WOMEN IN STEM

Longitudinal Analysis of the 2011 Higher Education Cohort and Completion Rate Analysis of the 2012-16 Cohort

Prepared by the Australian Bureau of Statistics for the Department of Industry, Science, Energy and Resources

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Contents

EXECUTIVE SUMMARY

Introduction

The aim of the Women in STEM Longitudinal Analysis project was to provide evidence to inform government policy relating to employment and further study outcomes for women who graduated with Science, Technology, Engineering and Mathematics (STEM) qualifications.

The analysis was conducted using ABS and administrative data available in the Multi-Agency Data Integration Project (MADIP).

This report presents descriptive analyses of Australian students who completed their higher education studies in 2011 and investigates their employment and income outcomes. In addition, there is analysis on undergraduates who started their study in 2012 to investigate the transition of these students through higher education.

The key findings from this report are presented in two chapters:

- Longitudinal analysis of further study 2011 Higher Education cohort (Chapter 3)
- Completion rate analysis of the 2012-16 cohort (Chapter 4)

Background

The Australian Government has committed $147 million from 2016-17 to 2027-28 to improve STEM gender equity in Australia, by encouraging girls' and women's participation in STEM education and the workforce. As part of this work, the Department of Industry, Science, Energy and Resources (DISER) releases related statistics via the STEM Equity Monitor (the Monitor) annually.

The Monitor is a national data report on girls' and women's participation in STEM. It presents the current state of STEM gender equity in Australia. It also provides a baseline for measuring change and trends over time in key sectors and career phases of girls' and women's engagement with STEM. The Monitor follows the pathway of women's participation in STEM through primary and secondary school, higher education, graduate outcomes and the workforce. The Monitor also allows users to explore and compare data in their area of interest.

In 2021 DISER commissioned the ABS to undertake further longitudinal analysis of university graduates with STEM qualifications to inform the next Monitor.

Defining STEM and other fields of study

Students who completed their higher education studies in 2011 and went on to further studies were grouped according to their field of further study, STEM, Health and Non-STEM. STEM included qualifications in natural and physical sciences (eg. mathematical sciences, physics and astronomy, chemical sciences, earth sciences and biological sciences), information technology, engineering and related technologies, and agriculture, environment and related studies. Health included any health-related qualifications. Non-STEM included qualifications in all other fields of study. This grouping was based on the methodology in DISER's STEM Equity Monitor which uses the Australian Standard Classification of Education (ASCED). ASCED is comprised of two component classifications, Level of Education and Field of Education. The analysis contains both two-digit (narrow level) and four-digit level (detailed level) structures. For more information on the structures, please refer to the ABS website. For more information on the groupings used by DISER please refer to Appendix 4.

Summary of Key Findings

The first step in the analysis in Chapter 3 examined an individual's most recent qualification as at 2011 in order to capture people with STEM qualifications. The next step was to determine who then went on to complete further qualifications in STEM, health or non-STEM fields since 2011. This analysis complemented the 2020 longitudinal analysis by drilling down into more detail to look at the outcomes for STEM women with further qualifications.

In Chapter 4, the analysis established a second cohort of people who started their study in 2012 to investigate the proportion who completed their study by 2016, those who didn't continue with their studies and those who were still studying. The purpose of this analysis was to look at the profile of younger students starting out in their STEM education journey and how they transitioned in and out of education.

The results of this analysis are reported in Chapters 3 and 4. A summary of the key findings is presented below:

Chapter 3: Longitudinal analysis of further study – 2011 cohort

- **Women** who completed a higher education STEM qualification in 2011 were around **1.6 times more likely** than men **to complete further study**
- 2 in 5 (41%) 2011 **STEM qualified women** who completed a **further qualification** remain **in a STEM field**
- **Graduates of STEM** who completed **Natural and Physical Sciences in 2011** were responsible for the **high rate of additional qualifications by STEM graduates**
- Unlike other fields, the **majority of second STEM qualifications** were at an **undergraduate level**
- Only **one-quarter of women and one-third of men** who completed an additional qualification in **Natural and Physical Sciences** were **at postgraduate** level
- **Additional qualifications were** associated with **lower income**, but this is likely confounded by limited time since completion

Chapter 4: Completion rate analysis - 2012-16 cohort

- **More than half** (57%) **of the women who had started any field of undergraduate** study in **2012** had completed **a bachelor's degree** by 2016, compared with just under half (48%) of the men
- **Around half of the women** (49%) who started **in Natural and Physical Sciences had completed** that degree by 2016, which was slightly higher than the rate for men (44%)
- Of people who started an undergraduate degree in IT in 2012, **men (37%) were considerably more likely than women (25%) to have graduated with an IT degree** by 2016
- **Around one-third (34%) of both men and women** who started **Engineering and Related Technologies in 2012 completed** that degree by 2016
- **Just under half of women (47%) and men (48%)** who commenced a bachelor's degree in **Agriculture, Environmental and Related Studies had completed** that qualification by 2016

Next Steps

The outcomes for graduates are in their early stages of analysis and graduate pathways will become clearer as more time periods are added to the analysis. More years of data are required to see graduate pathways for those STEM qualified graduates who have completed further study.

Adding new time points to the 2011 Higher Education cohort when the second and third phases of the longitudinal analysis are run would show outcomes of graduates who completed further study after 10 years and 15 years.

CHAPTER 1: INTRODUCTION

1.1 Background on Women in STEM

Since 2016, the Australian Government has committed $147 million to improve science, technology, engineering and maths (STEM) gender equity in Australia and encourage more girls and women to pursue STEM study and careers, including postdoctoral research. As part of this work, the Department of Industry, Science, Energy and Resources (DISER) annually releases the STEM Equity Monitor (the Monitor).

The Monitor is a national data report on girls' and women's participation and engagement in STEM. It presents the current state of STEM gender equity in Australia. The 2020 Monitor provided a baseline and will be delivered annually for 10 years to measure change and trends over time in key sectors and career phases of girls' and women's engagement with STEM. This consolidation of data on girls' and women's participation in, and engagement with STEM will help policymakers and the STEM sector support programs that target ages, career stages and sectors where girls and women continue to remain underrepresented. The Monitor follows the pathway of women's participation in STEM through primary and secondary school, higher education, graduate outcomes and the workforce.

The Monitor is the first key deliverable of the Government's Advancing Women in STEM 2020 Action Plan, which commits to government leading a data-driven approach to improving gender equity in STEM.

