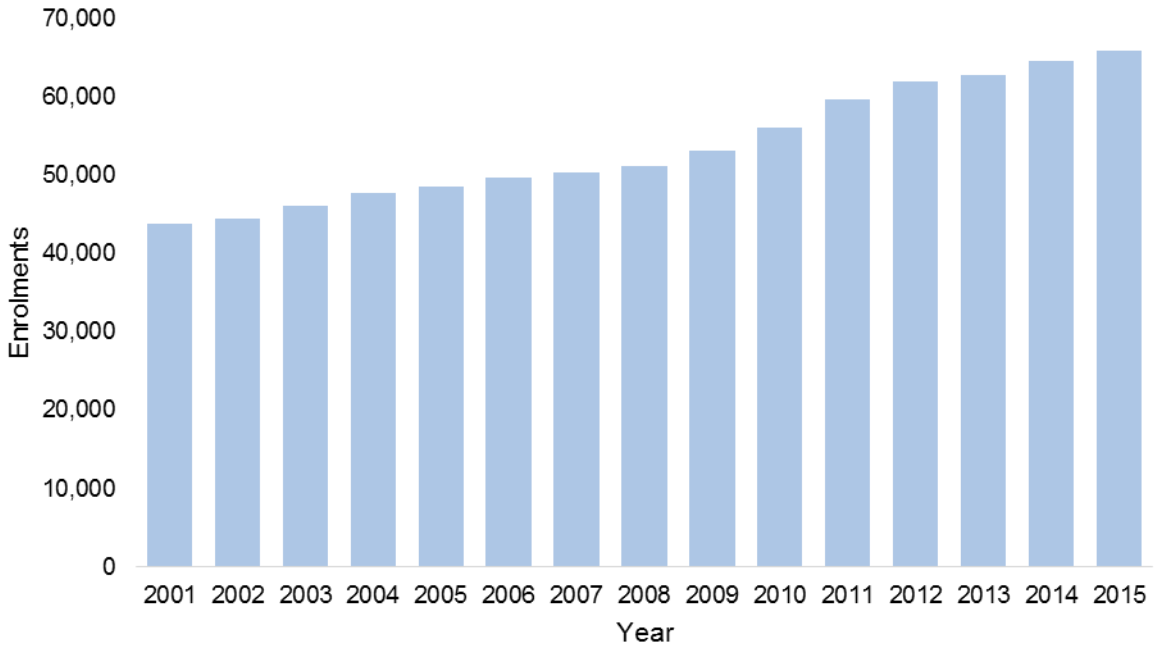


Figure 1: Domestic and international HDR enrolments, numbers, 2001 to 2015

Source: DET, 2017

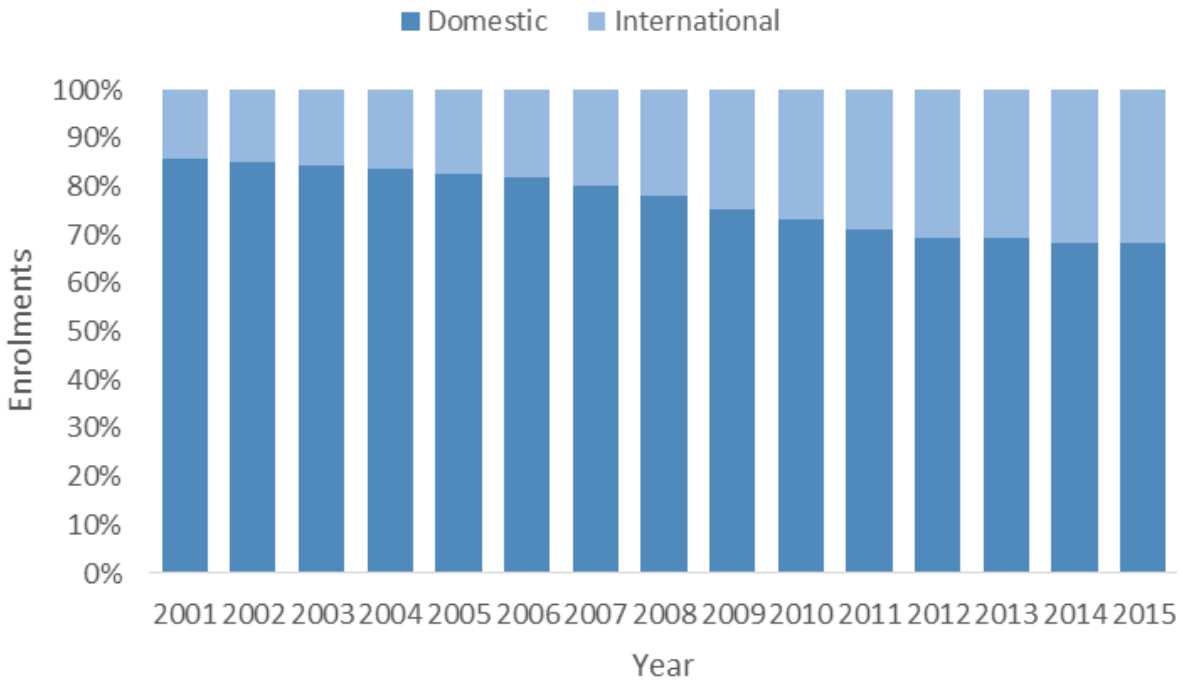


Figure 2: Domestic and international HDR enrolments, per cent, 2001 to 2015

Source: DET, 2017

Research and research training in Australia is currently funded through a combination of Australian Government funding – via competitive grants and research block grants – and university funding from other sources, including student fees, investments and donations (Watt, 2015). The research block grant system has recently been reviewed, and the block grants are currently administered through the Research Training Program (RTP) and Research Support Program (RSP) schemes. The RTP provides funding to support domestic and international students who are undertaking HDR studies through scholarships – currently the full-time base stipend is valued at close to $27,000 (DET, 2017b). The RSP provides a stream of funding to

universities to cover the indirect costs of research and research training (Australian Government, 2017). In 2017, the RTP will provide Australian universities with around $1.01 billion to fund HDR training, and the RSP will provide them with around $879 million to fund the costs of research (Australian Government, 2017).

Recent years have also seen a number of activities, reviews, and policy changes aimed at improving Australia's research training system and increasing participation. Recent reviews of note have included the *Review of Research Policy and Funding Arrangements* (Watt, 2015), and the *Review of Australia's Research Training System* (McGagh et. al., 2016) undertaken by the Australian Council of Learned Academies.

This particular review provides some of the impetus for the PREQ review. The *Review of Australia's Research Training System* was commissioned in 2015 to understand the current state of the research training system in Australia and to understand how the system could be improved. Based on extensive consultations, reviews of literature and analysis of other reviews, several key findings were reported and recommendations were made regarding Australia's research training system.

One finding relevant to the PREQ review included the finding that the information currently available to inform potential HDR candidates about the career outcomes of HDR graduates and quality of HDR training is not currently adequate, and the Quality Indicators for Learning and Teaching (QILT) website may be an appropriate way to communicate this type of information to aspiring candidates. The review also reported that the data currently available on the performance of HDR training is not currently adequate and that there are gaps in the data. The review also suggested the implementation of a longitudinal national data collection to collect better information on satisfaction with HDR training, completions and career outcomes over a longer term (McGagh et. al., 2016). These and other findings from the *Review of Australia's Research Training System* will be explored in the literature review.

Other activities have focused on increasing collaboration between universities and industry. These have included a recent review of Cooperative Research Centres (Miles, 2015), which recommended that Australia's Cooperative Research Centres Programme should focus on industry-led research; the Australian Research Council Linkage Projects Scheme (DET, 2016b), which provides funding to support research that involves collaboration between universities and government, industry or business; the National Collaborative Research Infrastructure Strategy (NCRIS), which aims to increase collaboration between researchers, government and industry by funding research infrastructure projects (DET, 2016c) and the National Research Infrastructure Roadmap, has recently been drafted to help identify priority areas for Australia's national research infrastructure (Finkel, 2016).

There has also been increasing focus on measuring the quality and impact of research output from Australian universities. The Australian Research Council's *Excellence in Research for Australia (ERA)* evaluates research activity in higher education institutions and benchmarks these internationally. Related to this is a national assessment of the engagement and impact of research produced by universities which is currently being undertaken (DET, 2016d).

About the PREQ

The PREQ was developed in 1999 by the Graduate Careers Council of Australia (later known as Graduate Careers Australia) and ACER (GCA & ACER, 2010). It was developed to collect information on core aspects of the HDR experience and was informed by a literature review and focus groups with HDR candidates. The PREQ was designed to complement the Course Experience Questionnaire (CEQ) which is administered to recent graduates from undergraduate and postgraduate coursework degrees.

The PREQ is currently administered as part of the GOS which is conducted as a census of recent graduates from Australian universities, and participating non-university higher education institutions. Prior to 2016, the PREQ was administered as part of the Australian Graduate Survey (AGS) which was conducted between 1972 until 2015.

The GOS is conducted with graduates four-to-six months after they have graduated. It includes various questions relating to graduates' current employment, study and job seeking activities, and also includes either the CEQ or PREQ to measure graduates' course experience and satisfaction. The PREQ provides graduates the opportunity to provide feedback on their overall experience in their HDR training.

The PREQ asks HDR graduates to rate their level of agreement with a series of 28 items on a five-point scale. These items are used to compute six scales and include a single-item overall satisfaction indicator. A description of each of these scales is given in Table 1 and the items are listed in Table 2. In addition, like the Course Experience Questionnaire (CEQ) administered to coursework graduates, the PREQ includes two open-ended questions inviting respondents to provide comments on the best aspects of their course and those most in need of improvement.

Table 1: Description of PREQ scales

Scale	Description	Number of items
Supervision	Quality of research supervision, including availability, support, advice and feedback	6
Intellectual Climate	Sense of learning community in the department	5
Skill Development	Development of transferable skills	5
Infrastructure	Quality of research infrastructure	5
Thesis Examination	Satisfaction with the thesis examination process	3
Goals and Expectations	Clarity of the standard of work and thesis requirements	3
Overall Satisfaction	Overall satisfaction with the quality of HDR training	1

Table 2: PREQ items and scales

Scale	#	Item	Response options
Supervision	PREQ01	Supervision was available when I needed it	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree
	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 analytical 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	

Scale	#	Item	Response options
	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	

There are some limitations in the current PREQ that have been noted previously (GCA & ACER, 2010). These include that given the broad use of the PREQ, its scope is limited. Some aspects of the HDR experience that are particular to certain disciplines, or to certain cohorts of candidates may not be measured by the PREQ currently. In addition, the PREQ provides a global perspective of graduates' experience of HDR training and may not capture the differences in HDR candidates' experience at different stages of their candidature. Another potential limitation in the PREQ is due to its focus on HDR graduates, and so only reflect the experience and satisfaction of people who have successfully completed their HDR training.

Although it is important to note these limitations, the PREQ provides information to government, universities and other stakeholders that help inform improvements to the quality of HDR training. At a national level, the PREQ provides information that can be used to track the quality of HDR training provision over time. At an institutional or disciplinary level, results can be used by universities to understand and improve HDR training and as a result improve candidates' experience and increase retention.

Project methodology

Phase 1

Overview

The aim of Phase 1 was to review the existing PREQ items and scales to determine whether the PREQ is still appropriate for measuring the experience of postgraduate research students in Australian higher education and whether it still meets the needs of data users. More specifically, the objectives of Phase 1 included:

- reviewing recent research into the experience and satisfaction of postgraduate research students;
- understanding the current practice and trends in the enrolment, characteristics and experience of postgraduate research students;
- exploring the statistical robustness of the current PREQ items and scales; and
- collecting information from stakeholders about postgraduate research students' experience and their use of PREQ data.

In order to meet these objectives, three key activities were conducted during Phase 1: a review of recent literature and current practice and trends, statistical analysis, and stakeholder consultations.

Review of literature and current practice and trends methodology

A detailed literature review was conducted to explore the latest scholarly research into the experience of postgraduate research students in Australia and internationally, and how HDR candidates' experience and

satisfaction is being measured. The literature search focused on scholarly literature published in the past five years, and included both peer-reviewed research, as well as grey literature, reports, data sets and survey instruments.

Concurrently, a review of current practice and trends was conducted via review of recent literature, consultation with stakeholders in Australian higher education, and a review of administrative data. This review focused on trends in HDR enrolment and candidate characteristics, and national and international practice in measuring HDR candidates' experience and satisfaction.

Statistical analysis methodology

During Phase 1, ACER psychometricians conducted a detailed statistical analysis of the current PREQ. The Department provided three de-identified data files that include three years of PREQ data that were collected in 2014 and 2015 through the Australian Graduate Survey (AGS) and collected through the GOS in 2016.

Our psychometricians first conducted exploratory analyses of the items and scales. They then conducted a range of psychometric analyses to explore the reliability and quality of the current PREQ items and scales. The psychometric analyses focused both on the performance of the individual items in the PREQ scales as well as the overall scales.

The analyses that were conducted included item response modelling (IRM) to explore the quality of the individual items, how the response options were used by respondents, and how well the items fit to the scales. Exploratory and confirmatory factor analyses were also conducted to investigate the dimensionality of the scale. Structural equation modelling was performed to investigate the relationship between the different dimensions of the scale and respondent characteristics. IRM was also used to perform Differential Item Functioning (DIF) analyses to test for interactions between items and groups of respondents in order to detect any potential bias that might occur with some items for some groups of students.

Stakeholder consultation process methodology

As part of Phase 1, ACER engaged a number of stakeholders in the Australian higher education sector who are involved in research and practice relating to HDR candidates' experience or are familiar with the PREQ. One objective of the consultations was to understand the ways in which the HDR cohort and experience may have changed since the PREQ was first designed in 1999. In addition, the consultations collected information about how PREQ data are being used, and any gaps between the information stakeholders need, and what the PREQ currently measures. The consultations were also conducted to identify ways in which the PREQ instrument could be amended or updated to better meet the needs of stakeholders.

ACER, in close consultation with the Department, developed a list of stakeholders with whom to consult. Individuals from the following organisations were invited via email to provide input into the PREQ review, or to nominate a representative from their organisation who could speak on their behalf:

- Universities Australia (UA)
- Deputy Vice-Chancellors (Research) from Australian universities
- Australian Council of Graduate Research (ACGR)
- Australian Council of Learned Academies (ACOLA)
- Tertiary Education Quality Standards Agency (TEQSA)
- the Australian Technology Network of Universities (ATN)
- the Regional Universities Network (RUN)
- the Innovative Research Universities (IRU)
- the Group of 8 (Go8)

In addition, ACER sought the opinions of a number of institutional stakeholders who use the PREQ data and who are familiar with the operational requirements of their institutions. These stakeholders represented a broad range of institutions. ACER also sought input from government stakeholders from the

Commonwealth Department of Education and Training and the Commonwealth Department of Industry, Innovation and Science.

Stakeholders were invited to contribute to the project by providing feedback to a number of consultation questions via email (a copy of these questions are included in Appendix A) or participating in a short telephone interview. In order to publicise the PREQ review, and encourage participation in the review, an article on the PREQ review was published by ACER.

ACER also invited a small group of stakeholders, from the Commonwealth Department of Education and Training, Universities Australia, IRU, ACGR and a couple of universities to form a PREQ Review Advisory Panel in order to provide advice and feedback on the progress of the project. The panel provided advice on the initial findings from the review of literature and current practice and trends, the statistical analysis, and consultations and on drafts of the interim and final reports of the Review of the PREQ.

Phase 2

Overview

The aim of Phase 2 was to redevelop the PREQ items and scales in order to measure the experience and satisfaction of postgraduate research graduates in a way that is appropriate and provides useful information for data users. More specifically, the objectives of Phase 2 included:

- creating a conceptual framework for the new PREQ instrument, underpinned by findings from Phase 1;
- developing new items and modifying current PREQ items and scales;
- conducting cognitive testing of the updated PREQ instrument with current and recent postgraduate research students;
- collaborating with the Social Research Centre (SRC) to conduct a pilot of the updated PREQ as part of the May GOS fieldwork;
- exploring the statistical reliability of the pilot PREQ items and scales;
- seeking feedback on the pilot PREQ items and scales from stakeholders; and
- delivering a final project report that summarises findings from the PREQ review and presents recommendations for future deployments of the PREQ.

In order to meet these objectives, a number of key activities were conducted during Phase 2. These included designing a new PREQ, cognitive testing, pilot of the new PREQ, statistical analysis of the pilot results, further stakeholder engagement, and the preparation of a final project report.

Development of new PREQ instrument

Based on feedback from the Department, the PREQ Review Advisory Panel and stakeholder consultations, the redevelopment of the PREQ focused on redeveloping the instrument to include questions relating to industry engagement and the development of broader generic skills and employability skills. More specifically, the redevelopment of the PREQ involved keeping most of the existing items and scales from the current PREQ, but update its content to ensure that the information collected in the PREQ is more appropriate for measuring the contemporary HDR candidate experience.

The first stage of development involved creating a conceptual framework to inform the development of the new items. The conceptual framework was informed by national and international trends and research into the satisfaction and experience of postgraduate research students as well as the findings from Phase 1 of the PREQ review, advice from ACER psychometricians and discussions with the Department.

Following the development of the conceptual framework, new items were drafted to measure industry engagement and skills development. Feedback on these new items was sought from the Department and the PREQ Review Advisory Panel to ensure that the items had good face validity. Following this round of

feedback, the PREQ items were further refined before being tested with current and recent postgraduate research graduates.

Cognitive testing

Following the development of the updated PREQ instrument, ACER conducted four small focus groups and face-to-face discussions with seven current and recently-graduated postgraduate research students. The purpose of the sessions was to cognitively test the content updated PREQ instrument and ensure that the items are worded clearly and are understandable.

During the focus groups, participants were asked to complete the instrument on their own, and then were invited to discuss their thoughts on the content, logic and terminology of the items. They were also asked to provide more general feedback on their experience and satisfaction in their postgraduate research studies. Feedback from the cognitive testing was used to further refine the updated PREQ in preparation for a full-scale pilot of the instrument.

Pilot fieldwork

After the updated PREQ instrument was finalised, the next step was to pilot the updated instrument with recent postgraduate research graduates. ACER collaborated with SRC to conduct a pilot of the updated PREQ instrument as part of the GOS fieldwork that was conducted during May and June 2017.

ACER invited all Australian universities to participate in the PREQ pilot. Twenty universities agreed to participate in the pilot. A list of the universities that participated in the pilot are included in Table 3. SRC provided ACER with a de-identified population list of all postgraduate research graduates who were in the target population for the GOS from these 20 universities. The population list also included demographic and contextual information, including graduates' gender, level of study, whether they were domestic or international students, whether they were studying full-time or part-time, their study mode, disability status, the main language spoken at home and whether they identified as Aboriginal or Torres Strait Islander. This information was used to stratify the file and draw a random sample of graduates for inclusion in the PREQ pilot from each participating university.

Table 3: List of universities that participated in the PREQ pilot fieldwork

University Name	
Bond University	Central Queensland University
James Cook University	Monash University
Southern Cross University	Swinburne University of Technology
The Australian National University	The University of Adelaide
The University of Melbourne	The University of Notre Dame Australia
The University of Queensland	The University of Western Australia
University of Canberra	University of New South Wales
University of Southern Queensland	University of Tasmania
University of the Sunshine Coast	University of Wollongong
Victoria University	Western Sydney University

There were a total of 2,777 graduates in the target population from these 20 universities. Based on the responses rates that universities had received in previous rounds of the GOS, in order to receive at least 500 responses to the updated PREQ, a total of 1,131 graduates were selected for the pilot sample. The remaining graduates from these universities, and graduates from other universities who did not choose to participate in the pilot PREQ received the current PREQ instrument in the GOS.

SRC programmed the updated PREQ instrument into their survey system, and this was tested by SRC and ACER before fieldwork commenced. The fieldwork was conducted in May and June 2017 primarily via an

online survey instrument, with some Computer Assisted Telephone Interviews (CATI). Following completion of the GOS fieldwork, SRC provided a data file to ACER that included de-identified unit-level data for all responses given by postgraduate research graduates from the universities that participated in the pilot.

Statistical analysis methodology

ACER psychometricians conducted a detailed statistical analysis of the pilot PREQ. SRC provided one de-identified data file in SPSS format that included all the data collected in the May round of the 2017 GOS for postgraduate research graduates from the 20 universities who participated in the PREQ pilot.

Our psychometricians conducted a range of analyses on the pilot PREQ data, which were largely similar to those conducted in Phase 1. They first conducted exploratory analyses of the items and scales. They then conducted a range of psychometric analyses to explore the reliability and quality of the pilot PREQ items and scales. The psychometric analyses focused both on the performance of the individual items in the revised PREQ scales as well as the overall scales.

The analyses that were conducted included item response modelling (IRM) to explore the quality of the individual items, how the response options were used by respondents, and how well the items fit to the scales. Exploratory and confirmatory factor analyses were also conducted to investigate the dimensionality of the scale. Structural equation modelling was performed to investigate the relationship between the different dimensions of the scale and respondent characteristics. IRM was also used to perform Differential Item Functioning (DIF) analyses to test for interactions between items and groups of respondents in order to detect any potential bias that might occur with some items for some groups of students.

Stakeholder consultation process methodology

During Phase 2 of the review, ACER further engaged a number of stakeholders in the Australian higher education sector to seek their more specific feedback on the revised PREQ instrument. These consultations built upon the consultations that were conducted during Phase 1 to better understand the way in which the HDR cohort and experience have changed in recent years, how PREQ data are being used, and the gaps between the information stakeholders are seeking about HDR students and what the PREQ measures.

ACER initially sought feedback on the draft pilot PREQ instrument from members of the PREQ Review Advisory Panel. Feedback from the PREQ Review Advisory Panel was used to further refine the instrument before undertaking cognitive testing. During the pilot fieldwork, ACER also sought feedback from Deans of Graduate Research on the content of the pilot PREQ instrument, both via the Australian Council of Graduate Research (ACGR) and by direct email invitations.

Review of literature and current practice and trends

Overview

This literature review outlines changes in the HDR population since the PREQ was first designed, recent trends in HDR training, and recent approaches to the measurement of the HDR student experience. The focus is on the Australian experience, with some reference to international trends and practices where these are applicable to the Australian context. The review ends with a discussion of implications for the PREQ as an indicator of the contemporary HDR student experience in Australia.

The HDR population

Increasing student numbers

Since the PREQ was first used to collect data in 1999, there has been a dramatic increase in the number of HDR students in Australia. This is part of a longer-term trend, and growth in HDR student numbers has also been noted internationally (Dobson, 2012; McGagh et al, 2016).

Between 2001 and 2015:

- HDR commencements grew by 36 per cent, from 10,958 to 14,910;
- HDR enrolments grew by 51 per cent, from 43,728 to 65,872; and
- HDR completions grew by 79 per cent, from 5,738 to 10,252 (DET, 2017).

Research doctorate students comprise a growing proportion of the HDR student body in Australia (Edwards et al, 2011: 11; McGagh et al, 2016: 3). By 2015, there were 57,130 research doctorate students and 8,422 research masters students enrolled in Australian universities (DET, 2016e).

Growth has not been uniform across fields of education. Enrolments in some fields, most notably engineering, information technology, health and science, have grown substantially more than others, while enrolments in education have fallen slightly (DET, 2017a).

Increasing diversity of students

As total HDR student numbers have increased, so too has the diversity of students. Some of the major trends are outlined below.

Enrolment growth has been especially marked among international students, who comprised 14 per cent of postgraduate research enrolments in 2001, rising to 32 per cent in 2015. While international student enrolments increased across all fields of education, there is considerable variation between fields. By 2015, international students comprised over half of enrolments in engineering and information technology (DET, 2017).

The proportion of HDR students who were female has risen slightly over the past 15 years. In 2001, females comprised half of domestic HDR enrolments and 39 per cent of international HDR enrolments. By 2015, these figures had risen to 54 per cent and 42 per cent respectively (DET, 2017).

HDR students who are part-time, external, or mature age may have significant work or family commitments which make it difficult for them to operate as part of an academic community. Between 2001 and 2015, the number of HDR students studying part-time increased by five per cent and the number studying externally increased by 19 per cent. In 2015, 31 per cent of HDR enrolments were part-time and seven per cent were external (DET, 2017). Over 60 per cent of doctorate by research and masters by research students were 30 years and over, and 28 per cent were 40 years and over (DET, 2016e).

Changing pathways into research doctorates have also been noted. For example, while honours remains the most common pathway into a research doctorate in Australia, the proportion of students using honours as an entry qualification is declining, while an increasing number of candidates commence having completed a coursework masters degree or having been in the workforce (McGagh et al, 2016: 17).

As student diversity increases, levels of preparedness and levels of competing work and family commitments also change. This has implications for both the provision of training and the HDR student experience, with some groups potentially requiring additional or different types of support (Austin, 2011; Go8, 2013; Son & Park, 2014).

Trends in graduate destinations

Growth in HDR enrolments has been greater than growth in the number of research only and teaching and research staff in Australian universities (DET, 2017). Consequently, as the number of HDR completions have increased, the proportion of graduates finding work in universities in traditional teaching and research roles has decreased and career paths have become more diverse. This trend has also been noted internationally (see reviews by Lee & Boud, 2009; McGagh et al, 2016).

Not all HDR students intend to find work in the higher education sector and their intentions may change as they progress through their courses. For example, the 2010 National Research Student Survey found that while the majority of HDR research students had considered an academic career at some time during their training, only 57 per cent of PhD students and 36 per cent of research masters students intended to pursue

an academic career in the medium- to long-term. Overall, 19 per cent of HDR students in the study intended to perform research work outside a university and 23 per cent intended to work in non-research professional roles in the medium- to long-term (Edwards, et al, 2011: 22-24). Similarly, 21 per cent of doctoral students and 42 per cent of research masters students in the 2016 Canadian Graduate and Professional Student Survey reported that their primary reason for enrolling in their postgraduate program was to equip them to start a career or advance an existing career outside of academia (Simon, 2016).

In recent years, there has been some tightening in HDR graduate labour market, as illustrated by data from the AGS and GOS. These surveys provide information on the destinations of HDR graduates soon after graduation. HDR graduates in full-time employment (as a proportion of those available for full-time employment) declined from 89.5 per cent in 2001 to 73 per cent in 2015 (GCA, 2011, 2016a). Just over two-fifths of recent domestic HDR graduates in full-time work were employed in higher education in 2015 (GCA, 2016a).