> *'Every organisation in Australia is increasingly reliant on STEM skills to thrive, whether they operate in government, academia, industry, or the education sector. All these stakeholders face a common challenge: the need to tackle the significant under-representation of women in the STEM workforce, because we can ill afford to under-utilise all of the nation's available talent. To achieve this requires removing barriers to participation at every point of the STEM pipeline. We must create an environment where girls and women can readily engage in STEM education and then use those skills to progress through their careers to senior levels.' (Office of the Chief Scientist, 2016)*

DISER has commissioned the Australian Bureau of Statistics (ABS) to undertake this work on longitudinal analysis of graduates to inform the next STEM Equity Monitor.

The 2020 longitudinal analysis (published as part of the 2021 Monitor) done by the ABS was the first of its kind which followed the professional journeys from 2012 to 2016 of the individuals who graduated in 2011, and hence had the potential to uncover some new challenges and also provide further evidence of some of the previously known barriers to engagement with STEM.

1.2 Project objectives

The aim of the Women in STEM analytical project was to undertake longitudinal analysis of employment outcomes of Australians with STEM qualifications from a gender perspective. This will provide crucial insights on progression for women in the STEM pathway, through longitudinal evidence using the Multi-agency Data Integration Project (MADIP) dataset. While each step in the pathway was examined in the 2020 Monitor, the data shown was static trend data and linkages between data sources were not available.

The longitudinal analysis undertaken by ABS complements existing STEM Equity Monitor data which is currently updated annually with the latest available higher education and workforce data. The insights focus closely on gender gaps and key differences among women and men.

The analysis undertaken in 2021 examined 2011 graduates with STEM, Non-STEM and Health qualifications through to their employment outcomes in the 2015/16 Personal Income Tax dataset. This analysis assessed an individual's qualification as at 2011 in order to capture individuals with STEM qualifications who have then completed further qualifications in STEM or non-STEM fields since 2011.

A second cohort was examined to look at people who started their study (in STEM) in 2012 to investigate the proportion who completed their study by 2016, those who didn't continue with their studies and those who were still studying. The purpose of this analysis was to look at the profile of younger students at the beginning of their undergraduate study and how they transitioned in and out of education.

Insights from the Women in STEM analytical project will provide supporting data for policy and program development and evaluation.

1.3 Research questions (Chapter 3: Longitudinal analysis of further study – 2011 cohort)

- Of the STEM graduates who returned to higher education, who stayed in STEM and who changed to another field?
- How did an additional qualification impact their employment and earnings in 2016?
- Were they more likely to be in professional occupations if they did a further qualification?

1.4 Research questions (Chapter 4: Completion rate analysis - 2012-16 cohort)

- What proportion of young STEM students (aged under 25) who started their bachelor's degree studies in 2012 had completed their studies by 2016?
- What field did they start and finish their studies in?
- What proportion were still studying in 2016 and what proportion did not complete their studies?

CHAPTER 2: METHOD

2.1 Data

The MADIP dataset used in this analysis, called the Modular Product, relates to the resident Australian population between 1 January 2011 and 31 December 2016. The product is made up of modules containing key demographic, social, healthcare, education, government payment and income information for this population over the period 2011-16 from a number of different government departments.

The MADIP datasets used for this project included:

- Higher Education (HIED) – 2011-16
- The Census of Population and Housing – 2016
- Personal Income Tax (PIT) – 2011-16
- Social Security and Related Information (SSRI) – 2011-16

The analysis was conducted on students in the Higher Education dataset. Key variables of interest were: gender, STEM qualifications (type/level), occupation, taxable income and other demographics.

Higher Education dataset

The Higher Education dataset contains information about domestic students enrolled in or who had completed a university course with an Australian institution between 1 January 2011 and 31 December 2016.

Personal income tax (PIT) dataset

PIT data contains information about all persons who submitted a tax return to the Australian Tax Office between 2010-11 and 2015-16. PIT contains financial year data, whereas the other datasets in the linkage contain calendar year data.

Census dataset

The 2016 Census dataset contains information collected during the Census of Population and Housing on 9 August 2016 and is representative of the Australian population at the time of collection.

Social Security and Related Information (SSRI) dataset

SSRI data includes information about all persons who received at least one Australian Government benefit between January 2011 to December 2016.

More information on the scope of MADIP is in the methodology notes which are available on the ABS website in Microdata: Multi-Agency Data Integration Project. This contains information for the MADIP Modular Product, 2011-2016.

2.2 Population scope

The MADIP linked dataset was analysed and scoped to the population of Higher Education students who completed a qualification in 2011. The outcomes explored for this cohort relate to the six years between 2011 and 2016, with a primary focus on outcomes in 2016.

The following table outlines the size of the scoped population and the number of students after the datasets have been linked. These numbers exclude persons aged 14 years or under, overseas visitors and persons who have died.

Datasets	Frequency
Higher Education dataset (2011 completions)	161,091
Higher Education dataset (2011 completions) linked to PIT (2010/11 to 2015-16)	157,065
Higher Education dataset (2011 completions) linked to 2016 Census	130,667

2.3 Data quality

2.3.1 Use of MADIP Modular Product

All reasonable attempts have been made to ensure the accuracy of the MADIP Modular Product. Nevertheless, potential sources of error, including linking error, reporting error and processing error should be kept in mind when interpreting any results produced from the microdata product.

For more information on these types of error in MADIP please refer to the methodology notes which are available on the ABS website in Microdata: Multi-Agency Data Integration Project.

Missed links can occur for various reasons when linking the Higher Education data to the MADIP spine.

In relation to PIT data, not everyone lodges a tax return and it is not required if the income earned was below the tax-free threshold. Additionally, some missed links will result from missed links between the Higher Education dataset and the MADIP spine.

There may have been some Australian residents who completed a qualification in 2011, but were overseas on Census night and, therefore not counted in the 2016 Census. This may partially explain why linkage with the 2016 Census is lower than linkage with PIT. Another reason why linkage with 2016 Census may be lower is due to the younger age demographic of the population of interest. Young people were less likely to have responded to the Census compared with older people, resulting in a higher rate of missed links for this population.

2.3.2 Use of administrative datasets

For interpretation of the data the reader should be aware of the scope of the MADIP dataset and each dataset used in the analysis.

More information on the scope of MADIP is in the methodology notes which are available on the ABS website in Microdata: Multi-Agency Data Integration Project. This contains information for the MADIP Modular Product, 2011-2016.