National data on longer-term HDR graduate outcomes are now available for Australia from the 2017 Graduate Outcomes Survey – Longitudinal (GOS-L). In 2014, shortly after graduation, the rate of full-time employment among HDR graduates was 77 per cent. Among this same cohort of graduates, three years later in 2017 their full-time employment rate had increased to 91 per cent. Also, 94 per cent of employed HDR graduates were working in managerial or professional occupations three years after graduation. Managerial and professional occupations are defined by the Australian Bureau of Statistics as being commensurate with requiring bachelor or higher level qualifications. , In addition, one further study reported that around half of Go8 PhD graduates were working in the higher education sector five to seven years after graduation (Western et al, 2007), and another study found that 41 per cent of Cooperative Research Centre (CRC) PhD graduates and 60 per cent of non-CRC graduates were employed in the higher education sector five to ten years after graduation (Manathunga et al, 2012: 848). At the time of the 2011 census, just over one quarter of all employed doctorate holders (irrespective of when they graduated) were working in a university or vocational education teaching position (McGagh et al, 2016).

Trends in HDR training

The changing context of higher education

A number of interrelated trends have impacted upon universities and HDR training. The increasing number and diversity of HDR students, and the growing number of HDR students finding employment outside the higher education sector have already been outlined. At the same time, knowledge and research are increasingly being conceptualised as a public good, integral to economic prosperity and societal well-being. Universities are being urged to help address pressing social and economic problems of national and global significance such as food security and environmental issues. These problems are complex in nature, often requiring multidisciplinary solutions as well as engagement beyond universities with industry, government and community groups.

This changing landscape in which universities operate has implications for HDR training. The literature – much of which focuses on research doctorates – points to a number of intertwined themes relating to the purpose and delivery of HDR courses. Underpinning many of these themes is a growing recognition that graduates need to be able to work in multidisciplinary settings as well as within their own fields, and to engage with industry and the broader community. Four themes are discussed below:

1. a shifting emphasis from the production of a thesis to the production of a researcher as the primary outcome of HDR training;
2. the place of generic or transferable skills in HDR training;
3. engagement with industry; and
4. trends in HDR supervision.

Shifting emphasis of doctoral training: from the production of a thesis to the production of a researcher

Traditionally, PhD training in Australia has been based upon a research 'apprenticeship' model in which students undertake a research project under the guidance of an academic supervisor, with an expectation of progressing on to an academic career upon graduation. Students are required to make a significant contribution to knowledge (demonstrated in the thesis, which is produced for an academic audience) and typically develop discipline knowledge and research skills in a highly specialised area (DoE, 2014, Go8, 2013).

While this largely continues to be the case, there have been some shifts in the delivery of HDR education in Australia, which will be discussed below. There has also been a shift from viewing the primary outcome of HDR training as the production of an original piece of research (the thesis), to the production of a researcher who has a set of research competencies and transferrable skills which can be used in a variety of settings (Lee & Boud, 2009; McGagh et al, 2016).

The place of generic or transferable skills in HDR training

With increasing numbers of HDR graduates working outside universities, frequently outside their area of specialisation, there is a growing recognition that HDR students need to be equipped with a broader set of knowledge, skills and experience relevant to a range of career paths (in addition to their narrower disciplinary expertise). While it can be argued that the development of generic or transferable skills has always been a by-product of the HDR training process, this has been implicit rather than a clearly articulated outcome. In recent years, however, numerous government and university discussion papers, reports and initiatives have explicitly addressed the work-readiness of graduates and the development of generic skills is increasingly seen as an essential part of HDR training (DoE, 2014; Go8, 2013). For example, one of the six Australian Graduate Research Good Practice Principles of the Australian Council of Graduate Research (2016) is that:

> Graduate research candidates are supported to undertake original research and scholarly activities *whilst developing key research and employability skills for academic and non-academic careers*.

The ACOLA Review of Australia's Research Training System found that many universities have made significant investments in this area (McGagh et al, 2016). For example, many now provide courses and workshops on a range of generic topics including communication skills, teamwork and networking, and project management and planning. Many initiatives linking students to industry (described in the following section) also aim to foster generic skills.

At the same time, however, HDR assessment remains focused exclusively on the thesis (Go8, 2013; McGagh et al, 2016). Interestingly, HDR students in the UK regard the development of research skills as more important than the development of transferable skills (Park et al, 2007: 19), and students in Australia tend to be more positive about their degree being effective preparation for academic research and publication than as preparation for university teaching or for non-academic careers (Edwards et al, 2011).

Engagement with industry

The Australian government's innovation agenda has led to a range of initiatives to increase university-industry and university-end user engagement and to increase the number of researchers working in industry (Innovation and Science Australia, 2016). This has implications for HDR research training, with a number of programs designed to promote favourable attitudes between students and industry and provide students with access to employment opportunities outside universities (in addition to equipping students with generic or 'industry-ready' skills as discussed in the previous section). Many of these initiatives have been outlined in recent reports and so are not described in detail here (e.g. DoE, 2014; Innovation and Science Australia, 2016; Manathunga et al, 2012; McGagh et al, 2016; Watt, 2015). Broadly, they include:

- Research in publicly funded research agencies and CRCs;
- doctoral training centres;

- industry placements and internships;
- industry-defined research projects;
- the inclusion of industry supervisors on supervisory panels; and
- industry-relevant training courses and workshops.

Comprehensive Australian data on the extent of engagement with industry during HDR training is not available. However, opportunities for HDR students to work in research organisations such as publicly-funded research agencies and CRCs appear to be higher than opportunities to undertake a research project within other industry organisations. Existing initiatives linking students with industry, such as industry placement schemes, are estimated to be small in scale or scope (Edwards et al, 2011: 93; DoE, 2014; McGagh et al, 2016).

A review of 15 Australian initiatives designed to enhance the professional development of research students concluded that the basic research training model remained the same across each of the initiatives. What varied, however, was:

> the context in which this takes place (including whether any industry supervisor is involved) and the focus of the research project; and these factors can have a significant effect on the experience and outcomes for the HDR candidate (DoE, 2014: 27).

For example, CRC PhD graduates report greater exposure to industry contacts and greater access to a range of professional development opportunities during their courses, and five to ten years after graduation are more likely than their non-CRC counterparts to be working in the private sector or in public sector research organisations (Manathunga et al, 2012).

HDR supervision

The final trend in HDR training addressed in this review relates to supervision. High-quality supervision continues to be cited as central to the facilitation of positive HDR training outcomes, both in Australia and internationally (e.g. Austin, 2011; McGagh et al, 2016; Park et al, 2007: 16; Son & Park, 2014; Zhao, 2012). In Australia, responsibility for the training of a doctoral student has traditionally rested primarily with a single supervisor. More recently, the Higher Education Standards Framework has stipulated that each research student should have a research-active principal supervisor and at least one associate supervisor (Australian Government, 2015). As indicated above, in some cases supervisory panels now include an industry supervisor from outside the higher education sector. In the UK and Europe, doctoral research centres have provided opportunities for doctoral students to be taught in groups rather than working with individual supervisors, and there are limited examples of this also occurring in Australia (for overview, see DoE, 2014; Go8, 2013; Watt, 2015).

Measuring the HDR experience

In this section, attention turns to the content of the PREQ and other national and international surveys and frameworks relating to HDR students. While the focus is primarily on whether the PREQ measures relevant aspects of the student experience in the current Australian context, the section also includes some methodological insights from the literature.

The PREQ

The PREQ was developed in the late 1990s by the Graduate Careers Council of Australia (now Graduate Careers Australia) and the Australian Council for Educational Research. It is currently administered to recent HDR graduates as part of the GOS.

The PREQ is used to measure postgraduate research experience in six domains – Supervision, Intellectual Climate, Skill Development, Infrastructure, Thesis Examination, and Goals and Expectations – as well as overall satisfaction which is measured via a single item. Throughout the period from 1999 to 2015, the highest mean percentage agreement scores were for Skill Development (90.2 in 1999; 93.6 in 2015) and

Goals and Expectations (87.7 in 1999; 93.4 in 2015), while the lowest mean percentage agreement scores were for Intellectual Climate (54.8 in 1999; 68.9 in 2015) (GCA, 2016b; GCA & ACER, 2010).

Postgraduate research student satisfaction, as measured by the PREQ, has increased since the development of the instrument in 1999, especially in the areas of Infrastructure, Intellectual Climate, and Supervision (GCA, 2016b; GCA & ACER, 2010). In part, these trends may reflect changes in the composition of the student body. For example, international students record higher scores than domestic students (GCA, 2016b) and comprise an increasing share of the student body (DET, 2017). They may also reflect changes in the delivery of HDR training.

Institutional measurement of HDR experience

While national surveys have been used as benchmarking tools to identify institutional strengths, weaknesses and trends over time, individual universities have also developed a range of instruments to collect data on the research experience of their current or recently completed HDR students. These surveys are typically used for internal purposes to identify ways in which institutions or schools and faculties within institutions can improve the HDR student experience. Compared with the PREQ, they often focus on current HDR candidates, often contain more items measuring the student experience, and sometimes cover a wider range of issues, including some specific to local contexts. Institutional surveys may provide institutions with more-targeted data that is more appropriate for informing change within the institution (Johnston, Sampson, Comer & Brogt, 2016).

There are numerous examples of institutional surveys. Some examples include the Student Research Experience Questionnaire (SREQ) which is conducted at the University of Sydney, the Flinders University Research Higher Degree Student Surveys, and the University of Canterbury Postgraduate Experience Questionnaire (UCPEQ). Many of these surveys, and other internal HDR experience surveys, are based on the PREQ, but adapted for use internally and for use with current candidates.

The SREQ is a biennial survey of current HDR students at The University of Sydney, which was first conducted in 2002 (The University of Sydney, 2016). The SREQ is based on the PREQ. All items from four of the PREQ scales – Supervision, Intellectual Climate, Skill Development, and Infrastructure – have been adapted for use with current students, and some additional items tapping those domains have also been included[1]. The PREQ overall satisfaction item has been adapted, but PREQ items on thesis examination and goals and expectations are not included.

SREQ results for currently enrolled students are consistent with the national-level PREQ results for recent graduates and the validity of the SREQ for current HDR students has been tested in a research-intensive university in Hong Kong. Results supported the construct validity of the four scales (Zeng et al, 2013).

Flinders University administers student satisfaction surveys to current HDR students, as well as exit surveys of both completing and non-completing HDR students. This suite of surveys includes topics similar to those covered by the PREQ, such as supervision, research environment (some similarities with PREQ Intellectual Climate and Infrastructure), research skills and attributes, thesis examination, and overall satisfaction. The exit surveys also include a generic and transferable skills module which has some overlap with the GOS graduate attributes module. In addition, Flinders University satisfaction surveys include modules on research dissemination, professional development opportunities, timely completion (completing students), and reasons for withdrawal (non-completing students) (Flinders University, 2016).

The UCPEQ, first conducted in 2004, is another example which is administered to current HDR students and complements other data collected through exit surveys and graduate destination surveys. Items have evolved to reflect the changing nature of postgraduate education as well as university priorities for information. For example, there has been a growing emphasis on networking, data storage and IT structure, career goals, and the ability of funding to support the breadth of possible research experiences.

[1] These scales have been renamed in the SREQ as Quality of Supervision, Research Climate, Generic Skills, Infrastructure, and Quality of Infrastructure.

Based on earlier qualitative responses, supervisory items have been extended beyond supervisory support for the research project to also include personal or non-academic support (Sampson et al, 2016).

The Postgraduate Research Experience Survey (PRES)

The Postgraduate Research Experience Survey (PRES) is a biennial online survey of current HDR candidates in the UK, overseen by the Higher Education Academy. While the PRES is also based upon the PREQ, there are a number of differences between the two survey instruments. The PRES includes items relating to the UK context, informed by the QAA Code of practice for the assurance of academic quality and standards in higher education, the Research Council's skills training requirements, and the Vitae's Researcher Development Framework (Park et al, 2007; Bennett & Turner, 2013; Turner, 2015).

The PRES was first conducted in 2007 (Park et al, 2007) and was redesigned in 2013 (Bennett & Turner, 2013). New items on research skills and professional development were added, reflecting the growing prominence of these issues. The current instrument covers the following seven areas of postgraduate research experience, as well as overall student experience:

- *Supervision:* questions relating to the supervisory relationship including supervisor's knowledge and skills.
- *Responsibilities:* questions relating to student and supervisor responsibilities.
- *Resources:* questions asking about resources such as working space and library provision.
- *Research skills:* questions relating to tools, methodologies, creativity and research integrity.
- *Research culture:* questions on issues around departmental community and research ambience.
- *Professional development:* questions relating to project management and transferable skills.
- *Progress and assessment:* questions about monitoring progress and procedures regarding the thesis (Turner, 2015).

The PRES and the PREQ yield broadly similar findings. For example, over several years of PRES, research culture (similar to PREQ Intellectual Climate) has been rated lowest (Turner, 2015: 8-9).

Recent consultations have been conducted to ensure that the 2017 and subsequent PRES surveys remain relevant to the needs of the higher education sector. Recommendations arising from these consultations included:

- The development of a module focusing on taught provision, partly to address non-standard groups such as those undertaking professional doctorates and masters by research, as well as first year PhD students.
- The evaluation of new measures around the engagement of HDR students with their study and the current 'Research Culture' section of PRES.
- Development of processes or questions to better understand the experience of students located at multiple sites, particularly those studying at doctoral training centres.
- The introduction of items measuring the well-being of students as an optional module in the 2017 survey (HEA, 2016).

Canadian Graduate and Professional Student Survey (CGPSS)

The Canadian Graduate and Professional Student Survey (CGPSS) has been conducted every three years since 2007. The 2016 survey collected information from current doctoral, research masters and coursework masters students enrolled at 50 Canadian universities. It included a larger number and range of items than the PREQ. Some items related to many of the PREQ scales, while other items related to emerging issues in HDR training, ranging from opportunities to engage in interdisciplinary work through to advice/workshops on career options outside academia (see Canadian Association for Graduate Studies, 2016 for a full listing of survey items).

The Vitae Researcher Development Framework (UK)

The Vitae Researcher Development Framework is a professional development framework which was developed in the UK in 2009. It was designed to support the development of individual researchers across a wide range of careers and career stages, including HDR students (Reeves et al, 2012). The framework, with its detailed mapping of the knowledge, behaviours and attributes of effective researchers, is of particular relevance to the current project. It covers four domains (knowledge and intellectual abilities; personal effectiveness; research governance and organisation; and engagement, influence and impact), twelve sub-domains, sixty-three descriptors, and between three to five phases within each of these domains, representing different stages of development or levels of performance (see Vitae, 2011 for details). A number of these areas relate factors addressed in this literature review, such as generic skills, project management, and the ability to work with others and to ensure the wider impact of research

Methodological considerations

As mentioned earlier, the PREQ is administered to HDR graduates approximately four-to-six months after the completion of their qualification, currently as part of the GOS. This timing was intended to give graduates 'time to form a more global perspective on their postgraduate research experience than might be the case immediately after course completion or in the final months of their research degree' (GCA & ACER, 2010: 1). However, whether this is the most appropriate time point to elicit information on the postgraduate research experience is subject to debate.

One set of arguments revolve around the timing of the PREQ/GOS being too late. Earlier administration to current students – as occurs in surveys such as SREQ, PRES, CGPSS, and UCPEQ – provides focused reflections concerning ongoing student experiences and facilitates an examination of various stages throughout the research journey (Sampson et al, 2016: 339; Turner, 2015:13). For example, studies in the UK and Canada have reported that satisfaction with various aspects of the student experience varied with year of study in programs (Bennett & Turner, 2013; Zhao, 2012). By focusing on current students and their experiences, re-evaluations at exit or in light of subsequent experiences are avoided (Sampson et al, 2016).

A focus on current HDR students also removes a potential source of bias by incorporating students who may not go on to complete their qualification (GCA & ACER, 2010: 3; Sampson et al, 2016: 339). For example, the 2010 National Research Student Survey found that the fields of education with relatively high proportions of students contemplating withdrawal were the fields where students reported being least engaged with other students and university life (Edwards et al, 2011: 52). Conversely, 'it may perhaps be of little surprise that [PREQ] survey respondents were generally very happy with the thesis examination process given that they have, by definition, successfully completed their course' (GCA & ACER, 2010: 18). The ACOLA Review noted that the inclusion of non-completing HDR candidates in the PREQ sample would increase the range of information available to drive performance improvements as well as help facilitate student choice (McGagh et al, 2016: 77).

A second set of arguments centre on the timing of the PREQ/GOS being too early to capture the employment outcomes of graduates. From this perspective, the PREQ is seen to provide a relatively immediate response to the student experience. This is viewed as problematic if there is a concern to have graduates reflect upon their research training in light of the employment situations in which they find themselves (Western et al, 2007). The GOS-L tracks HDR graduates over a longer period and provides information on their labour market outcomes three years after graduation.

The PREQ as an indicator of the contemporary HDR student experience

Changes in the HDR population since the PREQ was first conducted in 1999 and recent trends in HDR training have implications for the measurement of the HDR student experience. These trends are of particular significance for three PREQ scales – Supervision, Skill Development, and Goals and Expectations. These trends also point to other areas which are not currently covered by PREQ. Table 4

summarises aspects of the HDR experience which have been highlighted in this review, noting whether these aspects are currently measured in the PREQ and how this compares with other major surveys and frameworks.

Table 4: Measurement of the contemporary HDR student experience

Domain	Comments
Supervision	Supervision remains central to the HDR student experience, but the literature review identified issues which have implications for the way in which supervision is measured. While a move away from doctoral students having a single supervisor towards having a principal supervisor and at least one associate supervisor was identified, the PREQ items as they are currently presented are applicable to both single supervisors and multiple supervisors. A number of other trends, such as the employment of HDR graduates outside academia and a growing emphasis on generic and transferable skills, also have implications for supervision. The PREQ Supervision scale focuses on supervisory support as it relates to the student research project. In contrast, other survey instruments also include items relating to broader supervisory support, such as help identifying training and development needs as a researcher (PRES) and discussions about the current job market and various career prospects (CGPSS).
Intellectual climate	The PRES Research Culture scale includes similar items to the PREQ, although a recent review of the PRES questionnaire recommended the evaluation of these items and new measures of student engagement with their study.
Skill development	Skill development, both research skills and other generic or transferable skills, was an important theme identified in the literature review. The PREQ Skill Development scale includes a range of research skills. In addition, the GOS includes a graduate attributes module: for a range of foundation skills, adaptive skills and attributes, and teamwork and interpersonal skills, graduates are asked to indicate the extent to which they agreed or disagreed that their course prepared them for their current job. In contrast, a number of other survey instruments measure generic skills without reference to current employment. For example, the PRES has two scales measuring skill development (research skills and professional development), with the latter scale including items not currently measured in PREQ/GOS. Other examples of items measuring professional development and generic skills and attributes can be found in surveys as the CGPSS and the Flinders University student satisfaction surveys. The Vitae Researcher Development Framework is of particular value in identifying the range of skills and attributes of researchers
Goals and expectations	The PREQ Goals and Expectations scale focuses on standards of work and thesis requirements. In contrast, the PRES Progress and Assessment scale includes items such as these as well as items relating to induction into the HDR program and requirements for monitoring of progress. Induction may be of potential relevance given the increasing diversity of HDR students.
Coursework provision	A recent review of the PRES in the UK recommended the inclusion of items focusing on taught provision, partly to address non-standard groups such as those undertaking professional doctorates and masters by research as well as first year PhD students.

Domain	Comments
Industry engagement and cross-disciplinary engagement	Engagement with other disciplines, industry and the broader community is a recurrent theme in the literature. The GOS currently includes yes/no questions regarding overseas study, internships, training in IP awareness/business management/entrepreneurship and joint supervision or co-funding by an industry partner. Other surveys have also attempted to measure engagement. For example, the CGPSS includes items on support and opportunities for collaboration with faculty, internships, and contact with practising professionals and the SREQ includes an item on the ability to work collaboratively with other researchers. The Vitae Researcher Development Framework also identifies a range of relevant issues.
Employability skills development	The GOS includes a set of questions asking graduates who are in employment to assess the extent to which their course prepared them for their current job. An alternate approach, closely related to the skills development items discussed above, is to ask graduates to rate the quality of advice, support and training they received in relation to issues such as job searching and career options (see CGPSS for an example of this approach).

Findings from Phase 1

Statistical analyses

A number of exploratory analyses and psychometric tests were conducted on the PREQ data from 2014, 2015 and 2016 to determine the reliability and quality of the PREQ items and scales. A summary of these analyses are given here, and a complete report on the statistical and psychometric findings are included in Appendix B.

In each administration of the PREQ from 2014 to 2016, a total of around 5,000 responses were available for analysis. The analyses found that there were some notable differences in the respondent characteristics and response patterns between the 2014 and 2015 PREQ and the 2016 PREQ. These differences may be explained by both methodological changes and a change in the instrument in which the PREQ was administered in 2016. Given these differences, most of the analyses focused on the results from the 2016 PREQ.

The data for each administration of the PREQ was fitted to the Rasch Partial Credit model based on item response theory (IRT). This found that most of the items in the PREQ fit the model well, with test reliabilities of 0.894, 0.898 and 0.924 for 2014, 2015 and 2016 respectively.

A confirmatory factor analysis (CFA) was also used to model the PREQ scales using the 2016 data. The CFA excluded the PREQ28 item, as this is only a one-item scale that has very small variance. The remaining 27 items were fitted to a six-factor CFA model. The χ^2 test yields a value of 7488 (df=309), which has a corresponding p-value of .0000. The χ^2 is high due to the large sample size. The RMSEA is 0.067, which is within the 90% C.I., CFI and TLI are 0.965 and 0.961, respectively. The approximate fit is acceptable.

The factor loadings on each factor are all strong, the lowest standardised factor loading is 0.641 for item PREQ27, and other factor loadings are 0.7 or higher. This means that the items are good indicators of the scale, and it also indicate that each of six latent scales are well defined.

Overall, the analyses indicated that the PREQ items and scales were performing satisfactorily.

Stakeholder consultations

Overview

Stakeholders were directly approached to provide input into the PREQ review, or to nominate a colleague to participate. Stakeholders from universities, peak bodies and government provided feedback via email or telephone during the consultations. They were asked a range of questions relating to changes in the HDR candidate cohort, changes in the HDR student experience, as well as questions about their use of the PREQ results, their perceptions of the current PREQ, and whether they measure HDR student experience using other surveys or tools. In addition, feedback on the findings from these consultations was provided by the PREQ Review Advisory Panel.

Changes to the HDR cohort and experience

Stakeholders mirrored the findings described in the literature review, and noted that they had seen the student cohort becoming larger and more diverse in the past decade, including increases in the numbers of international students, mature-age students, part-time and external students enrolling in HDR degrees. In addition, some mentioned that although enrolments in doctorate by research degrees were increasing, stakeholders have noted a decline in enrolments in masters by research programs. Stakeholders also noted that students are more likely to have a diverse range of work and life experiences, and are more likely to be combining their training with work. They are also entering HDR training via different pathways and with different career goals with many seeking careers in industry rather than academia. Stakeholders noted that with this diversity comes new challenges in HDR training delivery and a more diverse range of

needs and expectations of those in HDR training, one example of this is the increased need for English language support for international students.

In terms of the way in which HDR students' experience has been changing, the most frequently noted changes included the requirements for HDR candidates to graduate with broader skills sets than those in the past, which has led to an increased focus on professional development and the need for universities to incorporate more coursework into HDR degrees. There is a perception that this is likely due to decreased likelihood of an academic career following a HDR degree. The need for HDR candidates to develop industry skills, such as entrepreneurship, commercialisation and business, was also noted by many stakeholders, as was the increased expectations for engagement with industry during HDR degrees. Some stakeholders also noted that there are greater expectations placed on HDR candidates than in the past. They are expected to network more frequently, interact with multiple supervisors, engage with industry, and publish their research more frequently. Stakeholders also indicated that they anticipate that changes in government policy, labour market adjustments, changes in digital technology and the findings from the current Office of Learning and Teaching Strategic Innovation and Development being conducted on *Design Options for the Future Doctorate* (Coates et al, 2016) may impact future HDR candidates' experience.

Current use of the PREQ

Stakeholders were asked about how their institution uses results from the PREQ to understand or improve the experience of HDR candidates. There was mixed feedback from stakeholders about their use of the PREQ results, with many universities reporting that they do use the findings, but often in a limited way. Some stakeholders reported that the results were used as a Key Performance Indicator, or that their use primarily focused on the overall satisfaction results, rather than using the results to understand HDR candidates' experience. Some indicated that PREQ findings have fed into reviews of their HDR programs.

The main reasons given for why the results are not used more extensively included the low response numbers and response rate, which makes the data difficult to analyse at a within-university level, or at a disciplinary or narrow field of research level. Other issues included the timing of the survey, with many stakeholders seeking information about current HDR candidates' experience, to enable more timely information on the HDR experience. On the other hand, a couple of stakeholders mentioned that the survey may be conducted too soon after graduation, at a time when graduates may not yet be settled in employment. Although the current GOS does collect qualitative feedback from respondents about their study experience, and how their institution prepared them for employment, some stakeholders were unaware that this information was available, and indicated that having such information would help contextualise responses and may provide further information on how the HDR experience could be improved.

Gaps in measurement

Stakeholders were also asked about the relevance and usefulness of the current PREQ items and scales, and other aspects of the HDR experience that are not currently captured, and that would be helpful to include in a future PREQ. Overall, most stakeholders indicated that the PREQ included some useful information, but that the items were a bit out-of-date and focused on older models of HDR candidature and the areas that they measured were a bit narrow to be appropriate for measuring the more contemporary HDR experience

There were also some specific gaps in terms of the areas measured in the PREQ that stakeholders noted. The most frequently mentioned gap was industry engagement. Candidates suggested including items that enable an understanding of candidates' experience with industry during their HDR study, including their involvement and satisfaction with placements and internships, their involvement with research collaboration and development of entrepreneurship skills.

Another gap mentioned by several stakeholders was the development of transferable and employability skills. Stakeholders were interested in understanding how candidates' HDR experience has helped them prepare for work in academia, and non-academic industry sectors. Although the Skill Development Scale

currently includes measurement of some transferable skills, some stakeholders indicated that this was not broad enough, and that the areas measured could be expanded based on the Vitae Researcher Development Framework (Vitae, 2011) or similar frameworks of research skills.

Career advice was also mentioned by a number of stakeholders as important to include in the PREQ. Stakeholders mentioned that given the increasing number of HDR graduates going on to work outside of academia, career advice was more vital than in the past, and that understanding HDR candidates' experience of career advice would be helpful.

Other gaps mentioned by stakeholders included:

- transitions, orientation and induction into HDR study;
- assessment of candidates' skills more generally, beyond the thesis examination;
- intellectual engagement beyond the candidate's immediate department;
- graduates' research publication or output either during or following candidature;
- non-academic support, or support beyond candidates' supervisors;
- access to specialist resources;
- candidates' experience lecturing or tutoring students during HDR study; and
- questions specific to international candidates' experience.