Linking rates are not expected to be 100%, as a match may not be possible for the following reasons:

- A person may not link to SSRI data because they do not receive any social security payments
- People who are out of the labour force or who earn under the tax-free threshold may not appear in income data sourced from PIT
- There may be differences in how a name is recorded on two different datasets which are not resolved by standardisation
- A person may have moved and may have a different address on each dataset
- In the case of non-unique matches, where two people with the same name live in the same geographic area, ABS attempts to find the true match using information available such as age. However, in some cases it may not be possible to identify the true link.

CHAPTER 3: LONGITUDINAL ANALYSIS OF FURTHER STUDY – 2011 COHORT

3.1 Profile of Higher Education completions in 2011 by further study, 2012-15

3.1.1 Previous findings

In the previous report from the longitudinal analysis of the 2011 Higher Education cohort, it was found that 58% of women from the 2011 STEM cohort had returned to Higher Education between 2012 and 2016. This was considerably higher than the proportion of male STEM graduates (40%).

Other key findings included:

- Graduates in Natural and Physical Sciences had the highest rates of returning to study with two-thirds of both men (67%) and women (68%) undertaking further Higher Education in the 2012-16 period
- Less than half (40%) of the women in the 2011 STEM cohort who did further study remained in a STEM field compared with 55% of men
- Over 60% of the women and men STEM graduates who were studying in 2016 were doing a full-time study program compared with around 40% of those who returned from non-STEM fields

While that earlier investigation reported on characteristics of the people and the study being pursued, this analysis explores the topic further by focusing on employment and earnings outcomes of those who completed another higher education qualification between 2012 and 2015.

The specific questions addressed include:

- Which STEM graduates who return to higher education stay in STEM and who changes to another field?
- How does an additional qualification impact their employment and earnings in 2016?
- Are they more likely to be in professional occupations if they did a further qualification?

3.1.2 Population of interest for the current study

The following information is based on the longitudinal cohort of 161,100 students who completed a higher education qualification in 2011. STEM graduates comprised 26,310 (16%) of the cohort, including 9,960 women.

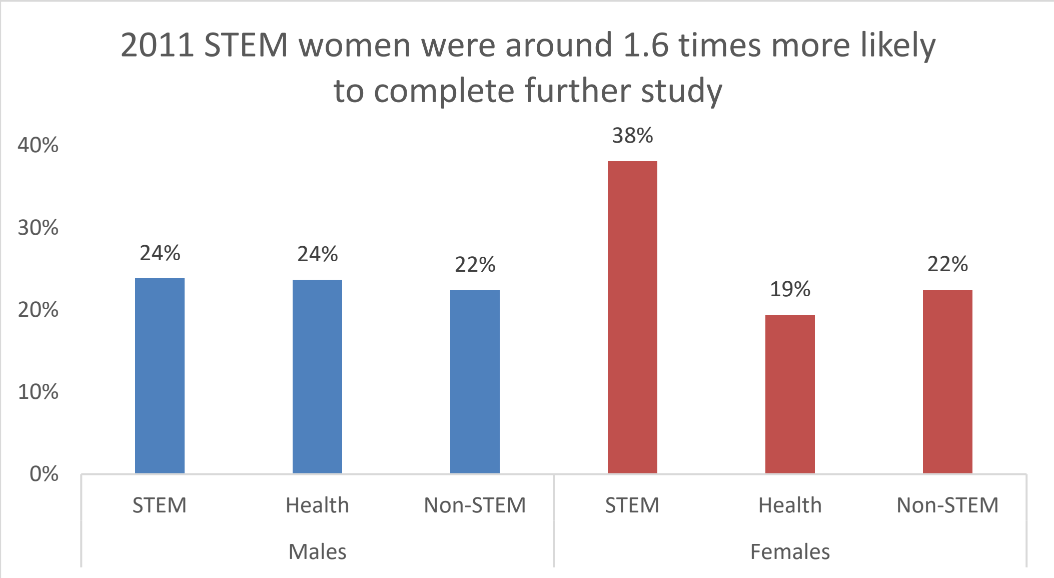
This section explores the characteristics and outcomes of students who completed another qualification between 2012 and 2015. The highest and most recent qualification attained was used as their indication of further study.

Although people who graduated in 2016 could have been included, they have been excluded from the current analysis to avoid confounding from including 2016 study completions with the 2016 outcomes.

3.1.3 Further study completions by field of first qualification

- 38% of women who completed a STEM qualification in 2011 had completed a second qualification between 2012 and 2015 which was around 1.6 times higher than for men and other fields for either gender

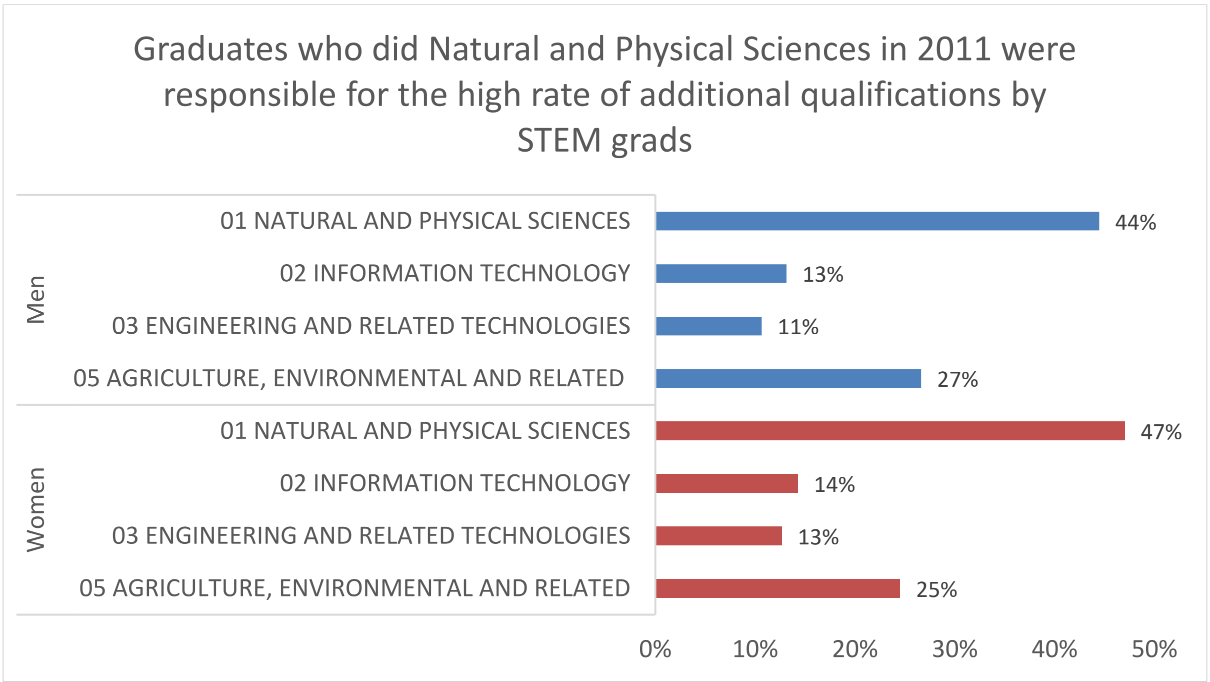
Figure 3.1 Proportion of 2011 graduates who completed a second qualification by 2015