Stakeholders also mentioned that they would like the GOS to collect more contextual or demographic information, such as whether respondents received a scholarship, their entry pathway into HDR study, and – although not yet relevant - their participation in the Australian National Internships Program (ANIP). Although currently there is a question in the GOS about internships more generally, it may be helpful to adapt this question in future to identify whether the internship was through the ANIP. In addition, more specific discipline area information and more specific work sector of employed HDR graduates – including information on whether graduates are working in academia – would also be helpful for contextualising the PREQ findings.

Stakeholders also mentioned some structural issues with the current PREQ. These included feedback that some specific questions were unclear and may be interpreted in multiple ways and the focus on satisfaction rather than behaviour. In addition, some stakeholders mentioned that they would like to understand how important each of these aspects of HDR training experience are for respondents, by adding in a response scale that asks graduates to rate the importance of each statement, as well as their agreement with each statement.

Feedback on PREQ reporting

Although not explicitly asked about the way in which the PREQ results are reported, many stakeholders provided feedback on the reports and suggestions for how the results could be reported differently. Some of the suggestions included more detailed reporting at disciplinary level, exploring differences between different groups of candidates, or linking the results from the PREQ to the findings from the GOS. Although this is done to some extent in the current GOS reports, there was a desire for more detailed analyses of aspects of graduates' experience of underemployment, differences in the PREQ findings for graduates in different types of employment and other more detailed analyses. There was also feedback that including more error bands or reporting of variance of the PREQ items and scales would enable universities to more accurately understand their PREQ results and benchmark these more accurately.

Other measures of HDR experience

Stakeholders were also asked about other surveys or tools being used to measure the HDR experience. Most universities indicated that they conduct surveys with their current HDR candidates in order to understand their experience. Some mentioned conducting surveys of supervisors as well as candidates. Many of these surveys are based on either the PREQ – with the Thesis Examination Scale excluded – or the PRES, which enables benchmarking. Some universities run multiple surveys at different stages of

candidature, or conduct one annual survey of their HDR candidates. Some also conduct focus groups and qualitative research on their HDR candidates' satisfaction and experience.

Universities indicated that these surveys help complement the results from the PREQ and are used to identify good practice and areas for improvement. These internal surveys were seen as providing a more timely assessment of HDR candidates' experience than the PREQ, as well as providing a picture of all candidates' experiences, including those who later withdraw from their studies. Some stakeholders would like to see a national survey of current HDR, while others would prefer that information on current candidates' experience or satisfaction is collected through internal surveys.

National survey of current HDR students

Although outside of the scope of the current review, many stakeholders felt that a national survey of current HDR candidates conducted in Australia should be considered. The reasons given for this included that a survey of current candidates would provide a more accurate picture of HDR candidates' experience, given around 30 per cent withdraw from their studies before graduating. In addition, a survey of current HDR candidates would have a larger population and so may allow more nuanced analysis and reporting of results at institutional and disciplinary levels.

Some stakeholders also suggested longitudinal measurement of HDR candidates' experience and graduate outcomes. This may provide more complete understanding of the reasons for attrition, and will enable more thorough quality assurance of HDR training. This may also provide more reliable information about longer-term employment outcomes.

Options for the redevelopment of the PREQ

Overview

Although the psychometric analyses suggest that overall the current PREQ items and scales are performing reasonably well, the findings from the review of literature and current practice and trends, and the findings from the stakeholder consultations indicate that there is a need to redevelop the current PREQ items and scales to provide a broader and more contemporary measure of HDR graduates' experience and satisfaction. This section presents five options for the redevelopment of the PREQ based on the findings from the review. These options are not mutually exclusive, and so the redevelopment of the PREQ could focus on more than one of these options.

Option 1

The first option is to keep some of the existing items and scales in the current PREQ, but update its content to ensure that the information collected in the PREQ is more appropriate for measuring the contemporary HDR candidate experience. This will likely involve both the development of entirely new items, and potentially new scales, and may also involve the redevelopment of existing items and scales.

Based on the findings from the literature review and the stakeholder consultations, new items should be developed to collect information about HDR graduates':

- engagement with industry during their HDR candidature; and
- development of employability skills.

Given the findings from the review that highlight the importance of industry engagement to the contemporary HDR experience, it would be appropriate to develop a new scale that measures industry engagement. Below are a few potential draft items that such a scale might include:

- My research experience prepared me for work outside of academia
- I had opportunities to meet and form connections with employers in industry
- I undertook an industry placement or project

Items relating to the development of employability skills could be incorporated into the current Skill Development Scale and may involve replacing or rewording existing items in the scale, as well as

developing new items. The items related to employability skills should be based on existing frameworks such as the Vitae Researcher Development Framework (Vitae, 2011). Below are a few potential draft items that could be used to measure employability skills:

- I developed the ability to independently manage a research project
- My research developed my ability to produce convincing arguments
- I developed time management skills

In addition, a new item or items should be developed relating to HDR graduates' career advice received during their candidature.

Option 2

The second option is that the PREQ incorporate one or two open-ended questions to help universities contextualise the findings from the PREQ. Given the very positive responses received in the PREQ, qualitative responses collected via the PREQ could be used by universities to help identify aspects of the HDR experience that could be improved.

Examples of draft open-ended questions that could be included in the PREQ include:

- What were the best aspects of your postgraduate research experience?
- What aspects of your postgraduate research experience were most in need of improvement?

Although information collected through open-ended items can provide helpful context, information provided in open-ended questions via online questionnaires is not always specific-enough or detailed-enough to be helpful for universities to use to improve the HDR experience. Richer and more useful information may be collected through focus-groups or in-depth interviews with HDR candidates or graduates. However, conducting focus groups and interviews require significant investments in time from both participants and researchers and so may not be as practical as including open-ended items in questionnaires.

Option 3

The third option is to include some contextual items in the PREQ or GOS, in addition to including new items relating to HDR graduates' experience. Based on the feedback from the stakeholder consultations, information about the following would be helpful for contextualising the results and using the findings to improve the HDR experience:

- respondents' pathway into HDR, such as their previous qualifications;
- whether respondents received an Australian Postgraduate Award or other scholarship;
- respondents' involvement in the Australian National Internships Program; and
- for employed respondents, information on whether they are working in academia.

Some of this information could possibly be collected through administrative data rather than by adding additional items into the PREQ.

Option 4

The fourth option does not relate to the PREQ instrument, but instead to the way in which the PREQ findings are reported. Currently results from the PREQ are reported as part of the overall GOS report which provides a good overview of the findings and includes a summary of graduates' overall satisfaction, findings at a scale level by field of research and demographic groups, and scale scores over time.

Including error bands or another measure of variance in the reports, or making this information available to universities, would be one small enhancement that would enable universities to benchmark their results against national results more accurately and get more value out of the PREQ data. In addition, including some more detailed analysis of the PREQ results at the national level, such as by field of research, or for graduates working in academia and those working in other sectors would also provide helpful insights into the findings. Another option may be to report on some of the findings at the item level, rather than focus on the results at scale level. It may also be helpful to include more detailed analysis of the employment

outcomes of graduates from postgraduate research degrees as collected in the GOS and GOS-L instruments and to include public reporting of the GOS-L findings to provide a longer-term outlook on HDR graduates' outcomes.

Option 5

The fifth and final option is to consider either replacing or complementing the PREQ with a national survey of current HDR candidates' experience. Although this recommendation is somewhat outside of the scope of the current project, many stakeholders felt that a national survey of current HDR candidates should be considered in order to provide universities with a more complete picture of HDR candidates' experience, and given the larger population, to enable more detailed analysis and reporting of the results at institutional and disciplinary levels.

Findings from Phase 2

Development of revised PREQ instrument

Overview

Following feedback from the Department, the PREQ Review Advisory Panel and stakeholder consultations, a decision was taken to pursue the first option for the redevelopment of the PREQ that was proposed at the end of Phase 1 of the PREQ review. This option involved keeping most of the existing items and scales in the current PREQ, but updating the instrument so that it is more appropriate for measuring the contemporary HDR candidate experience. The redevelopment focused on developing new items to measure HDR candidates' engagement with industry, and also to develop new items and redevelop the existing Skill Development Scale to better measure graduates' development of generic and employability skills.

There were several reasons why a decision was taken to pursue the first option for the redevelopment of the PREQ rather than the other options that were proposed. The second option involved collecting qualitative feedback on the HDR experience to help contextualise the PREQ responses. Currently some qualitative feedback is being collected about graduates' course experience via two open-ended questions included in the broader GOS instrument. Universities can already use the information collected via these questions to help contextualise the results from the PREQ. For this reason, the second option was not pursued as part of this project.

The third option was similar in its focus on collecting more contextual information about HDR graduates, relating to study pathways and previous qualifications, scholarship status, involvement in different work experience and industry engagement activities, and employment sector. Much of this information is currently collected by individual universities or is part of the HEIMS collection, and universities are already able to match this information into the GOS data files that are provided to them. Recently, the reporting requirements for HEIMS have been expanded to include some further contextual information on HDR candidates which will also provide universities with further opportunities for contextualising the PREQ results. Because universities are already able to match in this further contextual information, and many universities are already doing this, the third option was also not pursued as part of this project.

The fourth option focused on the way in which the PREQ findings are reported. The reports currently prepared at a national level on the overall GOS and PREQ findings have been intentionally designed to be lean and focus on the headline results. Although there is some appetite in the sector for more detailed analysis of the PREQ results, currently as part of a data sharing agreement, universities have access to their own GOS and PREQ data files, as well as benchmark data files that contain the results for other universities. In addition, a full historical data file containing the PREQ results from the past several years is currently being prepared. These data files should provide universities with all the information that they require to explore the PREQ results in more detail. In addition, this option also supported reporting the GOS-L results publicly in order to provide a longer-term outlook on HDR graduates' outcomes. Following

Phase 1, the results from the 2017 GOS-L were released publicly. Universities participating in the GOS-L will also be provided with data files containing their own GOS-L data as well as benchmark data files. Because universities have access to their own PREQ and GOS data files, as well as benchmark data files, it was deemed to be unnecessary to pursue the fourth option as part of this project.

The fifth option was to consider replacing or complementing the current PREQ with a survey of current HDR candidates. As this is outside of the scope of the current PREQ review, it was not pursued as part of this project. However, given the appetite in the sector for the development of a survey of current HDR candidates, the Department are planning to explore opportunities for the development of a current HDR candidate survey, subject to available resources. As well as being identified as an option for redevelopment of the PREQ in the current review, this issue has also been considered by a cross sector working group implementing the ACOLA Review of Australia's Research Training system. Both processes will inform the Department's consideration.

The development of the revised PREQ instrument followed a number of steps. First, a conceptual framework was developed to underpin the development of new and revised items in the revised PREQ instrument. Next, new and revised items were drafted and feedback on these was sought from the PREQ Review Advisory Panel. Following the revision of the PREQ instrument, a series of focus groups were conducted with current and recent HDR candidates to cognitively test the content of the updated PREQ instrument and ensure that it was clear and understandable. The instrument was then further revised before being piloted.

This section provides information on the conceptual framework that underpinned the development of the updated PREQ instrument. It also provide details on the new and revised items included in the updated PREQ instrument and the rationale behind these changes.

Conceptual framework

A conceptual framework was used to help inform the development of the generic and employability skills and industry engagement items. Following the review of literature and current practice and trends that was conducted in Phase 1, the Researcher Development Framework (Vitae, 2011) was identified as an appropriate framework to use for this purpose (see Table 5).

Existing items in the current PREQ were mapped onto the framework, along with items from the GOS and the PRES. Summaries of the desirable skills and qualities that HDR graduates should have, as described in the ACOLA Review (McGagh et al, 2016), and the learning outcomes listed in the Australian Qualification Framework (AQF) were also mapped onto the framework. Further details of this mapping are shown in Appendix C.

Table 5: Researcher Development Framework

Domain	Sub-domain	Descriptors
Knowledge and intellectual abilities	**Knowledge base**	Subject knowledge
		Research methods: theoretical knowledge
		Research methods: practical application
		Information seeking
		Information literacy and management
		Languages
		Academic literacy and numeracy
	Cognitive abilities	Analysing
		Synthesising
		Critical thinking
		Evaluating
		Problem solving
	Creativity	Inquiring mind
		Intellectual insight
		Innovation
		Argument construction
		Intellectual risk
Personal effectiveness	**Personal qualities**	Enthusiasm
		Perseverance
		Integrity
		Self-confidence
		Self-reflection
		Responsibility
	Self-management	Preparation and prioritisation
		Commitment to research
		Time management
		Responsiveness to change
		Work-life balance
	Professional and career development	Career management
		Continuing professional development
		Responsiveness to opportunities
		Networking
		Reputation and esteem
Research governance and organisation	**Professional conduct**	Health and safety
		Ethics, principles and sustainability
		Legal requirements
		IPR and copyright
		Respect and confidentiality
		Attribution and co-authorship
		Appropriate practice
	Research management	Research strategy
		Project planning and delivery
		Risk management
	Finance, funding and resources	Income and funding generation
		Financial management
		Infrastructure and resources
Engagement, influence and impact	**Working with others**	Collegiality
		Team working
		People management
		Supervision

Domain	Sub-domain	Descriptors
		Mentoring
		Influence and leadership
		Collaboration
		Equality and diversity
	Communication and dissemination	Communication methods
		Communication media
		Publication
	Engagement and impact	Teaching
		Public engagement
		Enterprise
		Policy
		Society and culture
		Global citizenship

Source: Researcher Development Framework (Vitae, 2011).

After mapping the existing PREQ items onto the framework, and also following a review of the findings from Phase 1, a number of specific gaps and potential areas for improvement were identified in the current PREQ in terms of its measurement of generic and employability skills. More specifically, these included gaps in the PREQ instrument's ability to measure HDR graduates':

- cognitive abilities;
- self-management;
- personal qualities – in particular development of self-confidence;
- communication methods – in particular expanding this from a focus only on written communication to different types of communication;
- influencing and leadership skills;
- research ethics and integrity; and
- research management skills.

The areas of industry engagement to include in the revised PREQ instrument were informed primarily by the findings from the ACOLA Review (McGagh et al, 2016). Some of the key findings related to industry engagement outlined in the ACOLA Review that were identified as potential areas for measurement included:

- that although around half of HDR graduates end up working outside of academia, many graduates are not aware of how they can transfer or use their skills developed during their HDR candidacy outside of academia;
- the recommendation that HDR candidates are provided with more opportunities to collaborate with industry partners;
- the recommendation that HDR candidates' have more opportunities to participate in work-integrated learning; and
- HDR candidates' ability to solve real-world or industry-defined problems.

Revised PREQ instrument

The PREQ instrument was revised to better measure graduates' development of generic and employability skills, and also to include new items designed to measure industry engagement. Focusing on the gaps identified in the current PREQ instrument, a series of new and revised items were developed for inclusion in a pilot PREQ instrument. A copy of the items that were piloted in the PREQ are provided in Appendix D.

Each of these new and revised items are listed below, along with the reason why they were chosen for inclusion in the revised PREQ instrument.

Skill Development items

I improved my ability to design and implement projects effectively

This item was included in revised PREQ instrument as there were no items in the existing PREQ or GOS that addressed the development of research governance skills. This was identified as a gap in the current PREQ when its items were mapped onto the Researcher Development Framework. A similar item (*My ability to manage projects has developed during my programme*) is included in the UK PRES instrument, so including this item would help facilitate international benchmarking.

I improved my ability to communicate information effectively to diverse audiences

The existing PREQ instrument included an item that captured the development of written communication skills - *I learned to develop my ideas and present them in my written work*. The GOS also includes items that ask about graduates' development of written and oral communication skills.

This new item was developed to replace the existing item. It provides a broader measurement of communication skills and methods and reflects the need for graduates to communicate to a number of different audiences and in different ways. For example, the ACOLA Review identified that HDR graduates needed to be able to communicate effectively through academic writing, report writing, grants and funding applications, oral presentations and in networking situations (McGagh et al, 2016). This item is also similar to an item included in the UK PRES (*My ability to communicate information effectively to diverse audiences has developed during my programme*) which means that the findings from this item could be internationally benchmarked.

I developed my skills in critical analysis and evaluation

This item was a revision of an existing PREQ item - *My research sharpened my analytical skills*. This item was revised in order to incorporate both analysis and evaluation, as there were no items in the PREQ or GOS that measured graduates' development of evaluation skills. Critical analysis and evaluation is one of the skills highlighted in the ACOLA Review that are required to be an effective researcher (McGagh et al, 2016). This change also makes the item more similar to an item included in the UK PRES (*My skills in critically analysing and evaluating findings and results have developed during my programme*) and means that findings from this item can be more easily benchmarked internationally.

I developed my understanding of 'research integrity' (e.g. rigour, ethics, transparency, attributing the contribution of others)

This item was developed to help fill one of the gaps in the current PREQ instrument's measurement. The current PREQ instrument does not include any items that mapped onto the Researcher Development Framework domain of 'research governance and organisation'. This item was created to measure graduates' understanding of professional conduct in research, and is similar to an item included in the UK PRES (*My understanding of 'research integrity' (e.g. rigour, ethics, transparency, attributing the contribution of others) has developed during my programme*) and so enables international benchmarking. It also helps measure one of the qualities outlined in the ACOLA Review that were found to be needed by HDR graduates to be able to work across a range of industries and in a range of careers (McGagh et al, 2016).

I improved my ability to plan and manage my time effectively

This item was a revision of an existing PREQ item - *Doing my research helped me to develop my ability to plan my own work*. The ability to plan and manage time is one of the key skills that industry and employers need from HDR graduates to be an effective researcher (McGagh et al, 2016). This item maps onto the self-management sub-domain of the Researcher Development Framework (Vitae, 2011).

I gained confidence in leading and influencing others

This item was developed to address HDR graduates' development of leadership skills. This area is not currently measured in the GOS or PREQ, and was identified as one of the key gaps of the current PREQ

instrument. Leadership skills were one of the higher-level interpersonal and communication skills identified by employers through the ACOLA Review as desirable for researchers to have (McGagh et al, 2016).

As a result of my research, I feel confident about tackling unfamiliar problems

This item was unchanged from the current PREQ Skill Development scale. The item was retained as it provides a helpful measurement of graduates' self-confidence and maps clearly to the Researcher Development Framework (Vitae, 2011).

Finally, one item included in the current PREQ Skill Development scale – *My research further developed my problem solving skills* – was removed from the pilot PREQ instrument. The reason for this was because a very similar item measuring graduates' development of problem solving skills is included in the broader GOS instrument in which the PREQ is located:

For each of the following skills or attributes, to what extent do you agree or disagree that your <COURSE> from <INSTITUTION NAME> prepared you for this job?

- *Ability to solve problems*

Industry Engagement items

I am confident that I can apply my skills outside the university sector

This is a new item that was developed for the pilot PREQ instrument to measure industry engagement. The ACOLA Review reported that around half of all Australian HDR graduates do not end up working in academia, with increasing numbers working in business and industry (McGagh et al, 2016). Given the likelihood that HDR graduates will be working outside of academia, it is vital that graduates are confident in their ability to work in business and industry settings and not just in academic settings. Findings from the ACOLA Review suggest that although many employers across a broad range of industries find the skills that HDR graduates have to be very desirable, many HDR graduates are unaware that their skills are relevant and transferable outside of academia (McGagh et at, 2016). This item was developed to measure HDR graduates' confidence in their ability to apply their skills in non-academic industries.

I had opportunities to develop professional connections outside the university sector

This is a new item that was developed for the pilot PREQ instrument to measure industry engagement. Given that a large proportion of HDR graduates will go on to work in industry, there is a need to understand whether HDR candidates are given opportunities to collaborate with business and industry. The ACOLA Review identified that providing opportunities for HDR candidates to collaborate with industry partners could help improve their development of industry skills (McGagh et al, 2016). This item was developed to help understand the extent to which graduates had opportunities during their study to meet others in business or industry. Currently the PREQ only includes an item about HDR candidates' opportunities to network within their department.

I had opportunities to work on research problems with real-world or industry applications

This is a new item that was developed for the pilot PREQ instrument to measure industry engagement. One finding from the ACOLA Review was that employers want HDR graduates to be able to solve real-world problems in industry (McGagh et al, 2016). This item was developed to understand whether HDR candidates are being presented with opportunities to develop these skills that are desired by industry.

Did you participate in other types of work-integrated learning (e.g. placements, practicums, consultancies, industry research projects) as part of your <COURSE>?

A number of items are included in the GOS that collect information about HDR graduates' development of specific business skills, participation in internships and information about whether their course was supervised or funded by an industry partner. Although not part of the PREQ questionnaire, this item was included in the pilot PREQ to understand graduates' participation in work-integrated learning, more broadly than looking only at participation in specific internship schemes. Ensuring HDR candidates gain work

experience and exposure to workplaces was one of the key themes that emerged from the ACOLA Review (McGagh et al, 2016).

Statistical analyses of pilot results

A number of exploratory analyses and psychometric tests were conducted on the pilot PREQ data to determine the reliability and quality of the revised PREQ items and scales. A summary of these analyses are given here, and a complete report on the statistical and psychometric findings are included in Appendix E.

The analyses focused on the results from the pilot PREQ administration that was conducted with 20 institutions.

The data for the pilot PREQ was fitted to the Rasch Partial Credit model based on item response theory (IRT). This found that most of the items in the PREQ fit the model well, with a test reliability of 0.937.

A confirmatory factor analysis (CFA) was also used to model the pilot PREQ scales. The CFA excluded the PREQ28 item, as this is only a one-item scale that has very small variance. The remaining 32 items were fitted to a seven-factor CFA model. The χ^2 test yields a value of 1,948 (df=443), which has a corresponding p-value of .0000. The RMSEA is 0.073, which is within the 90% C.I., CFI and TLI are 0.947 and 0.941, respectively. The approximate fit is acceptable.

The factor loadings on each factor are all strong, the lowest standardised factor loading is 0.708 for item PREQ25, and other factor loadings are 0.75 or higher. This means that the items are good indicators of the scale, and it also indicates that each of seven latent scales are well defined.

Overall, the analyses indicated that the revised PREQ items and scales were performing satisfactorily.

Following further feedback from the Department and the PREQ Review Advisory Panel, a decision was taken that it would be better to retain the following item in the Skill Development scale - *My research further developed my problem solving skills* – although this item was excluded from the pilot instrument. The reason for retaining this item instead of removing it was primarily to enhance the face validity of the Skill Development scale, and to ensure that an item relating to problem-solving skill development was included in the PREQ instrument, and not just in the GOS in case the PREQ instrument becomes decoupled from the GOS instrument in future.

As data from this item was not collected in the pilot PREQ, to explore the statistical impact retaining such an item would have, a proxy variable – GFOUND06 (*Ability to solve problems*) – that was included in the pilot PREQ instrument was included in the Skill Development scale and the CFA was used to model the updated pilot PREQ scales. Again the CFA excluded the PREQ28 item, and the remaining 33 items were fitted to a seven-factor CFA model. The χ^2 test yields a value of 2,249 (df=474), which has a corresponding p-value of .0000. The RMSEA is 0.077, which is within the 90% C.I., CFI and TLI are 0.945 and 0.939, respectively. This indicates that including this proxy item does not impact on the approximate fit of the model, and that the fit is acceptable.

While the overall fit is acceptable, the standardised factor loading for the proxy variable – GFOUND06 – is much lower than other factor loadings. Although the GFOUND06 item does not load strongly on the revised Skill Development, this does not necessarily indicate that the PREQ06 item would not load well on this scale.

Stakeholder consultations

In addition to the feedback sought from stakeholders during Phase 1 of the PREQ review, during Phase 2 feedback was again sought from stakeholders on the pilot PREQ instrument. Feedback was sought both via the Australian Council of Deans of Graduate Research, and directly from Deans of Graduate Research or staff in equivalent roles at all Australian universities. Feedback was provided by stakeholders on the specific content and focus of the pilot PREQ instrument.

Overall, the feedback received indicated that the sector felt that the revised instrument appeared to be robust, useful and well-written. Broadly, stakeholders indicated that they were comfortable with the proposed changes and the revised PREQ instrument. Some stakeholders expressed concerns with the inclusion of items measuring industry engagement, as these questions may exclude HDR candidates undertaking pure – rather than applied – research, and may also lead to incentivising universities to force all candidates into industry placements, whether or not this is appropriate for a candidate.

A small number of stakeholders suggested that there were still some gaps in the areas measured in the PREQ and suggested including items to measure aspects of graduates' experience such as:

- development of digital skills;
- experience of non-academic support;
- more specific aspects of supervision; and
- publication of research outputs during candidature.

Most of the feedback provided was quite specific and focused on item wording and content. In addition, most of the feedback was provided on items that were part of the current PREQ and not on items that were newly developed or revised in the pilot PREQ instrument.

There were quite a few comments relating to the 'additional items' included in the GOS about graduates' participation in overseas study, work-integrated learning and engagement with industry. One stakeholder indicated that the terminology used in the question – *Did you undertake any overseas study during your <COURSE> (e.g. student exchange or study abroad)?* – was not appropriate for HDR graduates and it was unclear whether this was trying to measure graduates' international experience generally, or whether they travelled overseas as part of their HDR candidature (e.g. to attend a conference or undertake research), or whether this overseas study was part of a formal international research collaboration.

Some stakeholders suggested that definitions were needed to help clarify the meaning of 'internship component', 'work-integrated learning' and 'industry partner'. There were also a couple of stakeholders who were unclear of the difference between internships and other types of work-integrated learning.

There were also some stakeholders who felt that some of the terminology used in the PREQ was a bit too broad or ambiguous, particularly in their use of specific terms such as 'satisfied', 'reasonable', 'fair' and 'the Department'. In addition, a few stakeholders suggested replacing the term 'research ambiance' with either 'research environment' or 'research culture' as 'ambiance' is not a term that is widely used or understood.

Beyond the feedback given on the specific items in the PREQ instrument, some of the feedback was broader in its focus and raised some of the same issues that were raised during the consultations undertaken during Phase 1 of the PREQ review. This broader feedback related to concerns about the low response numbers and response rates at an institutional level for the PREQ, as well as the lack of a survey of current HDR candidates.

Recommendations for future PREQ

Based on the findings from Phase 2 of the PREQ review, the main recommendation would be to retain the new and revised items that were piloted in future deployments of the PREQ. A comparison of the current and proposed PREQ instrument is given in Appendix F.

Specifically, the Skills Development scale be modified to include the following items:

- *My research further developed my problem solving skills* (existing item retained)
- *I improved my ability to design and implement projects effectively* (new item)
- *I improved my ability to communicate information effectively to diverse audiences* (revision to existing item)
- *I developed my skills in critical analysis and evaluation* (revision to existing item)
- *I developed my understanding of research integrity (e.g. rigour, ethics, transparency, attributing the contribution of others)* (new item)

- *I improved my ability to plan and manage my time effectively* (revision to existing item)
- *I gained confidence in leading and influencing others* (new item)
- *As a result of my research, I feel confidence about tackling unfamiliar problems* (existing item retained).

A new Industry Engagement scale be added with the following items:

- *I am confident that I can apply my skills outside the university sector*
- *I had opportunities to develop professional connections outside the university sector*
- *I had opportunities to work on research problems with real-world or industry application*

In addition, a further recommendation would be to make a couple of other revisions to the current PREQ instrument. These revisions include adding in one new contextual item:

- *Did you participate in other types of work-integrated learning (e.g. placements, practicums, consultancies, industry research projects) as part of your <Course>?*

These revisions also include updating one of the current items from the Intellectual Climate scale of the PREQ:

- The research environment in the department or faculty stimulated my work

In addition, there were several requests for further contextual information to be available to help contextualise the PREQ results. Quite a bit of contextual information is currently being collected by individual universities or as part of the HEIMS collection. Universities are already able to match this information into the data files that are provided to them. Recently, the reporting requirements for HEIMS have been expanded to include some further contextual information on HDR candidates which will also provide universities with further opportunities for contextualising the PREQ results.

In order to address concerns about the overall response numbers and response rates, one option that could be considered going forward would be to investigate whether using a combination of online and telephone surveying in the PREQ would be a valid approach. Currently only online survey responses are published in the publicly available data due to concerns about mode effects impacting the results. Complementing the online surveying with telephone follow-ups would likely increase response numbers and this option may be worth exploring.

Finally, there appears to be quite a bit of interest in the sector to develop a survey of current HDR candidates. The Department are planning to explore opportunities for the development of a current HDR candidate survey, subject to available resources. As well as being identified as an option for redevelopment of the PREQ in the current review, this issue has also been considered by a cross sector working group implementing the ACOLA Review of Australia's Research Training system. Both processes will inform the Department's consideration of this activity. Any new survey of current HDR candidates should also be informed by the outcomes of some of the current activities in the sector around HDR candidates' experience. This includes the ARC's pilot of the Engagement and Impact Assessment (Australian Research Council, 2017), the Design Options for the Future Doctorate project (Coates et al, 2016), ACGR's Mapping External Engagement of Australia's Higher Degree by Research Candidates (Bentley & Bexley, 2017), increased reporting requirements for HEIMS and the changing policy environment.

References

Austin, AE. (2011). 'Preparing doctoral students for promising careers in a changing context: Implications for supervision, institutional planning and cross-institutional opportunities. In Kumar, V. & Lee, A. (eds). *Doctoral Education in International Context: Connecting Local, Regional and Global Perspectives.* Malaysia: Univesiti Putra Malaysia Press.

Australian Council of Graduate Research. (2016). *Australian Graduate Research Good Practice Principles*. Retrieved 7 March 2017 from http://www.ddogs.edu.au/good-practice-principles

Australian Government. (2017). New research funding arrangements for universities. Retrieved April 5, 2017, from https://www.innovation.gov.au/page/new-research-funding-arrangements-universities

Australian Government. (2015). *Higher Education Standards (HES) Framework (Threshold Standards) 2015.* Retrieved 7 March 2017 from https://www.legislation.gov.au/Details/F2015L01639

Australian Qualifications Framework Council. (2013). *Australian Qualifications Framework Second Edition January 2013.* South Australia: Australian Qualifications Framework Council.

Australian Research Council. (2017). *Engagement and Impact Assessment.* Retrieved October 17, 2017 from http://www.arc.gov.au/engagement-and-impact-assessment

Bennett, P., & Turner, G. (2013). *PRES 2013: Results from the Postgraduate Research Experience Survey.* The Higher Education Academy.

Bentley, P. & Bexley, E. (2017). *Plain Language Statement: Mapping external engagement of Australia's Higher Degree by Research candidates.* Retrieved October 17, 2017 from http://www.lhmartininstitute.edu.au/userfiles/files/Projects/DOCUMENTS%20for%20PB/PLS%20-%20Mapping%20HDR%20External%20Engagement%20(RHD%20Candidates)%20(170517).pdf

Canadian Association for Graduate Studies. (2016). *Canadian Graduate and Professional Student Survey. Instrument 2016*, Retrieved 15 March from http://www.cags.ca/documents/cgpss/2016/Instrument%20EN.pdf

Coates, H., Bexley, E., Burnett, P., Carroll, M., Connell, L., Croucher, G., … Strugnell, D. (2016). *Design Options for the Future Doctorate: Project Plan.* Canberra: Office for Learning & Teaching.

Department of Education. (2014). *Initiatives to enhance the professional development of research students.* Canberra: Department of Education and Training.

Department of Education and Training. (2017a). *Higher Education Statistics. Higher Education Data Cube (uCube).* http://highereducationstatistics.education.gov.au/

Department of Education and Training. (2016a). *2015 – Award course completions.* Canberra, Department of Education and Training. https://docs.education.gov.au/documents/2015-award-course-completions

Department of Education and Training. (2017b). Research Training Program. Retrieved April 5, 2017, from https://www.education.gov.au/research-training-program

Department of Education and Training. (2016b). Australian Research Council (ARC) Linkage Projects Scheme. Retrieved April 5, 2017, from https://www.education.gov.au/australian-research-council-arc-linkage-projects-scheme

Department of Education and Training. (2016c). National Collaborative Research Infrastructure Strategy (NCRIS). Retrieved April 5, 2017, from https://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris

Department of Education and Training. (2016d). Assessing engagement and impact in university research. Retrieved April 5, 2017, from https://www.education.gov.au/assessing-engagement-and-impact-university-research

Department of Education and Training. (2016e). *Selected Higher Education Statistics - 2015 Student data. Full Year Data. All Students*. Canberra: Department of Education and Training.

Dobson, IR. (2012). 'PhDs in Australia, from the beginning'. *Australian Universities' Review*, 54:1, 94-100.

Edwards, D., Bexley, E., & Richardson, S. (2011). *Regenerating the Academic Workforce. The careers, intentions and motivations of higher degree research students in Australia.* Melbourne: Centre for the Study of Higher Education & Australian Council for Educational Research.

Finkel, A. (2016). *Draft 2016 National Research Infrastructure Roadmap*. Canberra. Retrieved from https://docs.education.gov.au/system/files/doc/other/draft_2016_national_research_infrastructure_roadmap_2.pdf

Flinders University. (2016). *Annual Research Higher Degree (RHD) Student Satisfaction Survey.* Adelaide: Flinders University.

Graduate Careers Australia. (2011). *Postgraduate Destinations 2010. Supplementary tables and figures.* Melbourne: Graduate Careers Australia.

Graduate Careers Australia. (2016a). *Postgraduate Destinations 2015. Supplementary tables and figures.* Melbourne: Graduate Careers Australia.

Graduate Careers Australia. (2016b). *Postgraduate Research Experience 2015. A report on the perceptions of recent higher degree research graduates*. Melbourne: Graduate Careers Australia.

Graduate Careers Australia & ACER. (2010). *Postgraduate Research Experience 2009. The report of the postgraduate research experience questionnaire.* Melbourne: Graduate Careers Australia.

Group of Eight. (2013). *The Changing PhD. Discussion Paper*. Turner, ACT: Group of Eight.

Higher Education Academy. (2016). *PRES Consultation 2017 and beyond.* Retrieved from 28 February from https://www.heacademy.ac.uk/system/files/downloads/pres_consultation_2017_and_beyond_-_consultation_results_final.pdf

Innovation and Science Australia. (2016). *Performance Review of the Australian Innovation, Science and Research System 2016.* Canberra: Commonwealth of Australia.

Johnston, L., Sampson, K. A., Comer, K., & Brogt, E. (2016). Using doctoral experience survey data to support developments in postgraduate supervision and support. *International Journal of Doctoral Studies, 11,* 185-203.

Kot, FC., & Hendel, DD. (2012). 'Emergence and growth of professional doctorates in the United States, United Kingdom, Canada and Australia: a comparative analysis' *Studies in Higher Education,* 37:3, 345-364.

Larkins, F.P. (2011). *Australian higher education research policies and performance: 1987-2010.* Victoria: Melbourne University Press.

Lee, A., & Boud, D. (2009). 'Producing researchers: the changing role of the doctorate' in Brew, A., & Lucas, L. (eds). *Academic Research and Researchers.* McGraw-Hill Education.

Manathunga, C., Pitt, R., Cox, L., Boreham, P., Mellick, G., & Lant, P. (2012). 'Evaluating industry-based doctoral research programs: perspectives and outcomes of Australian Cooperative Research Centre

graduates' *Studies in Higher Education,* 37:7, 843-858.

McGagh, J., Marsh, H., Western, M., Thomas, P., Hastings, A., Mihailova, M. & Wenham, M. (2016). *Review of Australia's Research Training System.* Victoria: Australian Council of Learned Academies.

Miles, D. A. (2015). *Growth through Innovation and Collaboration: A Review of the Cooperative Research Centres Programme*. Canberra, Australia.

Park, C., Hanbury, A., Kulej, M., & Harvey, L. (2007). *Postgraduate Research Experience Survey. Final report.* The Higher Education Academy.

QILT. (2016). *Graduate Outcome Survey National Report*. Retrieved from https://www.qilt.edu.au/about-this-site/graduate-satisfaction

Reeves, J, Denicolo, P., Metcalfe, J., & Roberts, J. (2012). *The Vitae Researcher Development Framework and Researcher Development Statement: methodology and validation report.* UK: Careers Research and Advisory Centre Ltd. Retrieved 14 March 2017 from https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae-methodology-report-2012.pdf

Sampson, K.A., Johnston, L., Comer, K., & Brogt, E. (2016). 'Developing evidence for action on the postgraduate experience: an effective local instrument to move beyond benchmarking' *Higher Education Research and Development,* 35:2, 337-351.

Simon, L. (2016). *Canadian Graduate and Professional Student Survey (ECEMD – CGPSS) 2016 edition results*. Ottawa: Canadian Association for Graduate Studies. Retrieved 15 March from http://www.cags.ca/cgpss_home.php

Social Research Centre. (2016b). *Graduate Outcomes Survey Methodological Report.* Melbourne: The Social Research Centre.

Son, J-B., Park, S-S., (2014). 'Academic experiences of international PhD students in Australian higher education: From an EAP program to a PhD program' *International Journal of Pedagogies and Learning,* 9:1, 26-37.

The University of Sydney. (2015). *Student Research Experience Questionnaire (SREQ). Faculty Results Summary 2008-2014.* Retrieved 8 March 2017 from http://sydney.edu.au/education-portfolio/qa/sreq/facultytables.htm

The University of Sydney. (2016). *About the Student Research Experience Questionnaire (SREQ).* Retrieved 8 March 2017 from http://sydney.edu.au/education-portfolio/qa/sreq/about.cfm

Turner, G. (2015). *PRES 2015. The research student journey.* Higher Education Academy.

Vitae. (2011). *Researcher Development Framework*. UK: Careers Research and Advisory Centre Ltd. Retrieved 14 March 2017 from https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae.pdf/view

Watt, IJ. (2015). *Review of Research Policy and Funding Arrangements*. Canberra: Department of Education and Training.

Western, M., Boreham, P., Kubler, M., Laffan, W., Western, J., Lawson, A, & Clague, D. (2007). *PhD Graduates 5 to 7 Years Out: Employment outcomes, job attributes and the quality of research training.* Brisbane: The University of Queensland Social Research Centre.

Zeng, L.M., Webster, B.J., & Ginns, P. (2013). Measuring the research experience of research postgraduate students in Hong Kong, *Higher Education Research & Development*, 32:4, 672-68.

Zhao, H. (2012). *Exploring the Canadian Graduate and Professional Student Survey (CGPSS): Results from 2007 and 2010 for Ontario Universities*. Toronto: Higher Education Quality Council of Ontario.

Appendix A: Consultation questions from Phase 1

Overview

The Commonwealth Department of Education and Training (the Department) has engaged the services of the Australian Council for Educational Research (ACER) to review the current Postgraduate Research Experience Questionnaire (PREQ). This project is being conducted in order to determine whether the PREQ is still relevant and useful, and whether it requires updating.

As part of this review, ACER are conducting statistical and psychometric analyses of PREQ data, a review of recent literature and current practice and trends, and consulting with a range of stakeholders.

About the PREQ

The PREQ was developed in 1999 to collect information on the course experience and satisfaction of recent graduates from postgraduate research degrees. It was designed to complement the Course Experience Questionnaire (CEQ) which is administered to recent graduates from undergraduate and postgraduate coursework degrees.

The PREQ is currently administered as part of the Graduate Outcomes Survey (GOS) which is conducted as a census of recent graduates from Australian universities, and participating non-university higher education institutions. The GOS is conducted with graduates four-to-six months after they have graduated. It includes various questions relating to graduates' current employment, study and job seeking activities, and also includes either the CEQ or PREQ.

The PREQ asks Higher Degree by Research (HDR) graduates to rate their level of agreement with a series of statements which are shown in Table 6. These items are used to compute six scales and include a single-item overall satisfaction indicator:

- Supervision Scale (SS)
- Intellectual Climate Scale (ICS)
- Skill Development Scale (SDS)
- Infrastructure Scale (IS)
- Thesis Examination Scale (TES)
- Goals and Expectations (GES)
- Overall Satisfaction (OS)

Table 6: Current PREQ Items

Item	Scale	Response options
Supervision was available when I needed it	SS	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree
The thesis examination process was fair	TES	
I had access to a suitable working space	IS	
I developed an understanding of the standard of work expected	GES	
The department provided opportunities for social contact with other postgraduate students	ICS	
My research further developed my problem solving skills	SDS	
My supervisor(s) made a real effort to understand difficulties I faced	SS	
I had good access to the technical support I needed	IS	
I was integrated into the department's community	ICS	
I learned to develop my ideas and present them in my written work	SDS	
I understood the required standard for the thesis	GES	
I was able to organise good access to necessary equipment	IS	

Item	Scale	Response options
My supervisor(s) provided additional information relevant to my topic	SS	
My research sharpened my analytical skills	SDS	
I was satisfied with the thesis examination process	TES	
The department provided opportunities for me to become involved in the broader research culture	ICS	
I was given good guidance in topic selection and refinement	SS	
I had good access to computing facilities and services	IS	
I understood the requirements of thesis examination	GES	
Doing my research helped me to develop my ability to plan my own work	SDS	
My supervisor(s) provided helpful feedback on my progress	SS	
A good seminar program for postgraduate students was provided	ICS	
The research ambience in the department or faculty stimulated my work	ICS	
I received good guidance in my literature search	SS	
The examination of my thesis was completed in a reasonable time	TES	
As a result of my research, I feel confident about tackling unfamiliar problems	SDS	
There was appropriate financial support for research activities	IS	
Overall, I was satisfied with the quality of my higher degree research experience	OS	

Currently, the results from the PREQ are reported publicly via the GOS National Report. Universities and participating non-university higher education institutions also receive an institution report, an institutional data file and access to a national data file. Findings from the PREQ are not currently reported on the QILT website.

Consultation questions

As part of the PREQ review, ACER wants to hear your thoughts about the PREQ and about postgraduate research students' experience more broadly. Below are some specific questions that we would like your response to.

1) What are the main ways in which you perceive the HDR student cohort has changed in the past decade?

2) What are the main ways in which you perceive the HDR student experience has changed in recent years or you expect will change in the coming decade?

3) Are results from the PREQ used at your institution to understand or improve HDR students' experience?

☐ **Yes, please describe broadly how the results are used.**

☐ **No, why do you think the results are not currently being used?**

4) What is your perception of the PREQ items and scales? Are these relevant and useful for understanding HDR students' satisfaction and experience?

5) Are there any other aspects of HDR students' experience that would be helpful to understand that are not captured in the PREQ?

6) If you are using, or have used any other measures (including other surveys, learning analytics data, or other measures) to collect information about HDR students' experience, please describe these.

7) Please let us know any other thoughts you have about the PREQ.

Thank you for your responses. We appreciate your input into the PREQ review. Please email your responses to these questions to Ali Radloff (ali.radloff@acer.edu.au).

Please do not hesitate to contact Ali with any queries about the PREQ review (03 9277 5742 / ali.radloff@acer.edu.au)

Appendix B: Psychometric analyses of current PREQ

Overview

Data from over 5,000 students across 2014, 2015 and 2016 were used for the psychometric analyses. Table 7 shows the number of responses received, and the number of valid cases after removing the invalid cases and CEQ students across three years.

Table 7: Data received and included in analyses

Year	Total responses	Invalid cases	CEQ students	Invalid level	Missing response	Number for Analysis
2014	142647	65	137288	4	58	5232
2015	131399	138	126183	0	61	5017
2016	131936	18124	108136	53	388	5235

Descriptive analyses

Table 8 shows the breakdowns of students by student background characteristics across the three years of the PREQ. This shows that in 2014 and 2015, around 51.5% of respondents were women. In 2016, the number of female respondents increased slightly to 52.8%.

There are very few Aboriginal or Torres Strait Islander graduates (less than 0.4%) and disabled students (<3.5%) in the data in each of the three years. Hence the results provided on these student groups should not be used in the final report.

In 2014 and 2015, there were about 37% non-English speakers, while in 2016 the percentage dropped to 24.3%.

In 2014 and 2015, there were 75% and 77% on-Campus students, respectively. The rest consists of about 13% distance students and about 10% mixed-mode student. In 2016, on-campus students increased to 93%, with 5% distance students and 2% mixed-mode students.

There was not much difference across the three years in terms of proportion of students with permanent residence status. There were 72% of Australians in 2014 and 2015, and 71% of Australians in 2016 participating in the survey, with the rest from overseas.

In 2014 and 2015, about 74% of participants were full time students, while in the 2016 cohort, there were about 67%. Over 84% of the participants were PhD students in each of the three years.

Table 8: Student background characteristics as percentage

Group	Category	2014	2015	2016
Total Students		5,232	5,017	5,235
Gender	**Female**	51.5%	51.4%	52.8%
	Male	48.5%	48.6%	47.0%
	Unknown	-	0.1%	0.2%
Indigenous status	**Not Indigenous**	98.1%	97.7%	99.4%
	Aboriginal	0.3%	0.2%	0.4%
	Torres Strait Islander	-	0.0%	-
	Aboriginal & Torres Strait Islander	0.0%	0.0%	-
	Missing	1.5%	2.0%	0.2%
Language	**English**	59.5%	59.9%	75.7%
	Other	37.2%	37.4%	24.3%
	Missing	3.2%	2.7%	-
	Internal (on-campus)	75.3%	76.9%	92.6%

Group	Category	2014	2015	2016
Attendance mode	External (distance)	13.4%	12.6%	5.0%
	Mixed mode	11.0%	10.2%	2.2%
	Missing	0.3%	0.3%	0.2%
International or domestic	Domestic	72.3%	72.4%	71.1%
	International	27.6%	27.5%	28.7%
	Missing	0.1%	0.1%	0.2%
Attendance type	Mainly Full-time	73.9%	74.6%	66.9%
	Mainly Part-time	25.9%	25.2%	32.9%
	Missing	0.2%	0.2%	0.2%
Disability	Yes	3.3%	2.5%	3.5%
	No	96.2%	97.1%	96.3%
	Missing	0.6%	0.4%	0.2%
Study level	Masters by research	14.0%	13.0%	15.3%
	Doctorate by research	86.0%	87.0%	84.7%

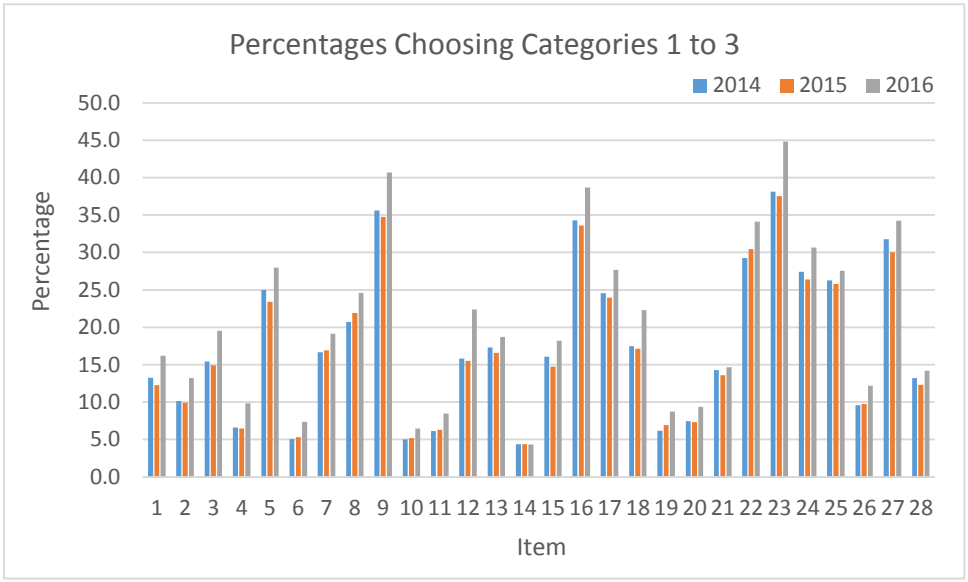
Overall, the cohorts of 2014 and 2015 are very similar in terms of student background characteristics, but there are some notable differences to the 2016 cohort.

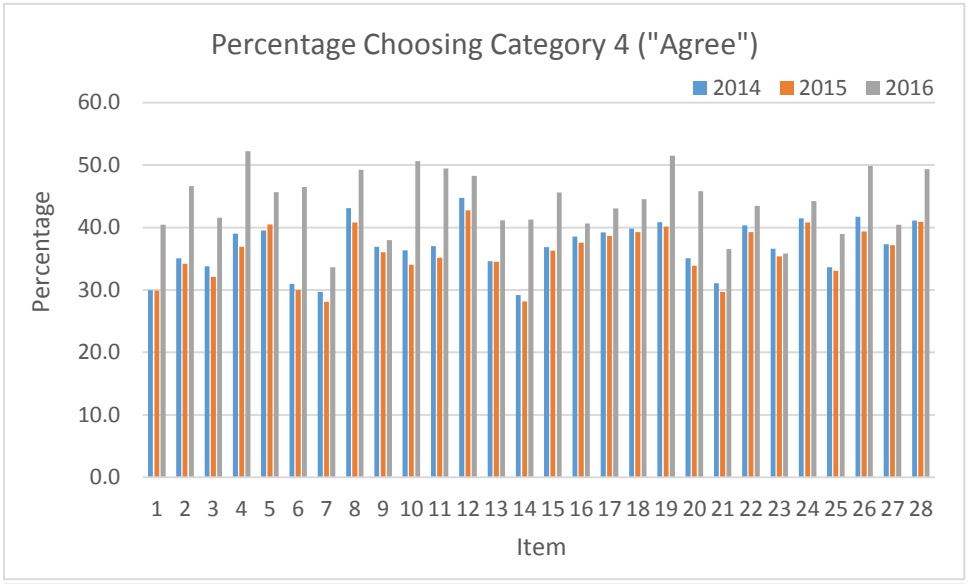
Response patterns

There were 28 items in the PREQ and five response categories in each item. Categories four and five ('Agree' and 'Strongly Agree') were selected by respondents most often. Many items had less than 15% of participants choosing the first three categories, especially in the Skill Development and Goals and Expectations scales. The percentages of students choosing the first three categories, the fourth category and the fifth category are shown in Figure 3 for 2014, 2015 and 2016.

An observation from Figure 3 below is that the response patterns from the 2014 and 2015 cohorts are very similar, but the patterns from 2016 cohort are different from those of 2014 and 2015.

Based on the student background information and response patterns, it is suggested that 2016 data should be analysed separately from the 2014 and 2015 data. Some of the following results are based on the 2016 data only.





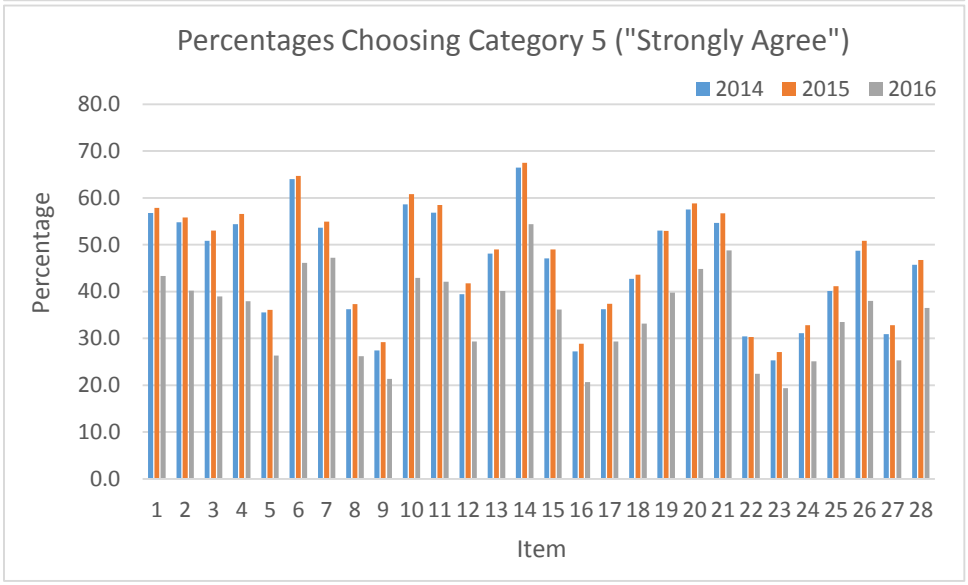


Figure 3: Response patterns across 2014, 2015 and 2016 PREQ items

Item Response Theory

Each year's data was fitted to the Rasch Partial Credit model based on Item response theory (IRT). A detailed item summary is given in Appendix 1.

Most items fit the IRT partial credit model well in all the three years. Only a few items did not fit the model well. The test reliabilities of the three years test are 0.894, 0.898 and 0.924, respectively. Items PREQ25 and PREQ27 have the worst fit to the IRT model, as shown in Figure 4. The ICCs of these two items show that the misfit mainly occurred in the lower categories and from a small proportion of the students. Overall, the data fit the IRT model quite well.