3.1.4 Further study completions by first qualification (2-digit field)

- The higher completion rate of additional qualifications among women STEM graduates was driven by graduates of the Natural and Physical Sciences with almost half of women (47%) and men (45%) obtaining another qualification by 2015
- As a consequence, the 2011 graduates of the Natural and Physical Sciences make up the majority of STEM women (85%) and men (63%) who completed a second qualification

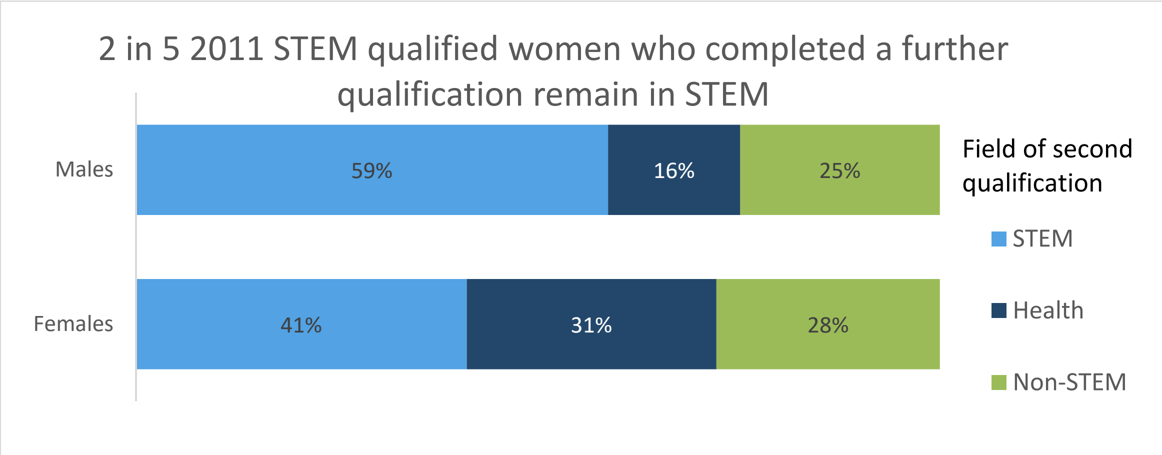
Figure 3.2 Proportion of 2011 STEM graduates completing another qualification in 2012-15



3.1.5 Field of second qualification

- Less than half (41%) of the 2011 STEM women who completed a second qualification in 2012-15 remained in a STEM field compared with 59% of men completing second qualification
- Just over half of the 2011 STEM women who completed a second qualification not in STEM graduated in a Health field (31% overall)

Figure 3.3 Distribution of second qualification fields from 2011 STEM graduates(a)



(a) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

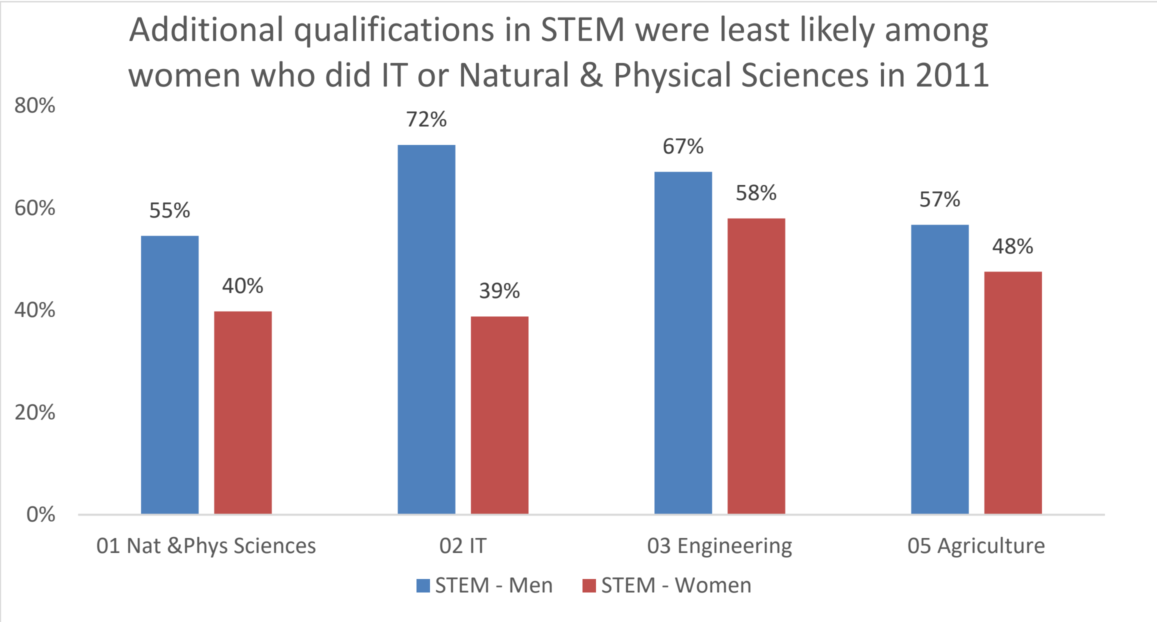
STEM graduates from the 2011 higher education cohort who obtained an additional qualification in 2012-15 had varying propensity of gaining another STEM qualification depending on their gender and 2011 field.

Additional STEM qualifications were most common among:

- Men who did IT or Engineering in 2011 (72%, 67% respectively)
- Women who did Engineering in 2011 (58%)

Additional STEM qualifications were least commonly obtained among women who did IT or Natural and Physical Sciences (39%, 40% respectively).