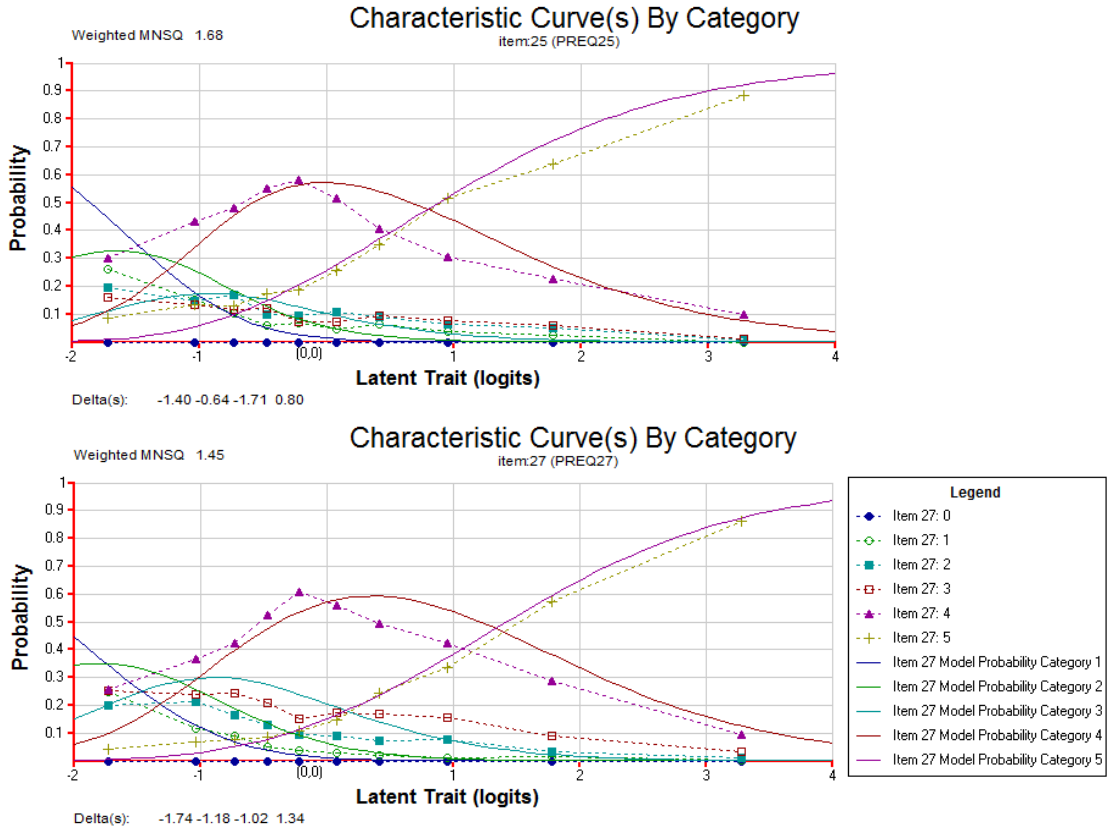


Figure 4: Item Characteristic Curves for Items PREQ25 and PREQ27 for the 2016 Data

EFA and CFA Results

In investigating the dimensionalities of the instrument, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) using MPlus were performed on the 2016 PREQ data.

EFA Results

EFA models with up to seven factors were fitted to the 2016 data investigating one to seven factor solutions. The Eigenvalues graph is shown in Figure 5. The detailed factor loadings of seven factors are given in Appendix 2: EFA Results. The eigenvalue graph shows that there is one main factor, and three or four minor factors. The factor loadings from the seven-factor EFA analysis indicates that the seven factors match with the seven conceptualised scales.

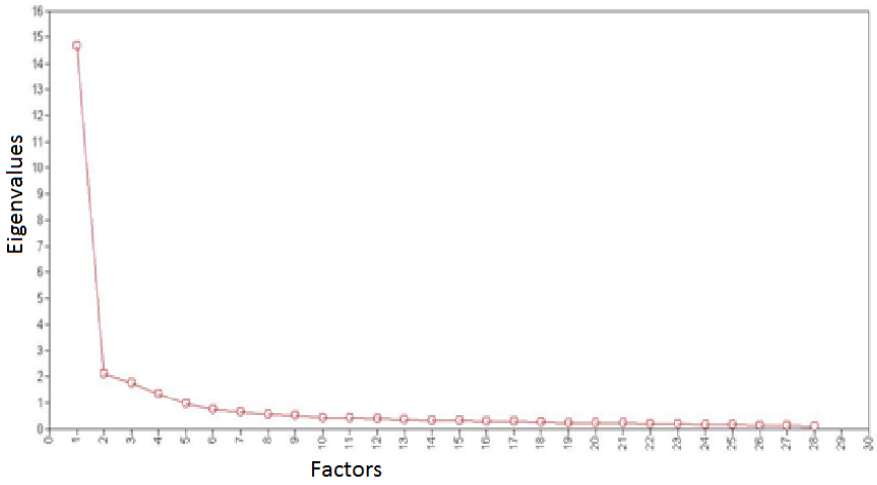


Figure 5: Eigenvalues Graphs of 28 Items from EFA Analysis

CFA Results

Item PREQ28 ("Overall, I was satisfied with the quality of my higher degree research experience") was not included in the CFA model as it is a one-item scale with very small variance. Item PREQ01 to PREQ27 were fitted to a six-factor CFA model using 2016 data. The χ^2 test yields a value of 7488 (df=309), which has a corresponding p-value of .0000. The χ^2 is high due to the large sample size. The RMSEA is 0.067, which is within the 90% C.I., CFI and TLI are 0.965 and 0.961, respectively. The approximate fit is acceptable.

The factor loadings on each factor are all strong, the lowest standardised factor loading is 0.641 for item PREQ27, and other factor loadings are 0.7 or higher. This means that the item are good indicators of the scale, and it also indicate that each of six latent scales are well defined. The factor loadings are shown in Appendix 3.

The correlations among the factors are moderate as shown in Table 9.Two pairs of factors, Intellectual Climate with Infrastructure and Skill Development with Goals and Expectations, have a correlation greater than 0.8.

Overall, the EFA and CFA model results indicate the current six PREQ latent scales work well.

Table 9: Correlations among latent scales in CFA model

Scale	Supervision	Intellectual Climate	Skill Development	Infrastructure	Thesis Examination
Intellectual Climate	0.657	-	-	-	-
Skill Development	0.682	0.637	-	-	-
Infrastructure	0.626	0.809	0.693	-	-
Thesis Examination	0.554	0.500	0.605	0.531	-
Goals and Expectations	0.734	0.641	0.830	0.727	0.692

Are there any redundant items?

Findings from the CFA model indicate that some items are highly correlated. Items with a correlation greater than 0.75 are listed in Table 10. Although there is high level of correlation among some pairs of items, the item pairs that show relatively high correlation do seem to be asking different aspects of the construct.

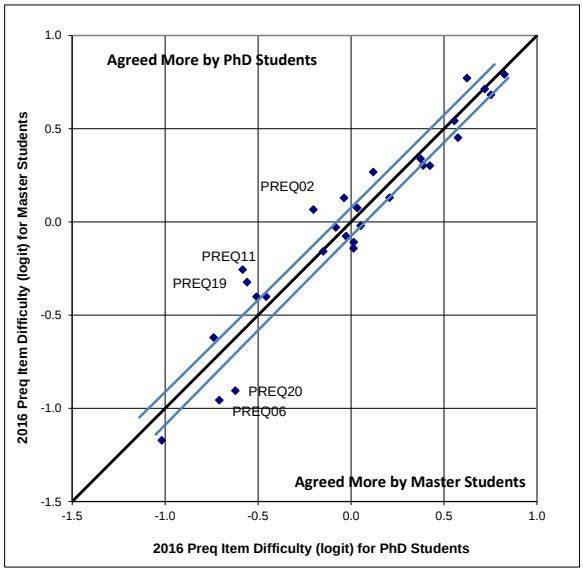
Table 10: Pairs of Items with correlations greater than 0.75

Scale	Item number		Item	Correlation
Supervision		PREQ01	Supervision was available when I needed it	-
	PREQ07		My supervisor(s) made a real effort to understand difficulties I faced	0.818
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.822
		PREQ07	My supervisor(s) made a real effort to understand difficulties I faced	-
	PREQ13		My supervisor(s) provided additional information relevant to my topic	0.786
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.863
		PREQ13	My supervisor(s) provided additional information relevant to my topic	-
	PREQ17		I was given good guidance in topic selection and refinement	0.759
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.755
Thesis Examination		PREQ02	The thesis examination process was fair	-
	PREQ15		I was satisfied with the thesis examination process	0.856
Goals and Expectations		PREQ04	I developed an understanding of the standard of work expected	-
	PREQ11		I understood the required standard for the thesis	0.755
		PREQ11	I understood the required standard for the thesis	-
	PREQ19		I understood the requirements of thesis examination	0.822
Skill Development		PREQ06	My research further developed my problem solving skills	-
	PREQ14		My research sharpened my analytical skills	0.774

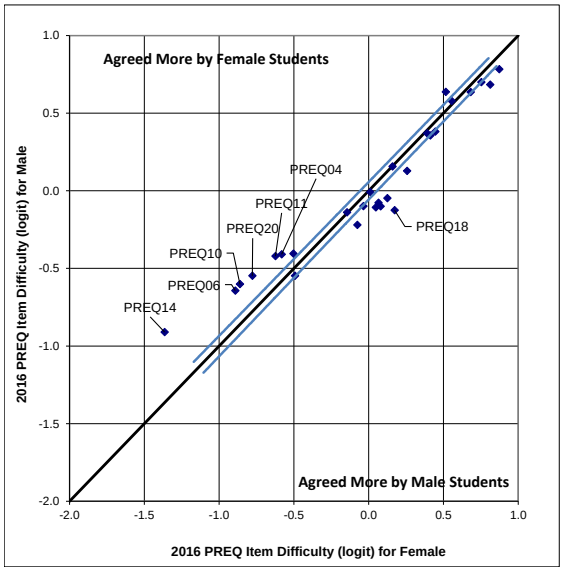
DIF Analysis by Subgroups

In order to detect potential item bias by subgroup, DIF analyses were conducted using ACER ConQuest. The results are shown in Figure 6. A summary of items which may show DIF is given in Table 11. The DIF analysis were carried out for various contextual variables, some items may fall outside the confidence band but the relative differences between groups for most items listed in Table 11 are in fact very small. The confidence band is very narrow due to the large sample size. These items may not display DIF, results need to be treated very cautiously.

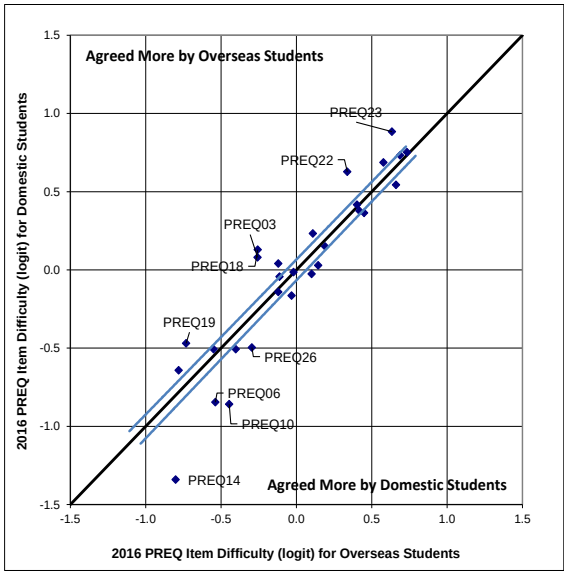
Level DIF



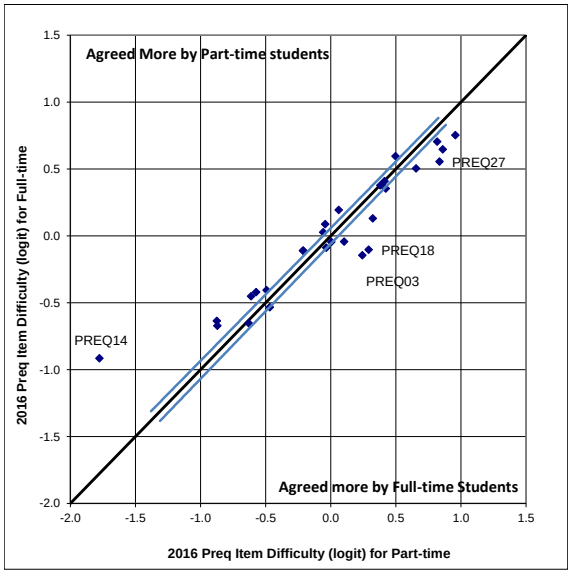
Gender DIF



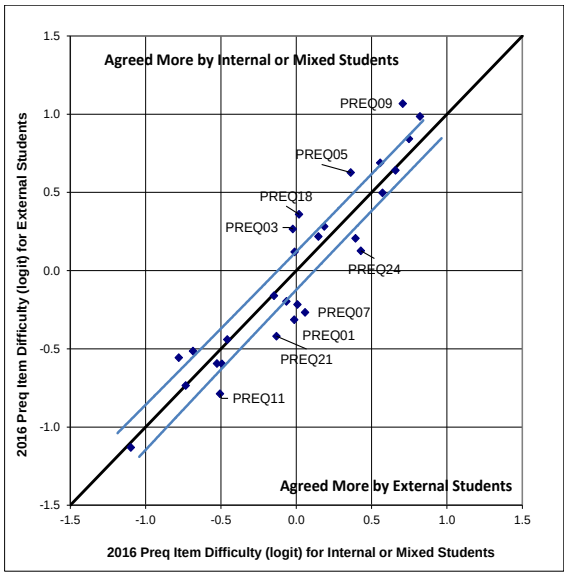
Citizenship



Attend (Full-time students vs part-time)



Internal or mixed-mode vs external



Disability vs no disability

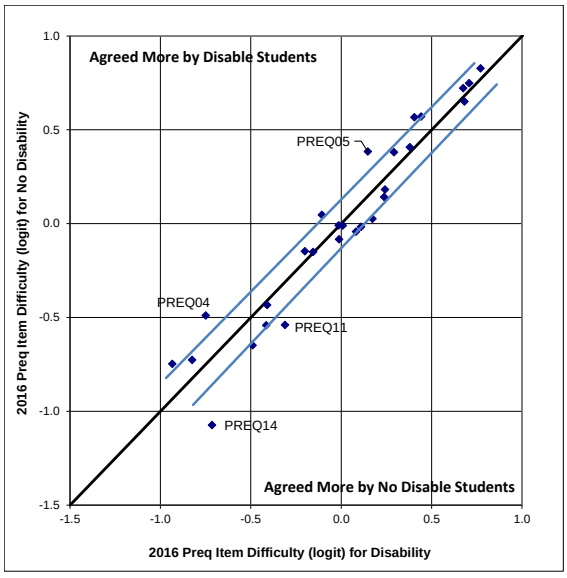


Figure 6: Differential Item Functioning by demographic and contextual groups

Table 11: Items falling outside confidence bands of DIF analyses

Item	Description	Relatively Agreed more by
Doctorate versus Masters		
PREQ02	The thesis examination process was fair (TES)	Doctorate
PREQ06	My research further developed my problem solving skills (SDS)	Master
PREQ11	I understood the required standard for the thesis (GES)	Doctorate
PREQ19	I understood the requirements of thesis examination (GES)	Doctorate
PREQ20	Doing my research helped me to develop my ability to plan my own work (SDS)	Master
Female vs Male		
PREQ04	I developed an understanding of the standard of work expected (GES)	Female
PREQ06	My research further developed my problem solving skills (SDS)	Female

Item	Description	Relatively Agreed more by
PREQ10	I learned to develop my ideas and present them in my written work (SDS)	Female
PREQ11	I understood the required standard for the thesis (GES)	Female
PREQ14	My research sharpened my analytical skills (SDS)	Female
PREQ18	I had good access to computing facilities and services (IS)	Male
PREQ20	Doing my research helped me to develop my ability to plan my own work (SDS)	Female
International students vs Domestic students		
PREQ03	I had access to a suitable working space (IS)	International
PREQ06	My research further developed my problem solving skills (SDS)	Domestic
PREQ10	I learned to develop my ideas and present them in my written work (SDS)	Domestic
PREQ14	My research sharpened my analytical skills (SDS)	Domestic
PREQ18	I had good access to computing facilities and services (IS)	International
PREQ19	I understood the requirements of thesis examination (GES)	International
PREQ22	A good seminar program for postgraduate students was provided (ICS)	International
PREQ23	The research ambience in the department or faculty stimulated my work (ICS)	International
PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems (SDS)	Domestic
Part-time vs Full-time Students		
PREQ03	I had access to a suitable working space (IS)	Full-time
PREQ14	My research sharpened my analytical skills (SDS)	Part-time
PREQ18	I had good access to computing facilities and services (IS)	Full-time
PREQ27	There was appropriate financial support for research activities (IS)	Full-time
Internal or Mixed Mode vs External		
PREQ01	Supervision was available when I needed it (SC)	External
PREQ03	I had access to a suitable working space (IS)	Internal or mixed mode
PREQ05	The department provided opportunities for social contact with other postgraduate students (ICS)	Internal or mixed mode
PREQ07	My supervisor(s) made a real effort to understand difficulties I faced (SC)	External
PREQ09	I was integrated into the department's community (ICS)	Internal or mixed mode
PREQ11	I understood the required standard for the thesis (GES)	External
PREQ18	I had good access to computing facilities and services (IS)	Internal or mixed mode
PREQ21	My supervisor(s) provided helpful feedback on my progress (SC)	External
PREQ24	I received good guidance in my literature search (SC)	External
Disabled vs Not disabled		
PREQ04	I developed an understanding of the standard of work expected (GES)	Disabled
PREQ05	The department provided opportunities for social contact with other postgraduate students (ICS)	Disabled
PREQ11	I understood the required standard for the thesis (GES)	Not Disabled
PREQ14	My research sharpened my analytical skills (SDS)	Not Disabled

Results from SEM modelling

The 2016 data (excluding item PREQ28) was fitted to a SEM model using MPlus (as illustrated in Figure 7) regressing the factors on to the background variables. The mode variable was coded into two dummy variables with internal (on-campus) students as a reference group, one dummy variable for mixed-mode students and the other dummy variables for external students. All other background variables have only two

categories coded using dummy variables. Again, item 28 was excluded from the modelling as it has a very small variance.

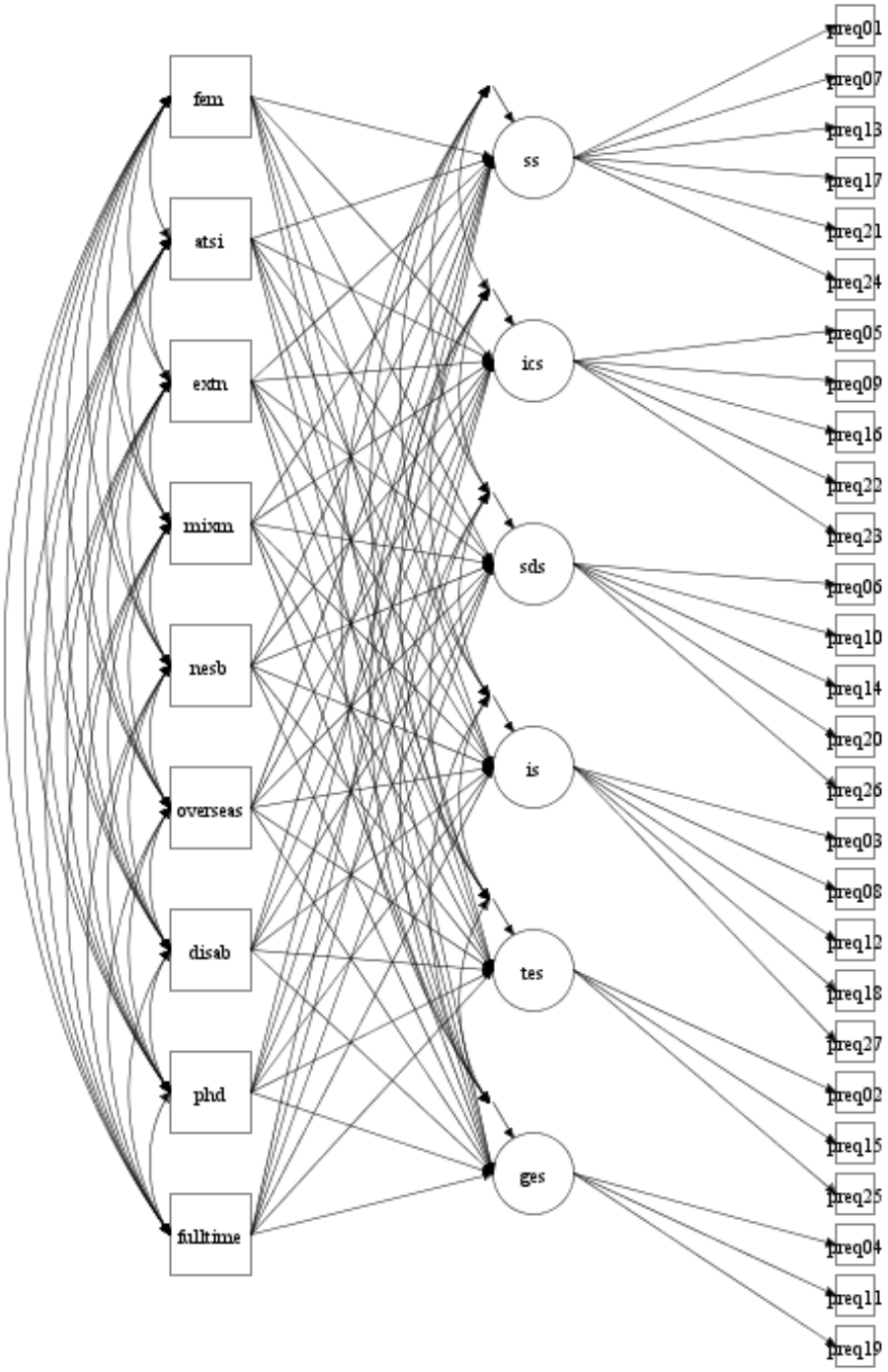


Figure 7: SEM Model

The χ^2 test yields a value of 8088 (df=499), which has a corresponding p-value of .0000. Again due to the large sample size the χ^2 is high. The RMSEA is 0.054, which is within the 90% C.I., CFI and TLI are 0.968 and 0.962, respectively. The approximate fit is acceptable.

Table 12 lists the factors/scales that show a significant difference between categories within a subgroup. The differences are all very small. The largest effect found is the Goals and Expectations Scale favouring PhD students by 0.271 compared with master students.

Table 12: Significant Effect from the SEM Modelling

Reference Group	Estimate	S.E.	Est./S.E.	P-value
Supervision				
Female students	-0.088	0.027	-3.224	0.001
External students	0.176	0.063	2.777	0.005
International students	0.131	0.037	3.506	0.000
Disabled students	0.152	0.069	2.219	0.026
Intellectual Climate				
Female students	-0.066	0.025	-2.602	0.009
External students	-0.201	0.060	-3.374	0.001
NESB	0.123	0.037	3.329	0.001
International students	0.237	0.036	6.680	0.000
Full-time students	0.088	0.028	3.101	0.002
Skill Development				
Doctorate students	0.213	0.038	5.529	0.000
Infrastructure				
Female students	-0.090	0.026	-3.505	0.000
NESB	0.150	0.037	4.092	0.000
International students	0.223	0.035	6.376	0.000
Disabled students	0.150	0.064	2.344	0.019
Doctorate students	0.149	0.035	4.212	0.000
Full-time students	0.220	0.028	7.778	0.000
Thesis Examination				
International students	0.134	0.039	3.412	0.001
Disabled students	0.186	0.076	2.455	0.014
Doctorate students	0.175	0.040	4.378	0.000
Goals and Expectations				
International students	0.144	0.039	3.739	0.000
Doctorate students	0.271	0.038	7.199	0.000

Appendix 1: Cohort Item Summaries

Table 13: 2014 cohort item summary

Item Label	Item Estimate (delta centred)	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ01	-0.0983	0.019	83.2	0.66	0.69	0.97	0.95	1.05	-1.10	5195
PREQ02	-0.2477	0.021	84.3	0.58	0.61	1.14	0.94	1.06	4.60	5185
PREQ03	-0.0179	0.020	81.1	0.56	0.60	1.23	0.95	1.05	8.00	4893
PREQ04	-0.5622	0.024	85.9	0.68	0.70	0.89	0.94	1.06	-4.00	5171
PREQ05	0.2622	0.019	74.3	0.59	0.62	1.18	0.96	1.04	7.60	5017
PREQ06	-0.7875	0.026	89.0	0.61	0.64	0.96	0.94	1.06	-1.20	5164
PREQ07	0.0814	0.018	81.1	0.68	0.72	0.94	0.95	1.05	-2.30	5146
PREQ08	0.1988	0.019	75.9	0.66	0.69	1.00	0.95	1.05	0.00	5061
PREQ09	0.6708	0.018	67.8	0.62	0.66	1.12	0.96	1.04	5.60	4971
PREQ10	-0.6835	0.026	87.6	0.65	0.68	0.90	0.94	1.06	-3.40	5154
PREQ11	-0.5822	0.024	86.7	0.68	0.70	0.89	0.94	1.06	-3.80	5159
PREQ12	-0.0613	0.022	79.1	0.65	0.68	0.99	0.95	1.05	-0.50	4835
PREQ13	0.1056	0.019	79.7	0.70	0.73	0.90	0.95	1.05	-4.00	5142
PREQ14	-0.8688	0.027	89.8	0.63	0.66	0.91	0.94	1.06	-3.00	5148
PREQ15	0.1156	0.019	79.6	0.57	0.61	1.22	0.95	1.05	8.10	5176
PREQ16	0.6745	0.018	68.1	0.67	0.70	1.01	0.96	1.04	0.30	5055
PREQ17	0.3663	0.018	74.2	0.72	0.75	0.87	0.96	1.04	-6.00	5098
PREQ18	0.0560	0.020	78.8	0.59	0.62	1.16	0.95	1.05	6.20	4923
PREQ19	-0.5302	0.024	85.7	0.68	0.70	0.87	0.94	1.06	-4.50	5156
PREQ20	-0.6000	0.024	86.6	0.61	0.64	0.99	0.94	1.06	-0.30	5139
PREQ21	-0.0021	0.019	82.4	0.71	0.74	0.86	0.95	1.05	-5.30	5155
PREQ22	0.4703	0.018	71.2	0.59	0.63	1.19	0.96	1.04	8.10	4994

Item Label	Item Estimate (delta centred)	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ23	0.7745	0.018	66.4	0.68	0.71	0.99	0.96	1.04	-0.40	4940
PREQ24	0.4426	0.018	72.2	0.70	0.73	0.92	0.96	1.04	-3.70	5134
PREQ25	0.6246	0.016	71.9	0.45	0.51	1.65	0.96	1.04	25.40	5170
PREQ26	-0.4142	0.023	83.7	0.62	0.65	0.99	0.95	1.05	-0.20	5123
PREQ27	0.6189	0.017	69.5	0.49	0.54	1.47	0.96	1.04	19.60	4971
PREQ28	-0.0060	0.020	80.8	0.80	0.82	0.67	0.95	1.05	-13.90	5184

Table 14: 2015 cohort item summary

Item Label	Item Estimate (delta centred)	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ01	-0.1123	0.020	83.8	0.67	0.70	0.97	0.94	1.06	-1.00	4984
PREQ02	-0.2202	0.022	84.6	0.58	0.62	1.18	0.94	1.06	5.60	4976
PREQ03	-0.0060	0.020	81.7	0.57	0.61	1.27	0.95	1.05	9.00	4723
PREQ04	-0.5382	0.025	86.4	0.70	0.72	0.86	0.94	1.06	-4.80	4967
PREQ05	0.2173	0.020	75.1	0.59	0.63	1.19	0.95	1.05	7.90	4832
PREQ06	-0.8432	0.027	89.1	0.63	0.65	0.95	0.94	1.06	-1.60	4939
PREQ07	0.0836	0.019	81.4	0.69	0.72	0.97	0.95	1.05	-1.20	4940
PREQ08	0.1537	0.020	76.0	0.68	0.70	1.00	0.95	1.05	-0.20	4862
PREQ09	0.6829	0.018	68.4	0.64	0.68	1.11	0.96	1.04	5.20	4786
PREQ10	-0.7971	0.027	88.1	0.69	0.71	0.86	0.94	1.06	-4.90	4953
PREQ11	-0.5328	0.025	86.8	0.70	0.72	0.87	0.94	1.06	-4.40	4964
PREQ12	-0.0869	0.023	79.8	0.69	0.71	0.94	0.95	1.05	-2.50	4637
PREQ13	0.0814	0.020	80.2	0.71	0.74	0.91	0.95	1.05	-3.40	4941
PREQ14	-0.8442	0.028	90.0	0.66	0.68	0.89	0.94	1.06	-3.40	4940
PREQ15	0.1097	0.019	80.4	0.56	0.60	1.31	0.95	1.05	10.60	4959

Item Label	Item Estimate (delta centred)	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ16	0.6799	0.018	68.7	0.67	0.70	1.03	0.96	1.04	1.60	4854
PREQ17	0.3668	0.019	74.6	0.73	0.76	0.88	0.95	1.05	-5.20	4905
PREQ18	0.0093	0.021	79.2	0.63	0.66	1.11	0.95	1.05	4.20	4740
PREQ19	-0.4544	0.025	85.3	0.68	0.70	0.91	0.94	1.06	-2.90	4941
PREQ20	-0.5822	0.025	86.9	0.65	0.67	0.96	0.94	1.06	-1.30	4922
PREQ21	-0.0345	0.020	83.1	0.71	0.74	0.89	0.95	1.05	-4.00	4951
PREQ22	0.5374	0.019	70.8	0.60	0.63	1.21	0.96	1.04	8.80	4803
PREQ23	0.8026	0.018	66.7	0.69	0.72	1.00	0.96	1.04	-0.20	4753
PREQ24	0.4530	0.019	72.8	0.72	0.75	0.91	0.96	1.04	-4.30	4930
PREQ25	0.6483	0.017	72.5	0.45	0.51	1.73	0.96	1.04	26.60	4949
PREQ26	-0.4254	0.024	84.2	0.63	0.66	1.01	0.95	1.05	0.30	4919
PREQ27	0.6531	0.018	70.3	0.53	0.58	1.41	0.96	1.04	16.70	4770
PREQ28	-0.0015	0.021	81.3	0.81	0.83	0.68	0.94	1.06	-13.00	4977

Table 15: 2016 cohort item summary

Item Label	Item Estimate	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ01	-0.0273	0.019	78.8	0.63	0.67	1.00	0.95	1.05	0.10	5229
PREQ02	-0.1508	0.021	79.8	0.56	0.59	1.13	0.95	1.05	4.80	5221
PREQ03	-0.0052	0.019	77.1	0.55	0.59	1.20	0.95	1.05	7.90	5217
PREQ04	-0.4920	0.023	81.0	0.68	0.70	0.84	0.95	1.05	-6.20	5221
PREQ05	0.3744	0.018	70.7	0.58	0.62	1.15	0.96	1.04	6.90	5223
PREQ06	-0.7609	0.025	84.1	0.61	0.64	0.92	0.95	1.05	-2.90	5219
PREQ07	0.0498	0.018	78.7	0.63	0.67	1.02	0.95	1.05	1.00	5219
PREQ08	0.1989	0.020	72.5	0.64	0.67	0.98	0.96	1.04	-0.80	5209
PREQ09	0.7238	0.017	64.4	0.64	0.68	1.08	0.96	1.04	3.80	5202

Item Label	Item Estimate	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ10	-0.7420	0.025	83.6	0.64	0.67	0.88	0.95	1.05	-4.70	5208
PREQ11	-0.5160	0.023	82.3	0.65	0.67	0.90	0.95	1.05	-3.60	5215
PREQ12	-0.0015	0.021	74.9	0.63	0.66	0.99	0.95	1.05	-0.50	5196
PREQ13	-0.0051	0.019	77.7	0.66	0.69	0.94	0.95	1.05	-2.40	5212
PREQ14	-1.1295	0.027	87.2	0.58	0.61	0.94	0.95	1.05	-2.40	5203
PREQ15	0.1502	0.019	76.2	0.53	0.57	1.26	0.95	1.05	9.80	5210
PREQ16	0.7486	0.017	64.6	0.67	0.71	1.00	0.96	1.04	0.10	5208
PREQ17	0.3814	0.018	71.5	0.70	0.74	0.89	0.96	1.04	-5.20	5209
PREQ18	0.0425	0.020	75.4	0.57	0.60	1.14	0.96	1.04	5.70	5200
PREQ19	-0.5217	0.023	81.7	0.64	0.66	0.91	0.95	1.05	-3.30	5209
PREQ20	-0.6636	0.024	83.1	0.59	0.62	0.98	0.95	1.05	-0.90	5209
PREQ21	-0.1442	0.019	81.1	0.66	0.70	0.91	0.95	1.05	-3.50	5213
PREQ22	0.5598	0.018	67.5	0.57	0.61	1.19	0.96	1.04	8.90	5218
PREQ23	0.8262	0.018	62.6	0.68	0.71	1.00	0.96	1.04	-0.10	5221
PREQ24	0.4117	0.018	69.8	0.69	0.72	0.92	0.96	1.04	-4.10	5217
PREQ25	0.5668	0.016	69.9	0.42	0.48	1.69	0.96	1.04	27.00	5221
PREQ26	-0.4585	0.023	80.6	0.57	0.60	1.02	0.95	1.05	0.80	5216
PREQ27	0.6547	0.017	66.9	0.49	0.54	1.45	0.96	1.04	19.50	5217
PREQ28	-0.0703	0.020	78.4	0.77	0.80	0.70	0.95	1.05	-13.00	5222

Appendix 2: EFA Results

Table 16: Loadings for seven-factor Exploratory Model

Dimension		Item	1	2	3	4	5	6	7
1	Supervision	PREQ01	0.876	-0.039	-0.046	0.107	0.073	-0.009	0.119
		PREQ07	0.959	0.012	0.038	-0.019	-0.015	-0.049	0.082
		PREQ13	0.810	0.027	0.068	-0.001	-0.067	-0.014	-0.148
		PREQ17	0.621	0.153	0.022	-0.026	0.012	0.050	-0.229
		PREQ21	0.936	-0.070	0.040	-0.023	0.012	0.014	-0.055
		PREQ24	0.584	0.206	-0.003	-0.042	-0.050	0.059	-0.318
2	Intellectual Climate	PREQ05	-0.026	0.782	0.071	0.045	0.012	0.000	0.154
		PREQ09	-0.006	0.836	-0.013	0.122	-0.043	0.018	0.123
		PREQ16	0.078	0.783	0.003	-0.022	0.071	-0.021	-0.008
		PREQ22	-0.096	0.640	0.010	0.043	0.014	0.060	-0.213
		PREQ23	0.025	0.767	-0.032	0.037	-0.021	-0.010	-0.210
3	Skill Development	PREQ06	0.014	0.101	0.909	0.025	-0.025	-0.074	0.141
		PREQ10	0.076	0.118	0.596	-0.005	-0.029	0.223	0.044
		PREQ14	0.132	-0.030	0.871	-0.045	-0.028	-0.010	0.031
		PREQ20	-0.028	-0.063	0.747	0.102	0.002	0.052	-0.116
		PREQ26	-0.041	-0.035	0.768	0.009	0.090	-0.048	-0.160
4	Infrastructure	PREQ03	0.001	0.068	0.013	0.777	0.073	-0.022	0.226
		PREQ08	0.157	0.129	-0.006	0.662	-0.057	-0.029	-0.004
		PREQ12	-0.007	0.121	0.076	0.646	-0.069	0.102	-0.001
		PREQ18	-0.075	0.048	-0.016	0.883	-0.039	-0.015	-0.018
		PREQ27	0.011	0.184	0.069	0.413	0.066	-0.125	-0.107
5	Thesis Examination	PREQ02	0.114	-0.004	0.037	0.041	0.809	0.020	0.147
		PREQ15	-0.042	0.004	-0.029	-0.037	1.048	0.010	0.021
		PREQ25	-0.021	0.034	0.048	-0.030	0.695	-0.051	-0.108
6	Goals and Expectations	PREQ04	0.228	0.059	0.205	0.160	0.099	0.338	0.134
		PREQ11	0.044	0.045	0.145	-0.022	-0.015	0.853	-0.016
		PREQ19	0.023	-0.052	0.090	0.161	0.206	0.546	-0.093
7	Overall Satisfaction	PREQ28	0.370	0.245	0.159	0.134	0.152	-0.064	-0.087

Appendix 3: CFA Results

Table 17: Unstandardised and standardised loadings for six-factor Confirmatory Model

Dimension		Item	Unstandardised		Standardised	
			Estimate	Standard Error	Estimate	Standard Error
1	Supervision	PREQ01	0.933	0.006	0.857	0.005
		PREQ07	0.961	0.005	0.883	0.004
		PREQ13	0.95	0.005	0.873	0.005
		PREQ17	0.953	0.006	0.875	0.005
		PREQ21	1.000	-	0.919	0.004
		PREQ24	0.935	0.006	0.860	0.005
2	Intellectual Climate	PREQ05	0.910	0.010	0.777	0.007
		PREQ09	0.975	0.009	0.833	0.006
		PREQ16	0.999	0.009	0.853	0.006
		PREQ22	0.878	0.010	0.750	0.008
		PREQ23	1.000	-	0.854	0.005
3	Skill Development	PREQ06	0.959	0.008	0.848	0.006
		PREQ10	1.000	-	0.884	0.006
		PREQ14	0.962	0.008	0.851	0.006
		PREQ20	0.941	0.009	0.832	0.006
		PREQ26	0.888	0.009	0.785	0.007
4	Infrastructure	PREQ03	0.906	0.011	0.753	0.008
		PREQ08	0.995	0.010	0.827	0.006
		PREQ12	1.000	-	0.831	0.006
		PREQ18	0.941	0.011	0.782	0.007
		PREQ27	0.771	0.013	0.641	0.010
5	Thesis Examination	PREQ02	1.000	-	0.937	0.005
		PREQ15	0.974	0.009	0.912	0.005
		PREQ25	0.783	0.011	0.734	0.009
6	Goals and Expectations	PREQ04	0.991	0.007	0.882	0.005
		PREQ11	1.000	-	0.890	0.004
		PREQ19	0.975	0.007	0.868	0.005

Appendix C: Pilot PREQ instrument development

The pilot PREQ instrument development was underpinned by the Researcher Development Framework (Vitae, 2011) as well as by findings from the ACOLA Review (McGagh et al, 2016) about the desirable skills and qualities that HDR graduates should have developed through their candidacy, and the learning outcomes for HDR graduates listed in the Australian Qualification Framework (AQF). Table 18 provides a mapping of items from the current Postgraduate Research Experience Questionnaire (PREQ), the Graduate Outcomes Survey (GOS), and the UK Postgraduate Research Experience Survey (PRES) onto the Researcher Development Framework.

Table 18: Mapping of survey items onto Researcher Development Framework

Domain	Code	Sub-domain	#	Descriptors	Existing Items
Knowledge and intellectual abilities *The knowledge, intellectual abilities and techniques to do research*	A1	Knowledge base	1	Subject knowledge	Broad general knowledge (GOS)
			2	Research methods: theoretical knowledge	Ability to develop relevant knowledge (GOS)
			3	Research methods: practical application	Ability to develop relevant skills (GOS)
					Ability to apply skills in different contexts (GOS)
					My skills in applying appropriate research methodologies, tools and techniques have developed during my programme (PRES)
			4	Information seeking	-
			5	Information literacy and management	-
			6	Languages	-
			7	Academic literacy and numeracy	Numeracy skills (GOS)
	A2	Cognitive abilities	1	Analysing	My research sharpened my analytical skills (PREQ)
					My skills in critically analysing and evaluating findings and results have developed during my programme (PRES)
			2	Synthesising	Ability to integrate knowledge (GOS)
			3	Critical thinking	Ability to think independently about problems (GOS)
			4	Evaluating	My skills in critically analysing and evaluating findings and results have developed during my programme (PRES)
			5	Problem solving	Ability to solve problems (GOS)
					My research further developed my problem solving skills (PREQ)
	A3	Creativity	1	Inquiring mind	Understanding of different points of view (GOS)
			2	Intellectual insight	-
			3	Innovation	Ability to develop innovative ideas (GOS)

Domain	Code	Sub-domain	#	Descriptors	Existing Items
					My confidence to be creative or innovative has developed during my programme (PRES)
			4	Argument construction	-
			5	Intellectual risk	-
Personal effectiveness *The personal qualities and approach to be an effective researcher.*	B1	Personal qualities	1	Enthusiasm	-
			2	Perseverance	-
			3	Integrity	-
			4	Self-confidence	As a result of my research, I feel confident about tackling unfamiliar problems (PREQ)
					My confidence to be creative or innovative has developed during my programme (PRES)
			5	Self-reflection	-
			6	Responsibility	Capacity to work independently (GOS)
	B2	Self-management	1	Preparation and prioritisation	-
			2	Commitment to research	-
			3	Time management	Doing my research helped me to develop my ability to plan my own work (PREQ)
			4	Responsiveness to change	Ability to adapt knowledge in different contexts (GOS)
			5	Work-life balance	-
	B3	Professional and career development	1	Career management	I have increasingly managed my own professional development during my programme (PRES)
			2	Continuing professional development	-
			3	Responsiveness to opportunities	-
			4	Networking	I have developed contacts or professional networks during my programme (PRES)
			5	Reputation and esteem	-
Research governance and organisation *The knowledge of the standards, requirements and professionalism to do research.*	C1	Professional conduct	1	Health and safety	-
			2	Ethics, principles and sustainability	My understanding of 'research integrity' (e.g. rigour, ethics, transparency, attributing the contribution of others) has developed during my programme (PRES)
			3	Legal requirements	-
			4	IPR and copyright	-
			5	Respect and confidentiality	-
			6	Attribution and co-authorship	-

Domain	Code	Sub-domain	#	Descriptors	Existing Items
			7	Appropriate practice	-
	C2	Research management	1	Research strategy	-
			2	Project planning and delivery	My ability to manage projects has developed during my programme (PRES)
			3	Risk management	-
	C3	Finance, funding and resources	1	Income and funding generation	-
			2	Financial management	-
			3	Infrastructure and resources	-
Engagement, influence and impact *The knowledge and skills to work with others and ensure the wider impact of research.*	D1	Working with others	1	Collegiality	Getting on well with others in the workplace (GOS)
			2	Team working	Working well in a team (GOS)
			3	People management	-
			4	Supervision	-
			5	Mentoring	-
			6	Influence and leadership	-
			7	Collaboration	Working collaboratively with colleagues to complete tasks (GOS)
			8	Equality and diversity	Ability to interact with co-workers from different or multicultural backgrounds (GOS)
	D2	Communication and dissemination	1	Communication methods	Oral communication skills (GOS)
					Written communication skills (GOS
					I learned to develop my ideas and present them in my written work (PREQ)
					My ability to communicate information effectively to diverse audiences has developed during my programme (PRES)
					-
			2	Communication media	-
			3	Publication	-
	D3	Engagement and impact	1	Teaching	-
			2	Public engagement	-
			3	Enterprise	Ability to identify new opportunities (GOS)
			4	Policy	-
			5	Society and culture	-
			6	Global citizenship	-

The ACOLA Review (McGagh et al, 2016) provided a summary of the desirable skills and qualities that HDR graduates should hold, including many employability and generic skills. These key competencies include:

- deep disciplinary knowledge and skills;
- workplace experience and awareness;
- problem solving skills;
- critical thinking skills;
- the ability to apply research skills flexibly and in a range of contexts;
- the ability to communicate to a diverse range of audiences;
- interpersonal skills, including the ability to collaborate and work in teams;
- leadership skills; and
- a commitment to lifelong learning.

The ACOLA Review also provided a summary of skills that HDR graduates should hold that are specific to academia and to industry settings. The competencies relevant for academia included:

- academic teaching experience; and
- the development of research profile.

The competencies relevant for industry included:

- the ability to solve real-world problems in industry settings;
- the ability to understand industry needs and drivers; and
- high-level communication and interpersonal skills.

The ACOLA Review also provided suggestions for how HDR candidates can develop stronger engagement with industry. These included providing greater opportunities for industry-relevant research training, the provision of funding to support HDR candidates to work on an industry-defined research problem, undertake research training in industry settings, or have an industry supervisor, and promoting industry placements.

The AQF provides a description of the learning outcomes that HDR graduates should have gained after completing a Masters or Doctoral degree. Table 19 provides a summary of these learning outcomes.

Table 19: Summary of AQF learning outcomes for HDR graduates

AQF level	Learning outcomes
Masters Degree *Level 9*	Demonstrate mastery of theoretical knowledge and reflect critically on theory and its application.
	Have the cognitive, technical and creative skills needed to investigate, analyse and synthesise complex information, problems, concepts and theories, and to apply established theories to different bodies of knowledge or practice.
	Have the cognitive, technical and creative skills needed to understand ideas and concepts at an abstract level.
	Have the cognitive and technical skills to design, use and evaluate research and research methods.
	Have the communication and technical skills needed to present a coherent and sustained argument and to disseminate research results to both specialist and non-specialist audiences.
	Have the technical and communication skills needed to design, evaluate, implement, analyse, theorise and disseminate research that makes a contribution to knowledge.
Doctoral Degree *Level 10*	Have the cognitive skills needed to demonstrate expert understanding of theoretical knowledge and to reflect critically on that theory and practice.
	Have the cognitive skills and intellectual independence to think critically, evaluate existing knowledge and ideas, undertake systemic investigation and reflect on theory and practice to generate original knowledge.
	Have expert technical and creative skills relevant to their field of work or learning.
	Have the communication skills needed to explain and critique theoretical propositions, methodologies and conclusions.
	Have the communication skills needed to cogently present a complex investigation of originality or original research, to examine research against international standards and to communicate research to both expert and non-expert audiences.
	Have the expert skills to design, implement, analyse, theorise and communicate research that makes a significant and original contribution to knowledge and/or professional practice.

Source: Australian Qualification Framework (Australian Qualifications Framework Council, 2013).

Appendix D: Pilot PREQ instrument

Please tell us about your postgraduate research experience.

If you have had more than one supervisor or have studied in more than one department or faculty, please respond to the questions below in relation to your most recent supervision experience, whether by one or more supervisors.

Please interpret 'thesis' and other research-related terms in the context of your own field of education.

Please indicate the extent to which you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with each of these statements.

Code	Item	Response options
preq01	Supervision was available when I needed it	Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree
preq02	The thesis examination process was fair	
preq03	I had access to a suitable working space	
preq04	I developed an understanding of the standard of work expected	
preqp01	**I am confident that I can apply my skills outside the university sector**	
preq05	The department provided opportunities for social contact with other postgraduate students	
preqp02	**I improved my ability to design and implement projects effectively**	
preq07	My supervisor(s) made a real effort to understand difficulties I faced	
preq08	I had good access to the technical support I needed	
preq09	I was integrated into the department's community	
preqp03	**I improved my ability to communicate information effectively to diverse audiences**	
preq11	I understood the required standard for the thesis	
preqp04	**I had opportunities to develop professional connections outside the university sector**	
preq12	I was able to organise good access to necessary equipment	
preq13	My supervisor(s) provided additional information relevant to my topic	
preqp05	**I developed my skills in critical analysis and evaluation**	
preq15	I was satisfied with the thesis examination process	
preq16	The department provided opportunities for me to become involved in the broader research culture	
preq17	I was given good guidance in topic selection and refinement	
preq18	I had good access to computing facilities and services	
preqp06	**I had opportunities to work on research problems with real-world or industry applications**	
preq19	I understood the requirements of thesis examination	
preqp07	**I developed my understanding of 'research integrity' (e.g. rigour, ethics, transparency, attributing the contribution of others)**	
preqp08	**I improved my ability to plan and manage my time effectively**	
preq21	My supervisor(s) provided helpful feedback on my progress	
preq22	A good seminar program for postgraduate students was provided	
preq23	The research ambience in the department or faculty stimulated my work	
preq24	I received good guidance in my literature search	
preqp09	**I gained confidence in leading and influencing others**	
preq25	The examination of my thesis was completed in a reasonable time	
preq26	As a result of my research, I feel confident about tackling unfamiliar problems	

preq27	There was appropriate financial support for research activities	
preq28	Overall, I was satisfied with the quality of my higher degree research experience	

And now some specifics about your postgraduate research.

Code	Item	Response options
Intl1	Did you undertake any overseas study during your postgraduate research (e.g. student exchange or study abroad)?	Yes No Not applicable
Pgreslink1	Did your <COURSE> include an internship component?	Yes No Don't know
Pgreslink4	**Did you participate in other types of work-integrated learning (e.g. placements, practicums, consultancies, industry research projects) as part of your <COURSE>?**	**Yes** **No** **Don't know**
Pgreslink2	Did your <COURSE> include training in…. IP awareness? Business management? Entrepreneurship?	Yes No Don't know
Pgreslink3	Was your <COURSE> jointly supervised or co-funded by an industry partner? Yes it was jointly supervised Yes it was co-funded No Don't know	Selected Not selected

Appendix E: Psychometric analyses of pilot PREQ

Overview

The analyses presented here are based on a data file provided by the Social Research Centre to ACER in late August 2017 and focus on the results from the PREQ pilot. The analyses also include some comparisons with previous PREQ collections. The data file included responses from graduates who participated in the 2017 GOS and were from one of the 20 pilot universities who chose to participate in the PREQ pilot. The file included results from both the pilot PREQ instrument and the current PREQ instrument.

The data file included 1,941 records, of which 1,751 cases included valid responses. The file included 630 cases who responded to the pilot version of the PREQ, and the remainder responded to the current version of the instrument. There were 54 cases whose responses were missing from all of the pilot items, and so they were excluded from the analyses presented below.

Descriptive analyses

Table 20 shows the breakdowns of students by student background characteristics across four administrations of the PREQ. This shows that in 2014 and 2015, around 51.5% of respondents were women. In 2016, the number of female respondents increased slightly to 52.8%, and in the pilot PREQ, there were more female respondents (53.8%) than male respondents.

There were very few Aboriginal or Torres Strait Islander graduates (<0.4%) or disabled graduates (<3.5%) in the data in each of the four administrations. Only two Aboriginal or Torres Strait Islander graduates participated the pilot PREQ in 2017. As a result, comparisons of Indigenous and non-Indigenous results have not been included in this report. In 2014 and 2015, around 37 per cent of respondents were non-English speakers, while in 2016 and 2017 the percentage of non-English speakers dropped to around a quarter of all respondents.

In 2014 and 2015, around three-quarters of respondents had studied on-campus, and around 13 per cent were studying externally and 10 per cent were studying via mixed mode. In 2016, the proportion of respondents who had studied on-campus increased to 93 per cent, and only five per cent were studying externally and two per cent via mixed mode. There was a further increase in 2017, with the proportion of respondents who had studied on-campus increasing to 96 per cent. In 2014 and 2015, around three-quarters of respondents had studying mostly full-time. In 2016 and 2017 this proportion had decreased to around two-thirds of respondents.

There were not many differences in the proportion of graduates who were domestic and international students in the 2014, 2015 and 2016 PREQ administrations. In 2017 there was a higher proportion of international students in the data, representing around a third of all responses.

Across all four administrations of the PREQ, the majority of respondents had completed a PhD. At least 84 per cent of respondents having completed a PhD in each administration.

Table 20: Student background characteristics as percentage

Group	Category	2014	2015	2016	2017	Pilot
Total Students		5,232	5,017	5,235	1,751	630
Gender	**Female**	51.5%	51.4%	52.8%	50.7%	53.8%
	Male	48.5%	48.6%	47.0%	49.3%	46.2%
	Unknown	-	0.1%	0.2%	**-**	**-**
Indigenous status	**Not Indigenous**	98.1%	97.7%	99.4%	99.8%	99.7%
	Aboriginal	0.3%	0.2%	0.4%	0.2%	0.3%
	Torres Strait Islander	-	0.0%	-	**-**	**-**
	Aboriginal & Torres Strait Islander	0.0%	0.0%	-	**-**	**-**

Group	Category	2014	2015	2016	2017	Pilot
Language	Missing	1.5%	2.0%	0.2%	-	-
	English	59.5%	59.9%	75.7%	75.8%	77.0%
	Other	37.2%	37.4%	24.3%	24.2%	23.0%
	Missing	3.2%	2.7%	-	-	-
Attendance mode	Internal (on-campus)	75.3%	76.9%	92.6%	96.0%	95.4%
	External (distance)	13.4%	12.6%	5.0%	3.2%	3.7%
	Mixed mode	11.0%	10.2%	2.2%	0.9%	1.0%
	Missing	0.3%	0.3%	0.2%	-	-
International or domestic	Domestic	72.3%	72.4%	71.1%	63.0%	66.4%
	International	27.6%	27.5%	28.7%	37.0%	33.7%
	Missing	0.1%	0.1%	0.2%	-	-
Attendance type	Mainly Full-time	73.9%	74.6%	66.9%	67.2%	67.9%
	Mainly Part-time	25.9%	25.2%	32.9%	32.8%	32.1%
	Missing	0.2%	0.2%	0.2%	-	-
Disability	Yes	3.3%	2.5%	3.5%	3.0%	2.2%
	No	96.2%	97.1%	96.3%	97.0%	97.8%
	Missing	0.6%	0.4%	0.2%	-	-
Study level	Masters by research	14.0%	13.0%	15.3%	12.2%	13.3%
	Doctorate by research	86.0%	87.0%	84.7%	87.8%	86.7%

Overall, the cohorts of 2014 and 2015 are very similar in terms of respondents' background characteristics, but there were some notable differences to the 2016 cohort. Also, there are many similarities between the 2016 and 2017 respondent characteristics, but it is important to note that there was a higher proportion of international students included in the 2017 data. Some of the differences between the 2016 and 2017 administrations may be due to the 2017 data only including a sub-set of institutions – the 20 universities who chose to participate in the pilot PREQ – rather than all institutions that participated in the PREQ.