Figure 3.4 Proportion of 2011 STEM graduates gaining their second qualification in STEM(a)

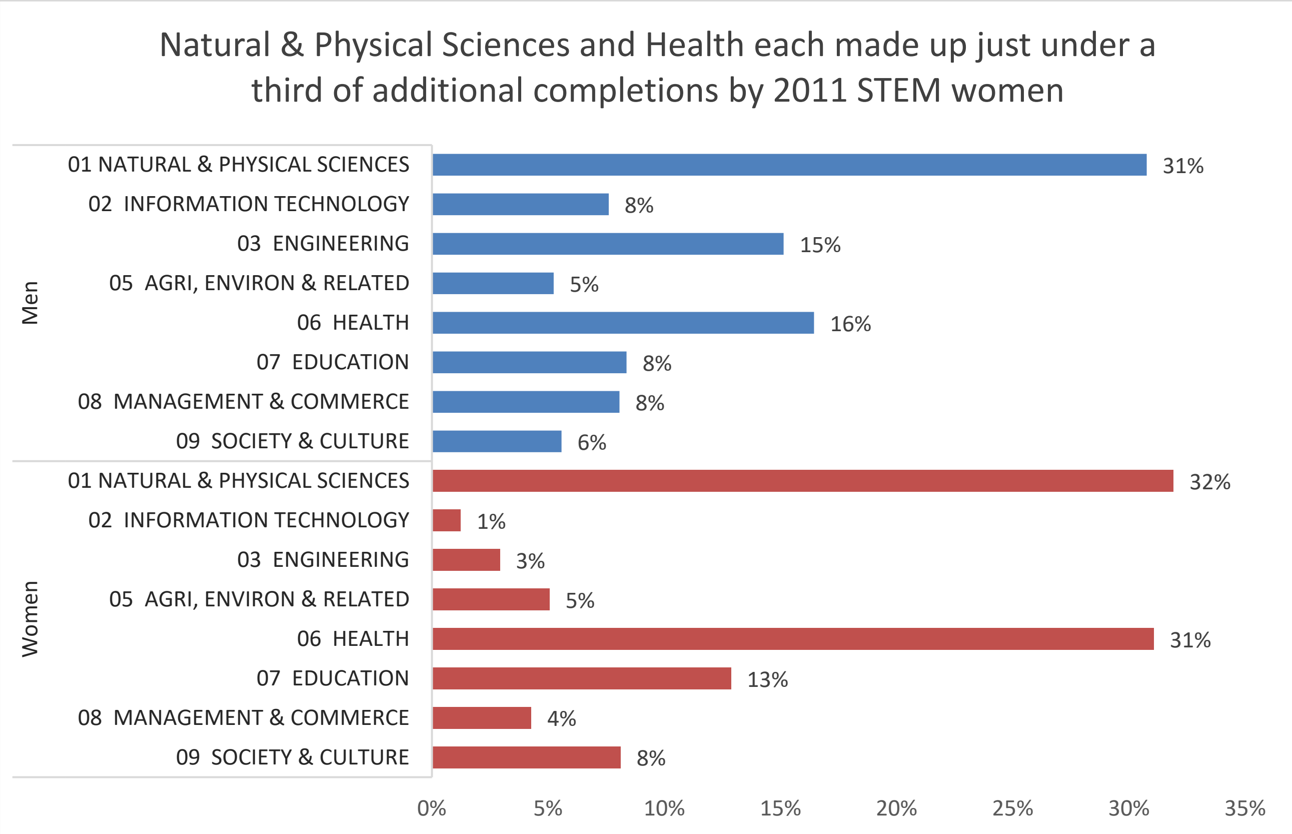


(a) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

Within the two-digit ASCED fields of additional qualifications:

- Natural & Physical Sciences made up 32% for women and 31% for men
- Health made up a similar amount for women (31%) and around half that (16%) for men
- Education was the third most common field for women (13%)
- Engineering was third for men (15%)

Figure 3.5 Distribution of additional qualification fields by 2011 STEM graduates(a)

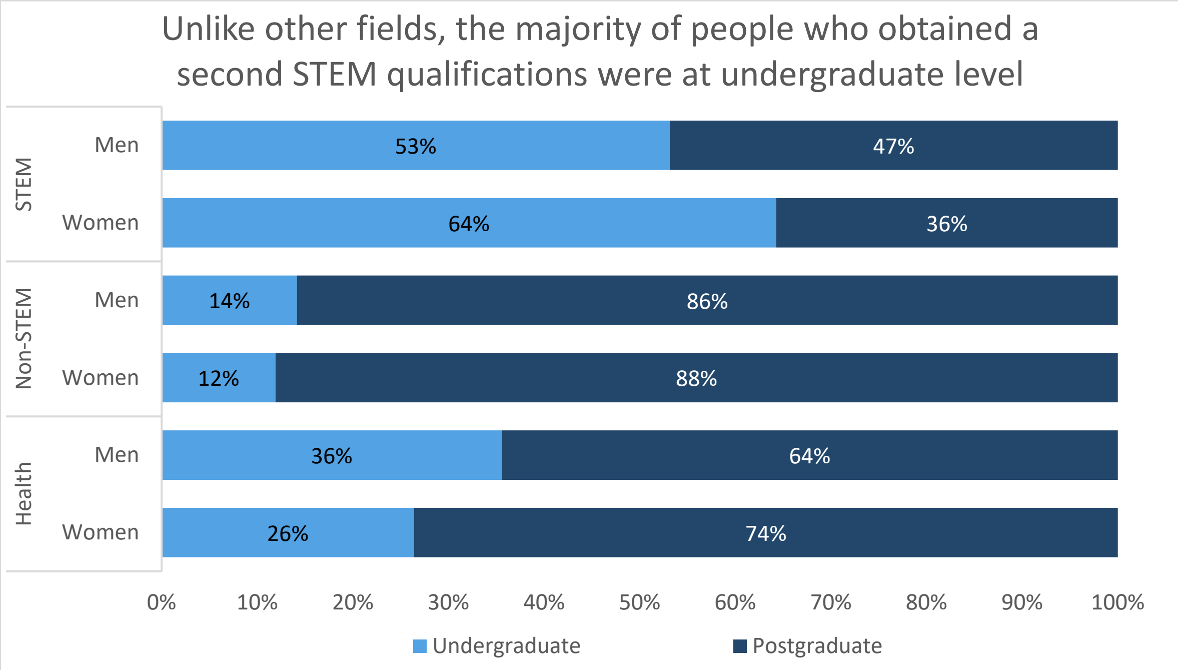


(c) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

3.1.6 Level of further study of second qualification

- Just over half of men (53%) and almost two thirds (64%) of women who completed a second STEM qualification were studying at an undergraduate level
- This was considerably higher than for men and women who completed either non-STEM (14% men, 12% women) or health qualifications (36% men, 26% women)