Response patterns

We now turn our focus to the 2017 pilot PREQ results. The pilot PREQ instrument included a total of 33 items. This included 24 items that are part of the current PREQ instrument, and nine newly developed items.

In addition there were also six additional items – PGRESLINK items that are part of the 'Additional Items' module in the GOS instrument – from the broader GOS instrument that were included in some of the initial analyses. The PREQ items each included five response categories, while the PGRESLINK items each had either three or six response categories. Initial analyses revealed that the PGRESLINK items were not coherent with the remaining items, so subsequent analyses focused on the 33 items included in the pilot PREQ instrument.

Across all 33 pilot PREQ items, the response options four ('agree') and five ('strongly agree') were selected by respondents most often. For many items, less than 15 per cent of respondents chose one of the first three response options – either one ('strongly disagree'), two ('disagree') or three ('neither agree nor disagree'). The percentages of respondents who selected one of the first three categories, the fourth category and the fifth category are shown in Figure 8 for 2014, 2015, 2016 and 2017.

Three of the newly developed items, PREQP04, PREQP06 and PREQP09 have a more even distribution among the five response options than other items in the PREQ.

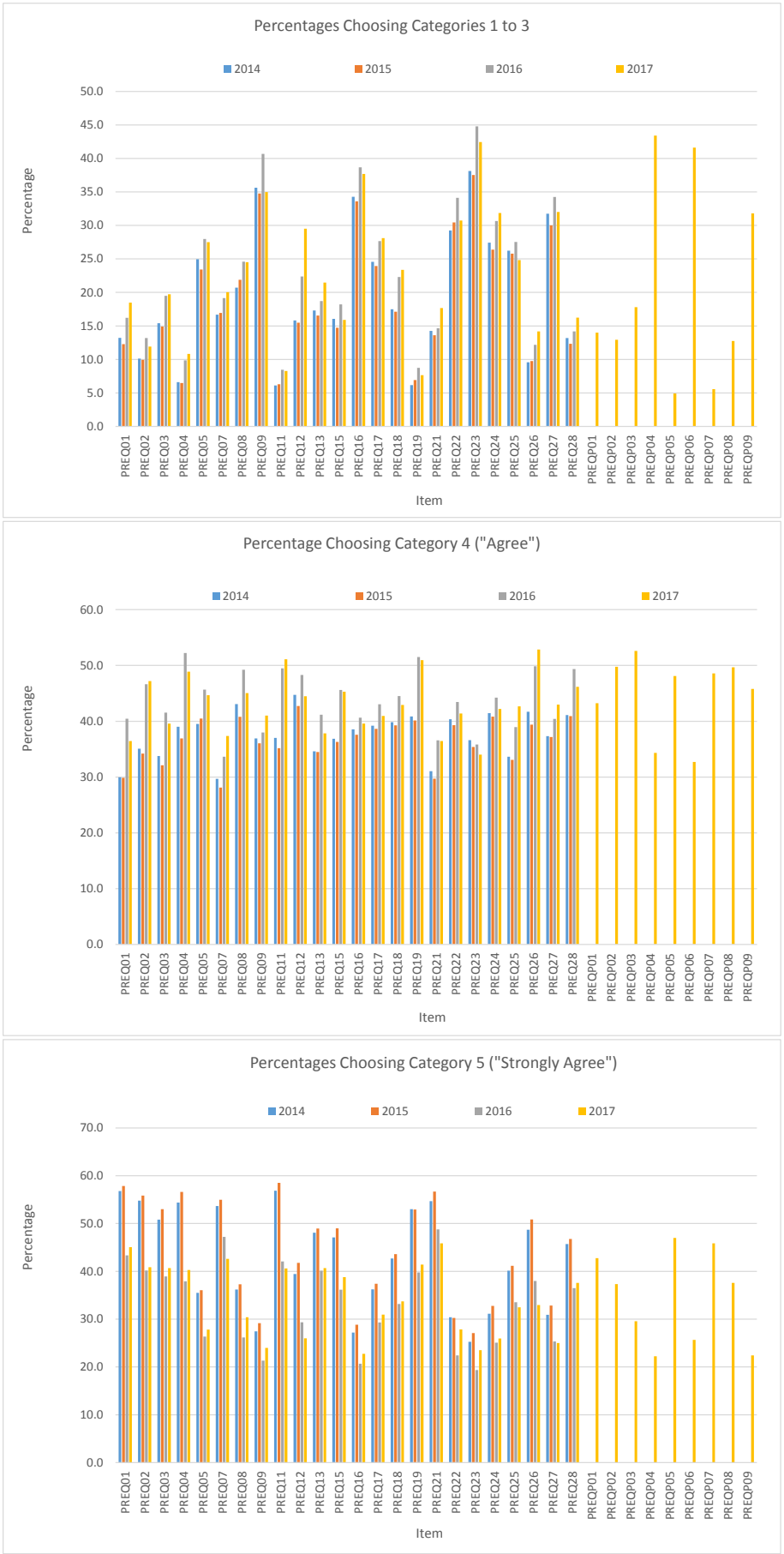


Figure 8: Response patterns across 2014, 2015, 2016 and 2017 PREQ items

Item Response Theory

The data from the 2017 PREQ was fitted to the Rasch Partial Credit model based on Item Response Theory (IRT). A detailed item summary is given in Appendix 1. Most items fit the IRT partial credit model well with the exception of a few items. The test reliabilities (WLEs) of the 2017 survey is 0.937.

Items PREQ25, PREQ27 and PREQP01 have the worst fit to the IRT model and in addition PREQP04 and PREQP06 did not fit the IRT model well. The Item Characteristic Curves (ICCs) of PREQP01 is shown in Figure 9, and it shows that the misfit mainly occurred in the lower categories. Overall, the data from the pilot PREQ fits the IRT model well.

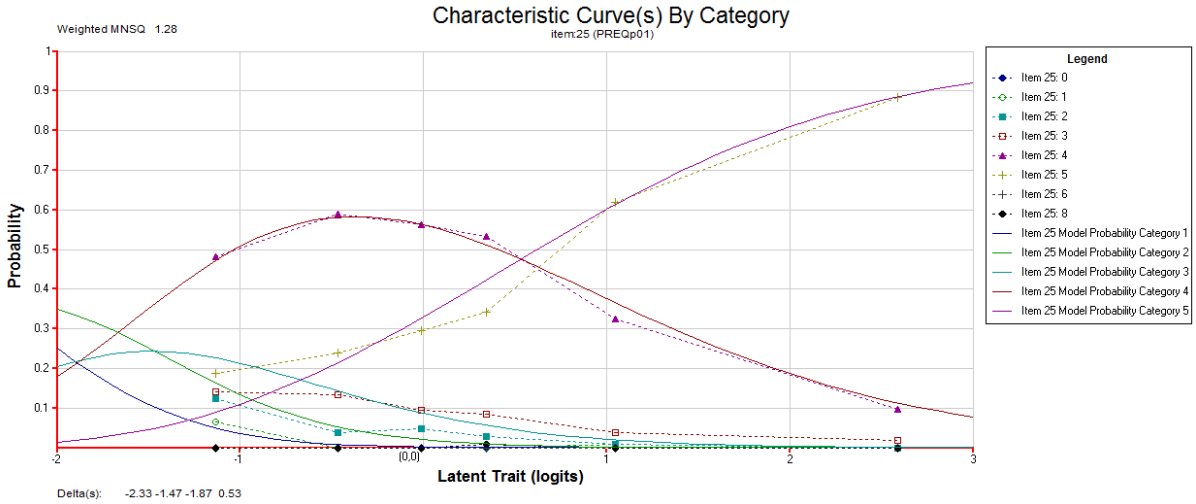


Figure 9: Item Characteristic Curves for Items PREQP01 of the 2017 Data

EFA and CFA Results

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) using MPlus were performed on the 2017 PREQ data to investigate the dimensionalities of the instrument.

EFA Results

Previous analyses found that the current PREQ instrument fit a six factor model quite well, with the PREQ28 item standing on its own. EFA models with up to seven factors were fitted to the 2017 PREQ data to investigate one to seven factor solutions, excluding PREQ28.

The Eigenvalues graph is shown in Figure 10 and detailed factor loadings of seven factors are given in Appendix 2. The eigenvalue graph shows that there is one main factor, and four more factors have eigenvalue greater than 1. The factor loadings from the seven-factor EFA analysis indicates that there are two items, PREQ04 and PREQ08 appear to load across two dimensions, and in addition, items from two scales (Skill Development; Goals and Expectations) loaded together on the same dimension.

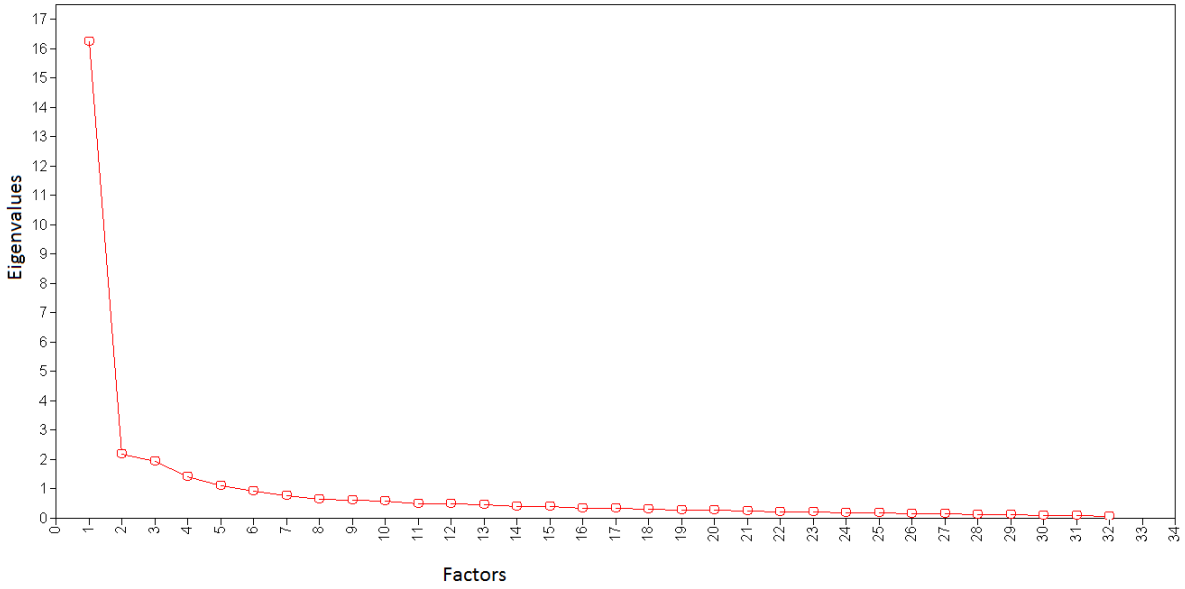


Figure 10: Eigenvalues graph of Items from EFA Analysis

CFA Results

The PREQ28 item – 'Overall, I was satisfied with the quality of my higher degree research experience' – was not included in the EFA model nor the CFA model as it is used as a one-item scale and has very small variance. The remaining 32 items from the pilot PREQ were fitted to a seven-factor CFA model.

Figure 11 shows the path diagram of the CFA model. The χ^2 test yields a value of 1948 (df=443), which has a corresponding p-value of .0000. The χ^2 is much lower than the χ^2 of 2016's data due to the much smaller sample size. The RMSEA is 0.073, which is within the 90% C.I., CFI and TLI are 0.947 and 0.941, respectively. This indicates that the approximate fit is acceptable.

The factor loadings on each factor are all strong, the lowest standardised factor loading is 0.708 for item PREQ25, and other factor loadings are 0.75 or higher. This indicates that the items are good indicators of the scales and also indicate that the seven latent scales are well defined. The factor loadings are shown in Appendix 3.

The correlations among the factors are moderate as shown in Table 21. Overall, the CFA model results indicate the seven pilot PREQ latent scales work well.

Table 21: Correlations among latent scales in CFA model

Scale	Supervision	Intellectual Climate	Skill Development	Infrastructure	Thesis Examination	Goals and Expectations
Intellectual Climate	0.567	-	-	-	-	-
Skill Development	0.520	0.530	-	-	-	-
Infrastructure	0.568	0.634	0.536	-	-	-
Thesis Examination	0.519	0.422	0.503	0.530	-	-
Goals and Expectations	0.649	0.507	0.634	0.587	0.641	-
Industry Engagement	0.472	0.539	0.487	0.511	0.384	0.441

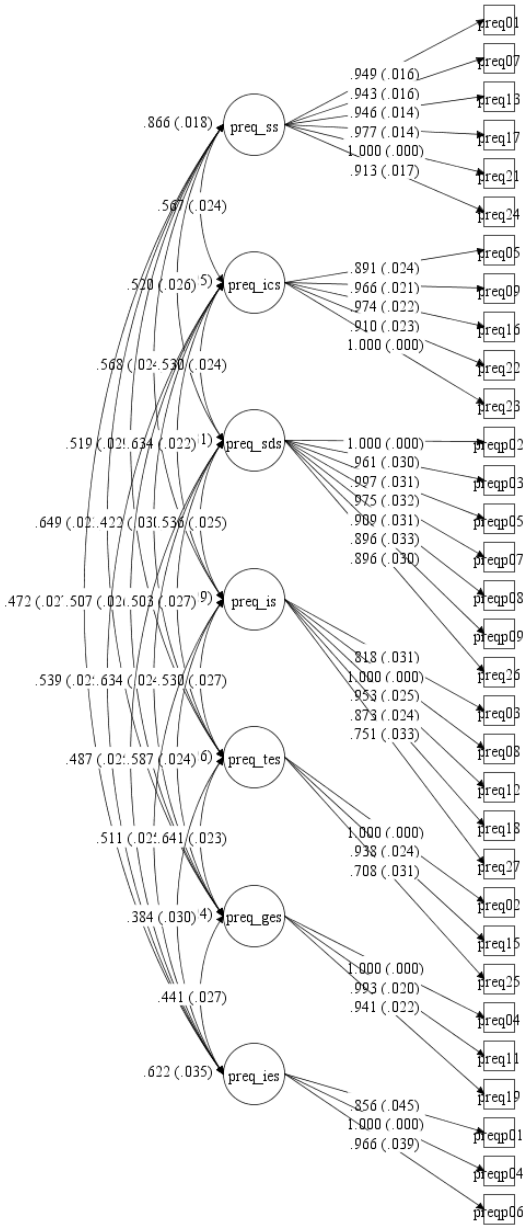


Figure 11: Path diagram of CFA analysis based on pilot PREQ data

Are there any redundant items?

Findings from the CFA model indicate that some items are highly correlated. Items with a correlation greater than 0.75 are listed in Table 22. Although there is high level of correlation among some pairs of items, the item pairs that show relatively high correlation do seem to be asking different aspects of the construct.

Table 22: Pairs of Items with correlations greater than 0.75

Scale	Item code		Item	Correlation
Supervision		PREQ01	Supervision was available when I needed it	-
	PREQ07		My supervisor(s) made a real effort to understand difficulties I faced	0.795
	PREQ13		My supervisor(s) provided additional information relevant to my topic	0.767
	PREQ17		I was given good guidance in topic selection and refinement	0.779
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.838

Scale	Item code		Item	Correlation
		PREQ07	My supervisor(s) made a real effort to understand difficulties I faced	-
	PREQ13		My supervisor(s) provided additional information relevant to my topic	0.823
	PREQ17		I was given good guidance in topic selection and refinement	0.777
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.857
		PREQ13	My supervisor(s) provided additional information relevant to my topic	-
	PREQ17		I was given good guidance in topic selection and refinement	0.794
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.821
	PREQ24		I received good guidance in my literature search	0.758
		PREQ17	I was given good guidance in topic selection and refinement	-
	PREQ21		My supervisor(s) provided helpful feedback on my progress	0.816
		PREQ21	My supervisor(s) provided helpful feedback on my progress	-
	PREQ24		I received good guidance in my literature search	0.774
Intellectual Climate		PREQ22	A good seminar program for postgraduate students was provided	-
	PREQ23		The research ambience in the department or faculty stimulated my work	0.757
Thesis Examination		PREQ02	The thesis examination process was fair	-
	PREQ15		I was satisfied with the thesis examination process	0.847
Goals and Expectations		PREQ04	I developed an understanding of the standard of work expected	-
	PREQ11		I understood the required standard for the thesis	0.767
		PREQ11	I understood the required standard for the thesis	-
	PREQ19		I understood the requirements of thesis examination	0.830

How are respondents using the response options?

As discussed earlier, most respondents tend to select 4 (‘agree’) or 5 (‘strongly agree’) for most of the items – in other words, most respondents tend to agree with the statements.

Figure 12 shows the distribution of responses for each item within each of the seven pilot PREQ scales. This shows that for most scales – particularly the Skill Development and Goals and Expectations scales – fewer than 10 per cent of respondents select a response other than ‘agree’ or ‘strongly agree’. In the Intellectual Climate scale, respondents selected ‘agree’ most frequently, with similar proportions of respondents selecting either ‘neither agree or disagree’ or ‘strongly agree’. The items included in the new Industry Engagement scale tend to have a more balanced distribution among the five response options.

Figure 12: Response option distributions

DIF analysis by respondent subgroups

In order to detect potential item bias by subgroup, DIF analyses were conducted using ACER ConQuest analysis software. DIF analyses were carried out for various contextual variables, and some items may fall outside the confidence bands, but the relative differences between groups for more items are in fact rather small.

As the overall number of respondents to the pilot PREQ is much smaller than previous administrations of the PREQ, this has resulted in there being some very small subgroups. The DIF analyses of the pilot PREQ data focused on subgroups that had at least 80 valid cases. Because of the smaller sample size, the

confidence intervals are wider than analyses found with other administrations of the PREQ, and resulted in a smaller number of items showing significant DIF.

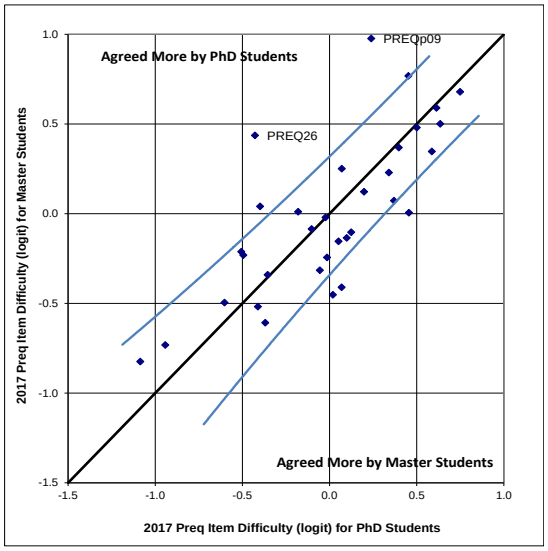
The results are shown in Figure 13. A summary of items which may show DIF is given in Table 23. It is important that the results – particularly those relating to level - are treated with caution given the small sample sizes.

Table 23: Items falling outside confidence bands of DIF analyses

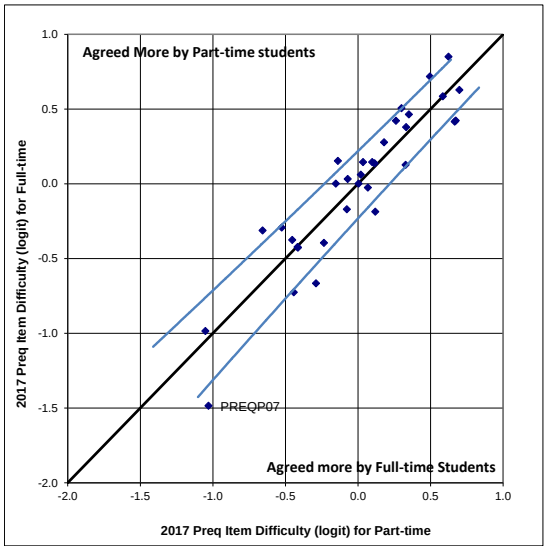
Item	Description	Relatively Agreed more by
Doctorate versus Masters*		
PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems	Doctorate
PREQP09	I gained confidence in leading and influencing others	Doctorate
Female vs Male		
PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems	Female
PREQP07	I developed my understanding of 'research integrity'	Female
International students vs Domestic students		
PREQ05	The department provided opportunities for social contact with other postgraduate students	International
PREQ25	Doing my research helped me to develop my ability to plan my own work	Domestic
PREQP08	I improved my ability to plan and manage my time effectively	International
Part-time vs Full-time Students		
PREQP07	I developed my understanding of 'research integrity'	Full-time
English speaking background vs Non-English speaking background		
PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems	Non-English speaking background
PREQP05	I developed my skills in critical analysis and evaluation	English speaking background
PREQP08	I improved my ability to plan and manage my time effectively	Non-English speaking background

*Note: these results are based on a very small number of Masters respondents (n=84).

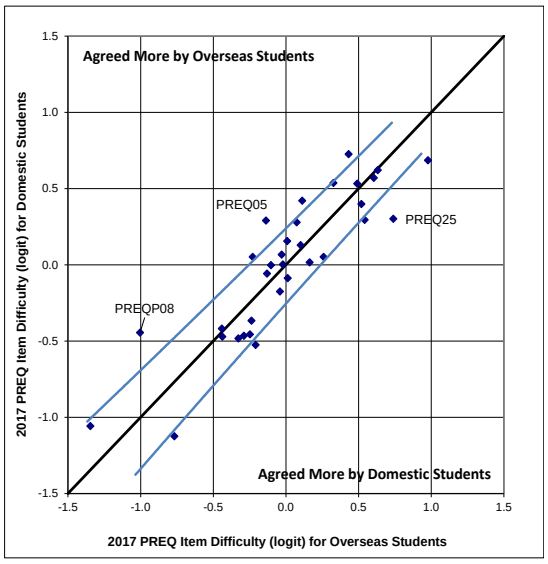
Level DIF



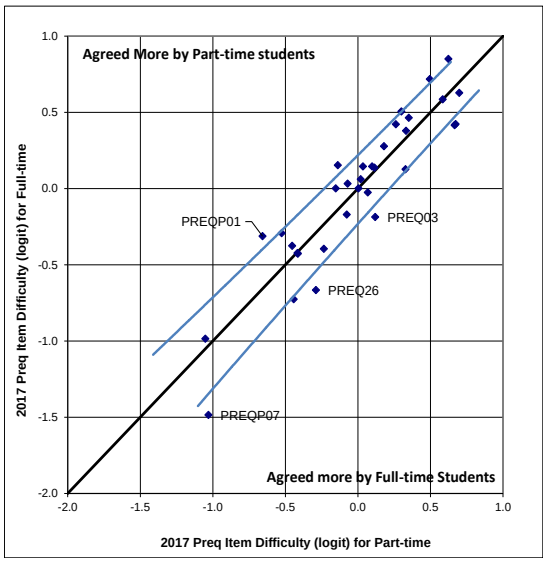
Gender DIF



Citizenship



Attend (Full-time students vs part-time)



NESB vs ESB

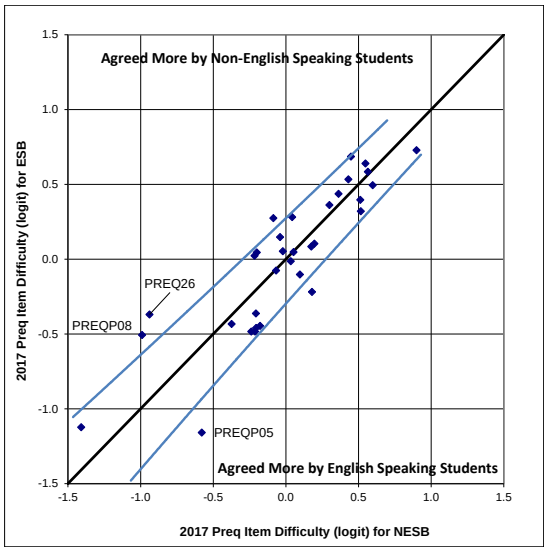


Figure 13: Item DIF by respondent subgroup

Results from SEM modelling

The 32 items in the pilot PREQ data were fitted to a SEM model using MPlus (as illustrated in Figure 14) regressing the factors on to the background variables. The mode variable was coded into two dummy variables, with internal / on-campus students being treated as a reference group, and one dummy variable for mixed-mode students and the other dummy variables for external students. All other background variables have only two categories coded using dummy variables. Again, item 28 was excluded from the modelling as it has a very small variance.

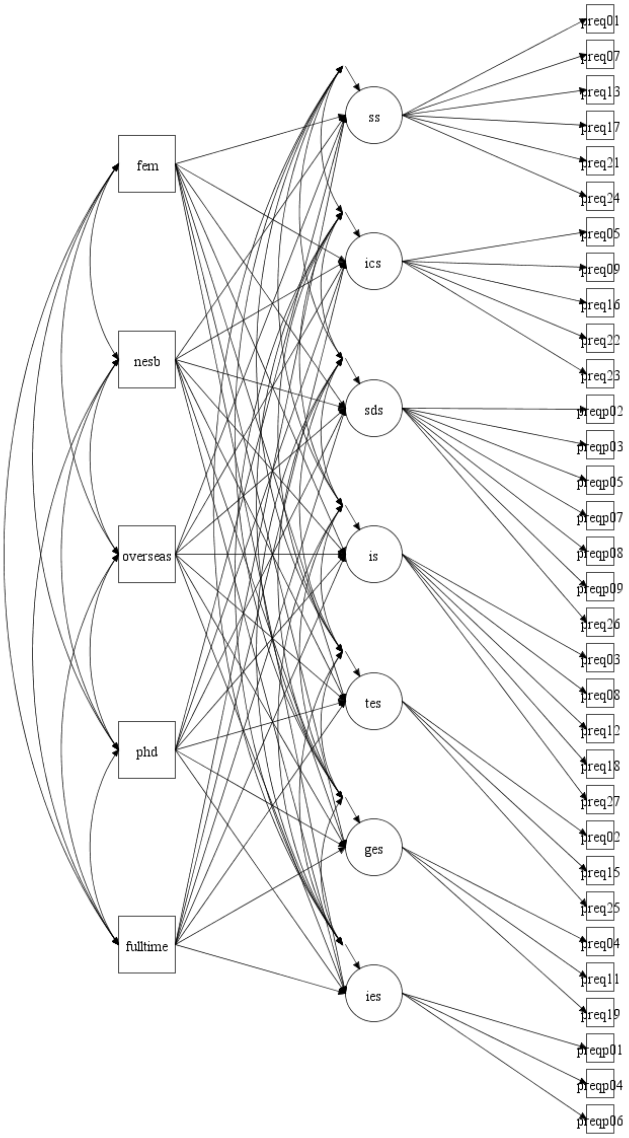


Figure 14: SEM Model

The χ^2 test yields a value of 2,097 (df=568), which has a corresponding p-value of .0000. The RMSEA is 0.065, which is within the 90% C.I., CFI and TLI are 0.950 and 0.942, respectively. The approximate fit is acceptable.

Table 24 lists the factors or scales that show significant differences between categories within a subgroup. Due to the small sample size, many factors that showed a significant difference in 2016 are no long significant. Respondents from non-English speaking backgrounds appear to have significant differences to the respondents from English speaking backgrounds for five of the seven scales.

Table 24: Significant effect from the SEM modelling

Reference Group	Estimate	S.E.	Est./S.E.	P-value
Intellectual Climate				
NESB	0.211	0.106	1.988	0.047
International students	0.276	0.100	2.765	0.006
Skill Development				
NESB	0.261	0.107	2.439	0.015
Infrastructure				
NESB	0.296	0.108	2.753	0.006
Full-time students	0.186	0.087	2.133	0.033
Thesis Examination				
NESB	0.357	0.123	2.907	0.004
Goals and Expectations				
NESB	0.241	0.105	2.282	0.022

Skill Development Scale

One of the changes made to the PREQ pilot instrument was to exclude the item PREQ06 – *My research further development my problem solving skills* – as the broader GOS instrument included a similar item – GFOUND06 – *Ability to solve problems* - that used the same response scale. Following the pilot fieldwork, further feedback was provided that to enhance the face validity of the Skill Development scale it would be preferred that item PREQ06 be retained in the future PREQ instrument. As data from this item was not collected in the pilot fieldwork, some further analyses were undertaken using the GFOUND06 item as a proxy.

Another CFA was conducted that included the GFOUND06 item in the Skill Development scale. Figure 15 shows the path diagram of this updated CFA model. Again the CFA excluded the PREQ28 item, and the remaining 33 items were fitted to a seven-factor CFA model. The χ^2 test yields a value of 2,249 (df=474), which has a corresponding p-value of .0000. The RMSEA is 0.077, which is within the 90% C.I., CFI and TLI are 0.945 and 0.939, respectively. This indicates that including this proxy item does not impact on the approximate fit of the model, and that the fit is acceptable.

The factor loadings on each factor are strong, with the exception of GFOUND06. The lowest standardised factor loading is 0.271 for item GFOUND06. All other factor loadings are 0.67 or higher. This indicates that the items are good indicators of the scales and also indicate that the seven latent scales are reasonably well defined. The factor loadings are shown in Appendix 3.

Although the GFOUND06 item does not load strongly on the revised Skill Development, this does not necessarily indicate that the PREQ06 item would not load well on this scale. Strong factor loadings are shown for items PREQP03, PREQP05 and PREQP08 – these items are adapted from items included in the current Skill Development scale – and item PREQ26 – which is included in both the current and revised PREQ instrument. In addition, while the PREQ06 and GFOUND06 items both appear to measure very similar aspects of HDR candidates' experience, results from the 2016 GOS suggest that these items are only moderately correlated (r=0.47, p<0.000). These findings, along with the finding in the analyses of the current PREQ instrument that showed that the PREQ06 item loaded strongly on the current Skill Development scale, suggests that the PREQ06 item should also load strongly on the updated Skill Development scale.

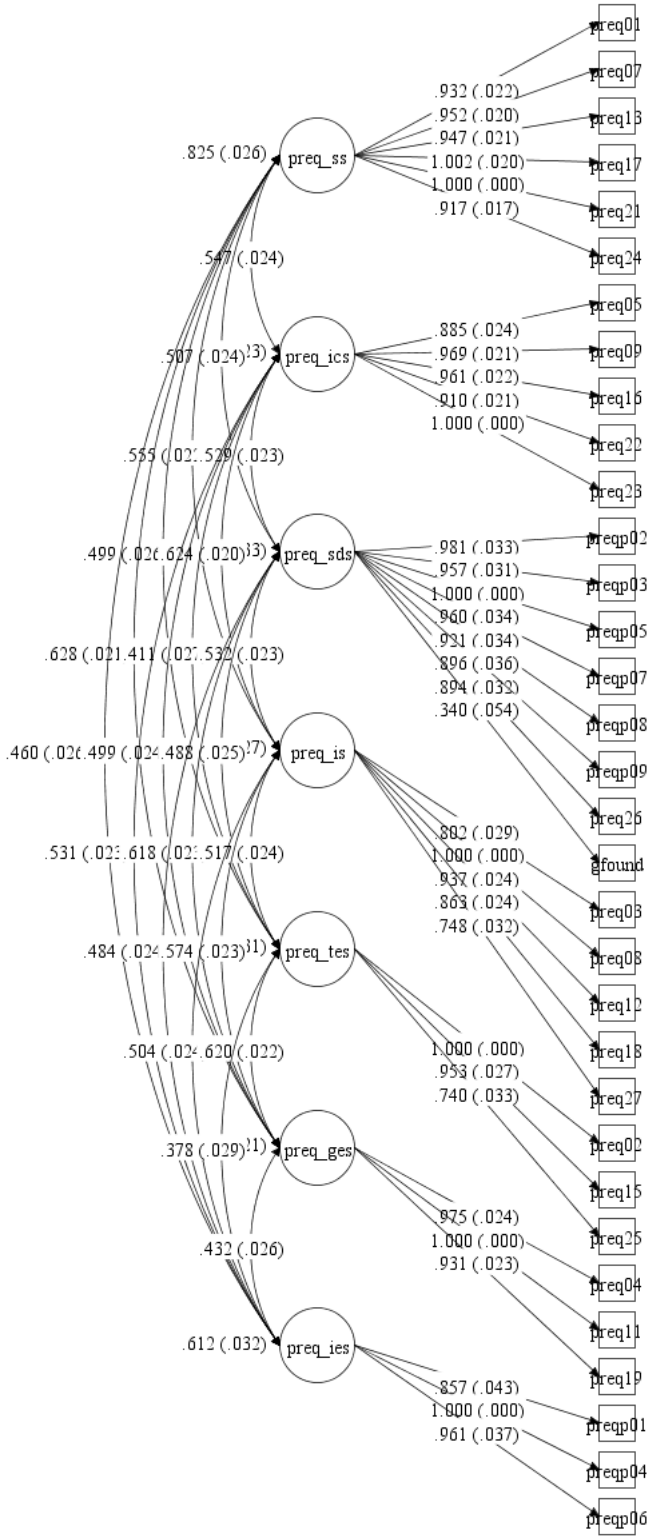


Figure 15: Path diagram of CFA analysis based on pilot PREQ data (includes GFOUND06 item)

In order to measure the internal criterion validity of the Skill Development scale, the scale was correlated with similar items included in the broader GOS instrument that measure respondents' development of generic skills. These correlations – shown in Table 25– suggest there are small-to-moderate statistically significant relationships between the Skill Development scale and these items. This provides some evidence for the internal validity of the revised PREQ Skill Development scale. Note that Table 25 includes the correlations for both the Skill Development scale as piloted (excluding the GFOUND06 item), and another version that includes the GFOUND06 item as a proxy for the PREQ06 item.

Table 25: Correlations between PREQ Skill Development scale and foundation skills items

Item	Skill Development Scale (excludes GFOUND06)	Skill Development Scale (includes GFOUND06)
Oral communication skills	0.361**	0.317**
Written communication skills	0.360**	0.384**
Numeracy skills	0.260**	0.321**
Ability to develop relevant knowledge	0.307**	0.354**
Ability to develop relevant skills	0.315**	0.355**
Ability to solve problems	0.365**	0.429**
Ability to integrate knowledge	0.395**	0.405**
Ability to think independently about problems	0.362**	0.412**

** $p<0.01$

Industry Engagement Scale

One of the changes made to the pilot PREQ instrument was to include some new items measuring HDR candidates' level of industry engagement. Although the DIF analyses did not indicate that there was any potential item bias for these items for respondents in different subgroups, there were some concerns raised by the PREQ Advisory Panel, as well as by some other stakeholders, that these items may not be relevant for all HDR graduates, in particular graduates whose research was pure rather than applied.

An analysis of the missing responses to these items indicated that there were no substantial differences in the proportion of respondents who chose not to respond to these questions when compared with other PREQ items. Analyses of the way in which different subgroups of HDR graduates responded to these items revealed that there were some small but statistically significant differences in the way in which some subgroups responded to item PREQP06 – *I had opportunities to work on research problems with real-world or industry application*, and in the way in which some subgroups responded to item PREQP04 - *I had opportunities to develop professional connections outside the university sector.*

No statistically significant differences were shown between male and female respondents, between part-time and full-time HDR candidates, between respondents who were employed and those who were not employed, nor between respondents employed in different employment sectors.

Respondents who were studying externally were significantly more likely than internal students to respond positively to the PREQP06 item, $t(24.26)=2.20$, $p=0.04$. This difference showed a small meaningful effect ($d=0.44$), but as only 23 external candidates respondents to this item, these results should be interpreted with caution.

International graduates also responded significantly more positively to the PREQP06 item when compared with domestic students, $t(475.64)=3.42$, $p<0.01$. This difference showed a small meaningful effect ($d=0.28$). International students also responded significantly more positively to the PREQP04 item than domestic students, $t(628)=2.21$, $p=0.03$, however, only a small meaningful effect was shown ($d=0.19$).

There were also differences shown for candidates from a non-English speaking background. Candidates from non-English speaking backgrounds responded more positively to item PREQP06, $t(268.36)=3.41$, $p<0.01$, and to item PREQP04, $t(628)=2.47$, $p=0.01$. Small meaningful effects were shown for PREQP06 ($d=0.31$) and for PREQP04 ($d=0.24$).

In addition to these differences, there were some statistically significant differences shown for item PREQP06 for different fields of education, $F(9, 618)=3.67$, $p<0.01$. Specifically, Engineering and Related Technologies graduates responded significantly more positively to this item than graduates from Natural and Physical Sciences, $t(224.95)=3.65$, $p<0.01$, and this difference had a small-to-moderate meaningful effect ($d=0.46$). HDR graduates who studied in the field of Health also responded significantly more positively than graduates who studied in the field of Society and Culture, $t(210.63)=3.20$, $p<0.01$, and this difference also showed a small-to-moderate meaningful effect ($d=0.43$). Finally, Engineering and Related

Technologies graduates also respondent significantly more positively to this item than graduates from Society and Culture, $t(206.17)=4.74$, $p<0.01$, and this difference showed a moderate meaningful effect ($d=0.65$).

Appendix 1: Cohort Item Summary

Table 26: 2017 cohort item summary

Item Label	Item Estimate	Item Error	Facility Rate	Disc	Item-Total Correlation	MNSQ	Confidence Interval		T	Data Points
PREQ01	-0.0300	0.048	77.4	0.66	0.69	0.94	0.87	1.13	-0.90	630
PREQ02	-0.3760	0.058	80.2	0.58	0.61	0.99	0.85	1.15	-0.10	630
PREQ03	-0.1070	0.051	77.0	0.52	0.56	1.19	0.87	1.13	2.80	630
PREQ04	-0.3830	0.059	80.4	0.68	0.70	0.82	0.85	1.15	-2.40	630
PREQ05	0.1720	0.052	71.6	0.60	0.63	1.05	0.88	1.12	0.70	630
PREQ07	0.0530	0.048	76.3	0.66	0.69	0.94	0.87	1.13	-0.90	630
PREQ08	0.0990	0.051	72.7	0.70	0.73	0.83	0.88	1.12	-2.80	630
PREQ09	0.4650	0.048	66.7	0.67	0.70	0.95	0.89	1.11	-0.80	630
PREQ11	-0.3120	0.060	81.2	0.66	0.68	0.86	0.83	1.17	-1.70	630
PREQ12	0.1290	0.054	71.3	0.64	0.67	0.94	0.88	1.12	-1.00	630
PREQ13	0.0090	0.049	75.8	0.67	0.70	0.91	0.87	1.13	-1.40	630
PREQ15	-0.0500	0.051	77.3	0.53	0.56	1.17	0.86	1.14	2.20	630
PREQ16	0.5270	0.047	65.3	0.68	0.71	0.94	0.89	1.11	-1.10	630
PREQ17	0.2960	0.047	70.6	0.74	0.76	0.80	0.88	1.12	-3.40	630
PREQ18	-0.0290	0.053	74.9	0.57	0.60	1.08	0.87	1.13	1.20	630
PREQ19	-0.3880	0.062	81.9	0.59	0.61	0.98	0.83	1.17	-0.20	630
PREQ21	0.0100	0.048	78.1	0.70	0.72	0.85	0.86	1.14	-2.20	630
PREQ22	0.3080	0.048	69.3	0.62	0.65	1.06	0.88	1.12	0.90	630
PREQ23	0.5860	0.047	63.8	0.72	0.74	0.89	0.89	1.11	-2.10	630
PREQ24	0.3840	0.048	68.3	0.69	0.72	0.90	0.88	1.12	-1.80	630
PREQ25	0.3650	0.045	70.6	0.41	0.45	1.60	0.88	1.12	8.20	630
PREQ26	-0.3680	0.063	78.5	0.56	0.58	1.02	0.85	1.15	0.30	630
PREQ27	0.4650	0.047	67.3	0.53	0.57	1.26	0.88	1.12	4.10	630
PREQ28	-0.0730	0.053	77.4	0.76	0.78	0.70	0.86	1.14	-4.60	630
PREQp01	-0.4270	0.057	80.4	0.44	0.48	1.28	0.86	1.14	3.60	630
PREQp02	-0.3250	0.060	79.5	0.62	0.64	0.93	0.85	1.15	-0.90	630
PREQp03	-0.1460	0.059	76.1	0.61	0.64	0.94	0.86	1.14	-0.90	630
PREQp04	0.6970	0.045	61.6	0.58	0.62	1.24	0.89	1.11	4.10	630
PREQp05	-0.9870	0.074	85.1	0.59	0.61	0.88	0.85	1.15	-1.50	630
PREQp06	0.5820	0.045	63.7	0.57	0.61	1.23	0.89	1.11	4.00	630
PREQp07	-0.8630	0.072	84.5	0.56	0.58	0.92	0.85	1.15	-1.00	630

PREQp08	-0.4800	0.063	80.0	0.56	0.59	1.00	0.86	1.14	0.00	630
PREQp09	0.1980	0.053	69.0	0.58	0.61	1.10	0.88	1.12	1.60	630

Appendix 2: EFA results

Table 27: Loadings for seven-factor Exploratory Model

Dimension		Item	1	2	3	4	5	6	7
1	Supervision	PREQ01	0.789	0.066	0.074	0.037	0.026	-0.006	-0.029
		PREQ07	0.931	-0.069	0.018	0.034	-0.027	0.048	0.031
		PREQ13	0.838	-0.016	-0.050	0.018	0.015	-0.060	0.134
		PREQ17	0.703	0.094	-0.034	0.057	0.091	-0.106	0.094
		PREQ21	0.865	0.006	-0.025	0.087	0.014	-0.105	0.016
		PREQ24	0.640	-0.048	-0.139	0.127	0.173	-0.335	0.087
2	Intellectual Climate	PREQ05	-0.048	-0.016	0.132	0.108	0.727	0.067	-0.040
		PREQ09	0.014	0.012	0.202	0.048	0.765	0.182	-0.059
		PREQ16	0.147	0.124	0.011	-0.088	0.607	0.029	0.209
		PREQ22	0.030	-0.032	-0.002	0.082	0.708	-0.245	0.010
		PREQ23	0.080	0.012	-0.015	0.011	0.749	-0.224	0.073
3	Skill Development	PREQP02	0.056	-0.056	0.071	0.591	0.040	0.085	0.248
		PREQP03	-0.011	-0.015	-0.078	0.577	0.373	0.125	0.053
		PREQP05	0.158	0.193	-0.083	0.571	-0.001	0.174	0.158
		PREQP07	0.091	0.021	0.173	0.663	-0.075	-0.123	-0.052
		PREQP08	0.007	-0.084	0.010	0.689	0.048	-0.156	0.087
		PREQP09	-0.122	-0.112	-0.028	0.449	0.205	-0.106	0.415
		PREQ26	-0.176	0.073	-0.078	0.616	-0.005	-0.036	0.427
4	Infrastructure	PREQ03	-0.030	0.019	0.756	0.077	0.032	0.084	0.005
		PREQ08	0.335	-0.090	0.449	0.065	0.135	0.012	0.104
		PREQ12	-0.032	-0.003	0.597	0.046	0.161	-0.047	0.212
		PREQ18	-0.097	0.025	0.709	0.044	0.142	-0.063	0.060
		PREQ27	-0.026	0.072	0.328	-0.043	0.176	-0.225	0.235
5	Thesis Examination	PREQ02	0.067	0.699	0.155	0.143	-0.041	0.073	0.024
		PREQ15	-0.023	0.947	-0.041	0.082	0.033	0.050	0.032
		PREQ25	-0.032	0.647	-0.028	0.016	0.064	-0.167	0.040
6	Goals and Expectations	PREQ04	0.348	0.040	0.225	0.437	0.008	0.053	-0.029
		PREQ11	0.193	0.105	0.032	0.755	0.090	-0.020	-0.225
		PREQ19	0.157	0.189	0.173	0.658	-0.116	-0.245	-0.218
7	Industry Engagement	PREQP01	-0.022	0.023	0.000	0.387	-0.138	0.078	0.534
		PREQP04	0.119	0.005	0.049	-0.104	0.216	0.020	0.618
		PREQP06	0.208	0.030	0.151	-0.116	-0.018	-0.048	0.627

Appendix 3: CFA results

Table 28: Unstandardised and standardised loadings for seven-factor Confirmatory Model

Dimension		Item	Unstandardised		Standardised	
			Estimate	Standard Error	Estimate	Standard Error
1	Supervision	PREQ01	0.949	0.016	0.883	0.014
		PREQ07	0.943	0.016	0.878	0.013
		PREQ13	0.946	0.014	0.880	0.012
		PREQ17	0.977	0.014	0.909	0.011
		PREQ21	1.000	-	0.930	0.010
		PREQ24	0.913	0.017	0.850	0.016
2	Intellectual Climate	PREQ05	0.891	0.024	0.781	0.019
		PREQ09	0.966	0.021	0.846	0.015
		PREQ16	0.974	0.022	0.853	0.015
		PREQ22	0.910	0.023	0.797	0.019
		PREQ23	1.000	-	0.876	0.014
3	Skill Development	PREQP02	1.000	-	0.800	0.019
		PREQP03	0.961	0.030	0.769	0.020
		PREQP05	0.997	0.031	0.798	0.021
		PREQP07	0.975	0.032	0.780	0.021
		PREQP08	0.909	0.031	0.727	0.022
		PREQP09	0.896	0.033	0.717	0.024
		PREQ26	0.896	0.030	0.717	0.022
4	Infrastructure	PREQ03	0.818	0.031	0.718	0.024
		PREQ08	1.000	-	0.878	0.017
		PREQ12	0.953	0.025	0.837	0.016
		PREQ18	0.873	0.024	0.766	0.019
		PREQ27	0.751	0.033	0.659	0.027
5	Thesis Examination	PREQ02	1.000	-	0.955	0.014
		PREQ15	0.938	0.024	0.896	0.014
		PREQ25	0.708	0.031	0.676	0.028
6	Goals and Expectations	PREQ04	1.000	-	0.903	0.013
		PREQ11	0.993	0.020	0.896	0.012
		PREQ19	0.941	0.022	0.850	0.016
7	Industry Engagement	PREQP01	0.856	0.045	0.676	0.031
		PREQP04	1.000	-	0.789	0.022
		PREQP06	0.966	0.039	0.762	0.024

Table 29: Unstandardised and standardised loadings for seven-factor Confirmatory Model (includes GFOUND06 item)

Dimension		Item	Unstandardised		Standardised	
			Estimate	Standard Error	Estimate	Standard Error
1	Supervision	PREQ01	0.932	0.022	0.846	0.015
		PREQ07	0.952	0.020	0.865	0.012
		PREQ13	0.947	0.021	0.860	0.013
		PREQ17	1.002	0.020	0.910	0.010
		PREQ21	1.000	-	0.909	0.014
		PREQ24	0.917	0.017	0.833	0.016
2	Intellectual Climate	PREQ05	0.885	0.024	0.766	0.018
		PREQ09	0.969	0.021	0.839	0.014
		PREQ16	0.961	0.022	0.832	0.015
		PREQ22	0.910	0.021	0.789	0.017
		PREQ23	1.000	-	0.866	0.013
3	Skill Development	PREQP02	0.981	0.033	0.782	0.020
		PREQP03	0.957	0.031	0.763	0.019
		PREQP05	1.000	-	0.797	0.020
		PREQP07	0.960	0.034	0.765	0.021
		PREQP08	0.921	0.034	0.734	0.021
		PREQP09	0.896	0.036	0.714	0.022
		PREQ26	0.894	0.032	0.713	0.021
		GFOUND06	0.340	0.054	0.271	0.043
4	Infrastructure	PREQ03	0.802	0.029	0.698	0.022
		PREQ08	1.000	-	0.871	0.015
		PREQ12	0.937	0.024	0.816	0.017
		PREQ18	0.863	0.024	0.751	0.018
		PREQ27	0.748	0.032	0.651	0.025
5	Thesis Examination	PREQ02	1.000	-	0.922	0.017
		PREQ15	0.953	0.027	0.879	0.016
		PREQ25	0.740	0.033	0.683	0.025
6	Goals and Expectations	PREQ04	0.975	0.024	0.858	0.017
		PREQ11	1.000	-	0.880	0.012
		PREQ19	0.931	0.023	0.820	0.018
7	Industry Engagement	PREQP01	0.857	0.043	0.671	0.029
		PREQP04	1.000	-	0.782	0.020
		PREQP06	0.961	0.037	0.752	0.023

Appendix F: Comparison of current and recommended PREQ instrument

Table 30: Current and proposed PREQ instrument

Scale	Current PREQ Instrument		Recommendation	Proposed PREQ Instrument	
	Code	Item		Code	Item
Supervision	PREQ01	Supervision was available when I needed it	Retain item	PREQ01	Supervision was available when I needed it
	PREQ07	My supervisor(s) made a real effort to understand difficulties I faced	Retain item	PREQ07	My supervisor(s) made a real effort to understand difficulties I faced
	PREQ13	My supervisor(s) provided additional information relevant to my topic	Retain item	PREQ13	My supervisor(s) provided additional information relevant to my topic
	PREQ17	I was given good guidance in topic selection and refinement	Retain item	PREQ17	I was given good guidance in topic selection and refinement
	PREQ21	My supervisor(s) provided helpful feedback on my progress	Retain item	PREQ21	My supervisor(s) provided helpful feedback on my progress
	PREQ24	I received good guidance in my literature search	Retain item	PREQ24	I received good guidance in my literature search
Intellectual Climate	PREQ05	The department provided opportunities for social contact with other postgraduate students	Retain item	PREQ05	The department provided opportunities for social contact with other postgraduate students
	PREQ09	I was integrated into the department's community	Retain item	PREQ09	I was integrated into the department's community
	PREQ16	The department provided opportunities for me to become involved in the broader research culture	Retain item	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	Retain item	PREQ22	A good seminar program for postgraduate students was provided
	PREQ23	The research ambience in the department or faculty stimulated my work	Revise item	PREQ23	The research environment in the department or faculty stimulated my work
Skill Development	PREQ06	My research further developed my problem solving skills	Retain item	PREQ06	My research further developed my problem solving skills
	PREQ10	I learned to develop my ideas and present them in my written work	Revise item	PREQP03	I improved my ability to communicate information effectively to diverse audiences
	PREQ14	My research sharpened my analytical skills	Revise item	PREQP05	I developed my skills in critical analysis and evaluation
	PREQ20	Doing my research helped me to develop my ability to plan my own work	Revise item	PREQP08	I improved my ability to plan and manage my time effectively

Scale	Current PREQ Instrument		Recommendation	Proposed PREQ Instrument	
	Code	Item		Code	Item
	PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems	Retain item	PREQ26	As a result of my research, I feel confident about tackling unfamiliar problems
	-	-	New item	PREQP09	I gained confidence in leading and influencing others
	-	-	New item	PREQP02	I improved my ability to design and implement projects effectively
	-	-	New item	PREQP07	I developed my understanding of research integrity (e.g. rigour, ethics, transparency, attributing the contribution of others)
Infrastructure	PREQ03	I had access to a suitable working space	Retain item	PREQ03	I had access to a suitable working space
	PREQ08	I had good access to the technical support I needed	Retain item	PREQ08	I had good access to the technical support I needed
	PREQ12	I was able to organise good access to necessary equipment	Retain item	PREQ12	I was able to organise good access to necessary equipment
	PREQ18	I had good access to computing facilities and services	Retain item	PREQ18	I had good access to computing facilities and services
	PREQ27	There was appropriate financial support for research activities	Retain item	PREQ27	There was appropriate financial support for research activities
Thesis Examination	PREQ02	The thesis examination process was fair	Retain item	PREQ02	The thesis examination process was fair
	PREQ15	I was satisfied with the thesis examination process	Retain item	PREQ15	I was satisfied with the thesis examination process
	PREQ25	The examination of my thesis was completed in a reasonable time	Retain item	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	Retain item	PREQ04	I developed an understanding of the standard of work expected
	PREQ11	I understood the required standard for the thesis	Retain item	PREQ11	I understood the required standard for the thesis
	PREQ19	I understood the requirements of thesis examination	Retain item	PREQ19	I understood the requirements of thesis examination
Industry Engagement	-	-	New item	PREQP01	I am confident that I can apply my skills outside the university sector
	-	-	New item	PREQP04	I had opportunities to develop professional connections outside the university sector
	-	-	New item	PREQP06	I had opportunities to work on research problems with real-world or industry application

Scale	Current PREQ Instrument		Recommendation	Proposed PREQ Instrument	
	Code	Item		Code	Item
Overall satisfaction	PREQ28	Overall, I was satisfied with the quality of my higher degree research experience	Retain item	PREQ28	Overall, I was satisfied with the quality of my higher degree research experience
Contextual items	-	-	New item	PGRESLINK4	Did you participate in other types of work-integrated learning (e.g. placements, practicums, consultancies, industry research projects) as part of your program?