Figure 3.6 Proportion of second qualifications by level and field of second qualification(a)



(a) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

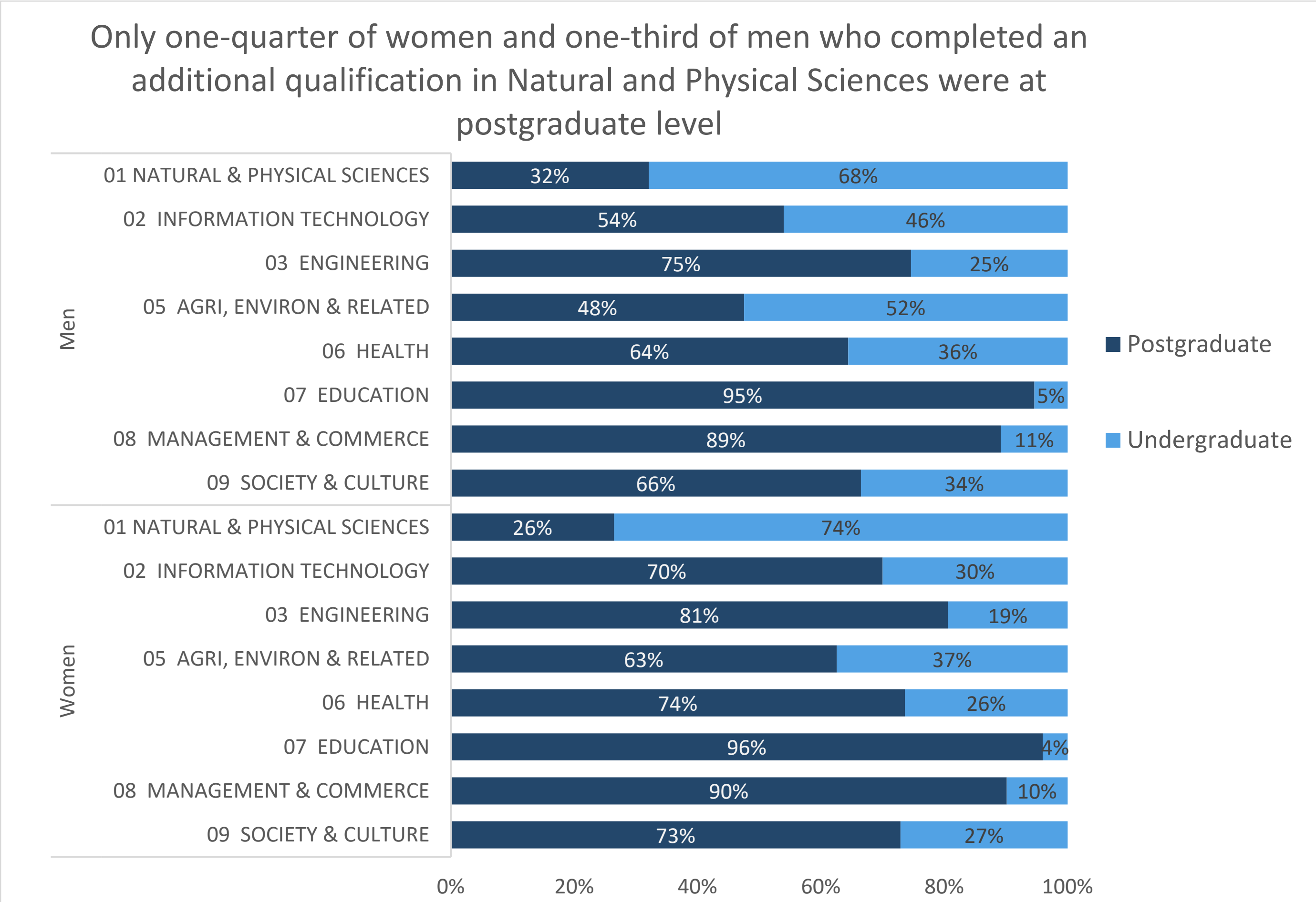
3.1.7 Level of further study of additional qualification by field

Although the majority (60%) of people who completed an additional qualification in STEM between 2012 and 2015 obtained a postgraduate qualification, there was considerable variability in the level associated with the field.

- Natural and physical Sciences qualifications were overwhelmingly at undergraduate level with just 32% of men and 26% of women gaining a postgraduate qualification
- The qualifications most likely to be at postgraduate level were Education (95%-96%) and Management and Commerce (89%-90%)
- Health had around twice the postgraduate rate as Natural and Physical Sciences for men (64% to 36%), but almost three times the postgraduate rate for women (74% to 26%)

The likely reasons or significance of the low proportion of the Natural and physical Sciences at postgraduate level is currently unclear. Closer inspection of the four digit ASCED fields (comparing the 2011 field with the 2012-16 field) was unable to provide further insight due to the Higher Education dataset having the majority of two digit field 'Natural and physical Sciences' classified as 'Not adequately defined' or 'Other Natural and physical Sciences'.

Figure 3.7 Distribution of second qualifications by level and field of second qualification(a)



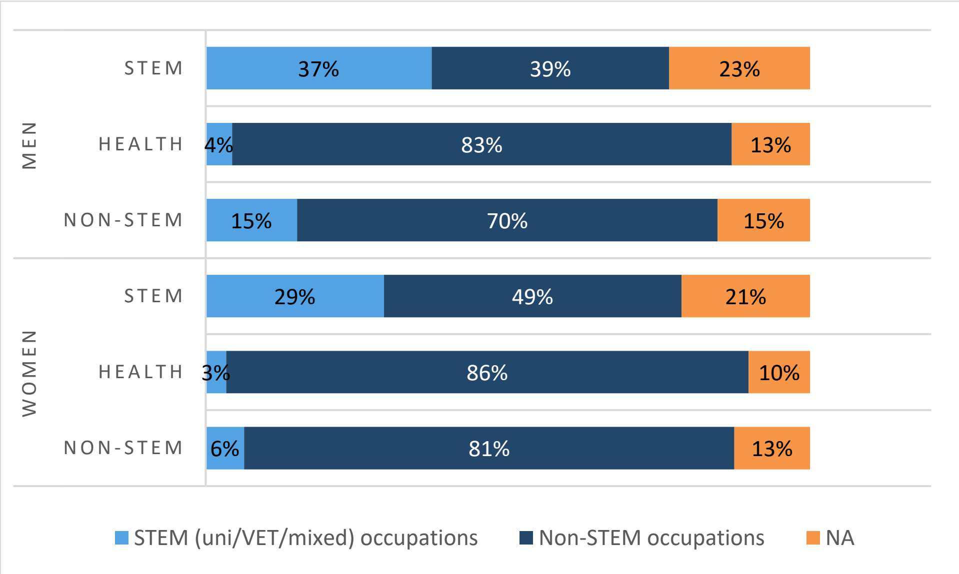
(a) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

3.2 Occupations in 2016 of people who did further study, 2012-15

3.2.1 Occupation type for students who did further study

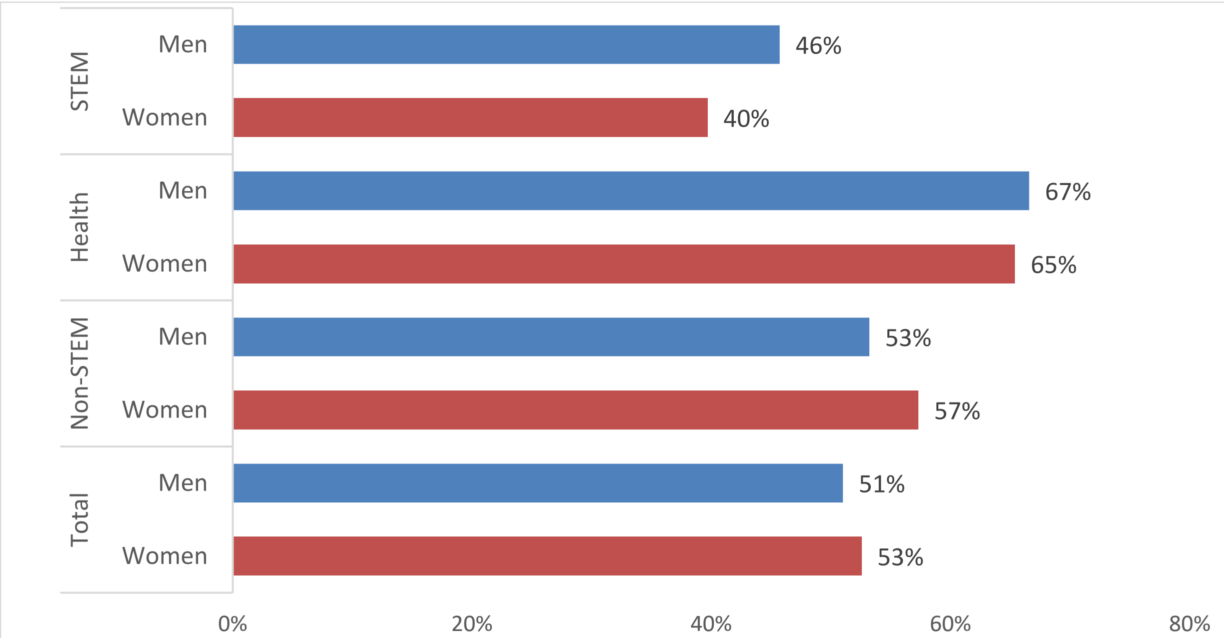
- One in two women (49%) who completed further study in STEM ended up in a non-STEM occupation compared with two in five men (39%)
- A higher proportion of men (15%) were working in STEM qualified occupations when their further study was non-STEM related, compared with 6% of women in the same situation

Figure 3.8 Type of occupation by field of further study, 2016



- 46% of men who studied two STEM qualifications compared with 40% of women who had done two STEM qualifications were employed as professionals
- However, women who studied in STEM for their first qualification and then did a non-STEM qualification, were more likely than men to be employed as professionals (57% of women, compared with 53% of men)

Figure 3.9 Persons employed in professional occupations by the field of additional qualification, 2016(a)

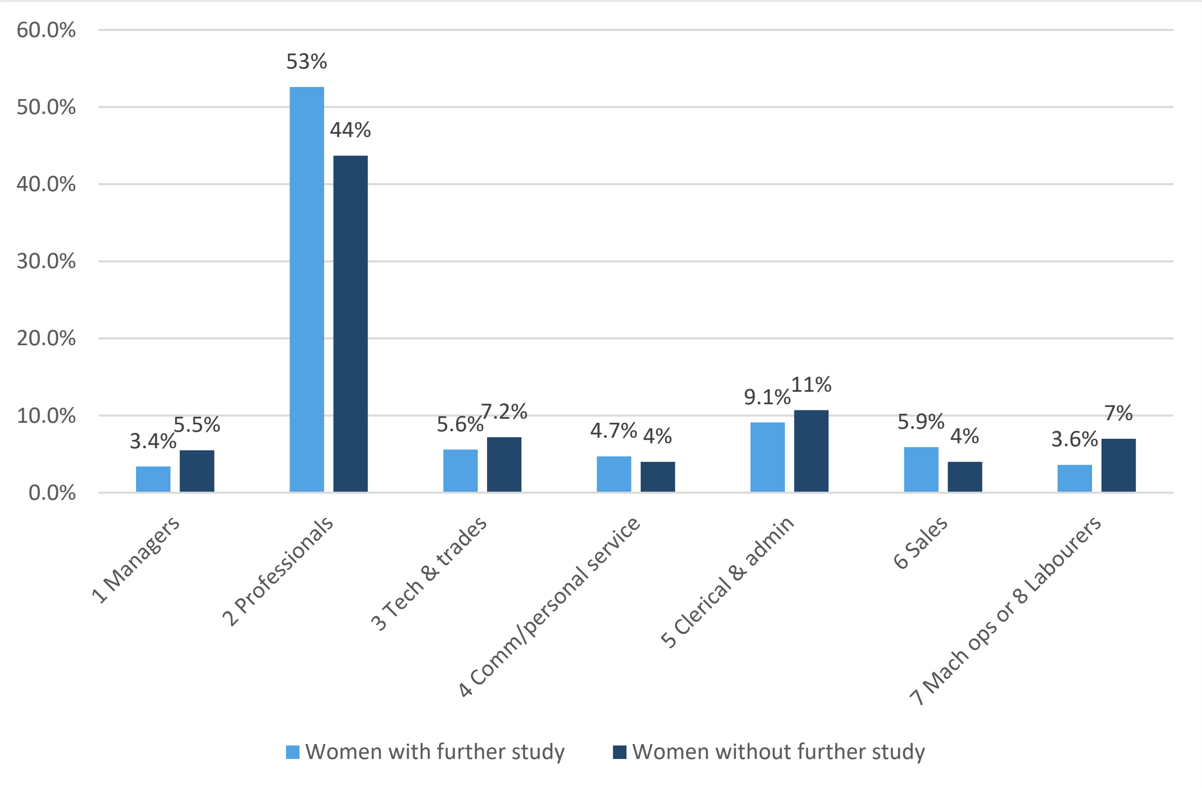


(a) Of the 2011 STEM cohort who completed an additional qualification in 2012-15

3.2.2 STEM qualified women by type of occupation and further study status

- Over half (53%) of 2011 STEM qualified women were in professional occupations if they had done another qualification compared with 44% of women who had not done further study. This figure includes all fields of further study (ie. STEM, non-STEM and health)
- The second most common type of occupation for women with or without another qualification was Clerical and Administrative Workers (9.1% and 11% respectively)
- Sales Workers (5.9%) and Technicians and Trades Workers (5.6%) were the next most common occupations for STEM qualified women who did complete further study
- Technicians and Trades Workers (7.2%) and Machinery Operators and Drivers (7%) were the next most common occupations for STEM qualified women who didn't complete further study

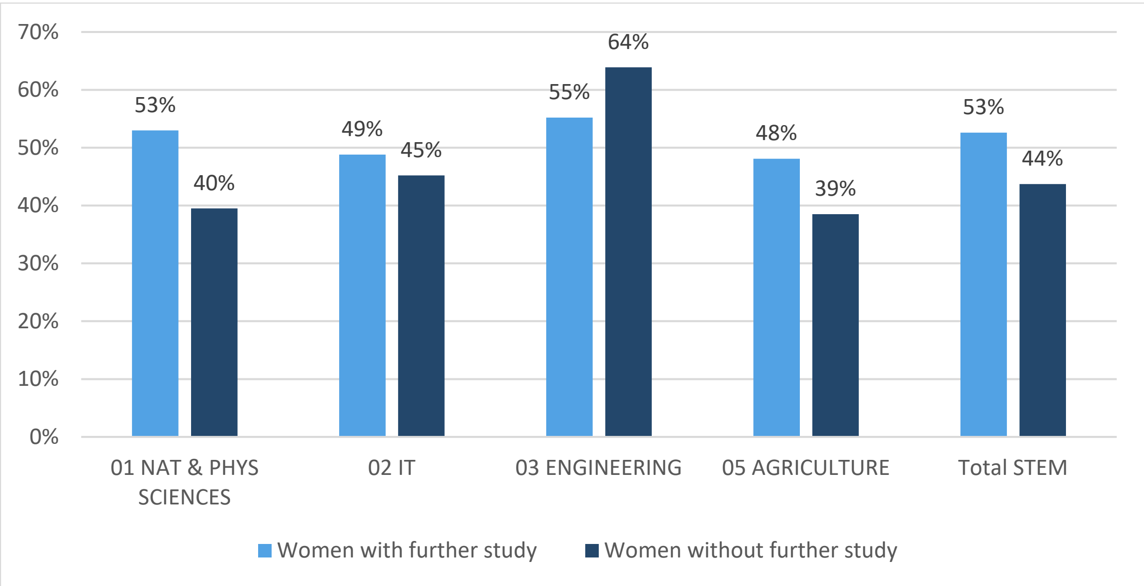
Figure 3.10 STEM qualified women by type of occupation by whether or not they had done further study, 2016



3.2.3 Women in professional occupations with further study

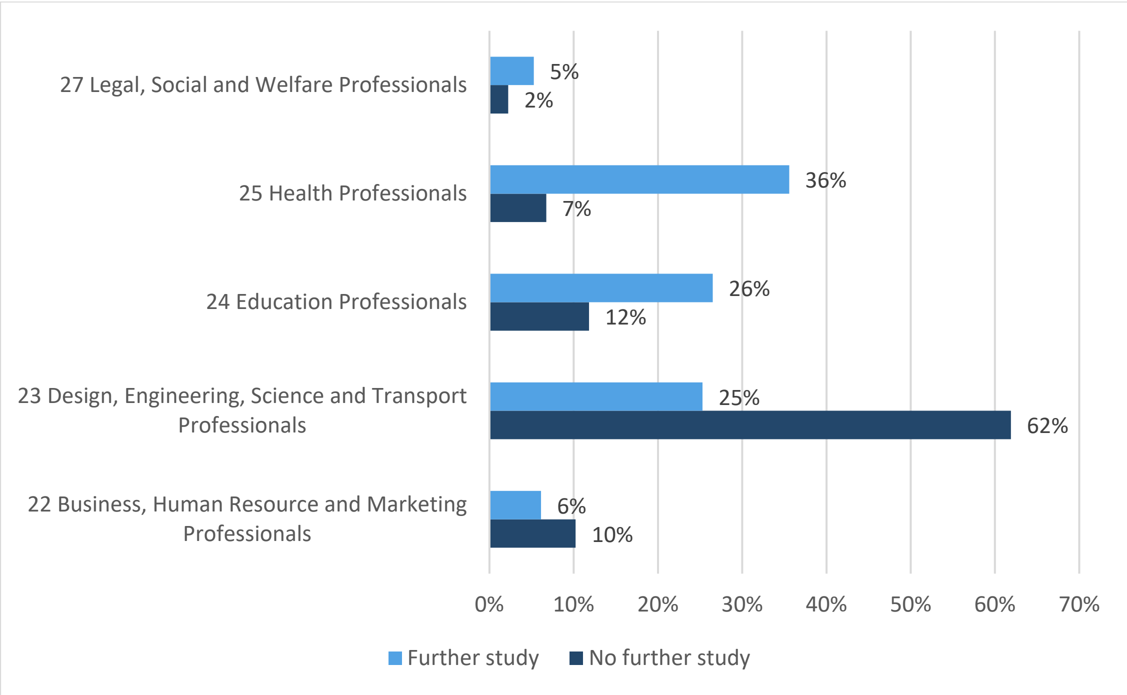
- Looking at the breakdown of STEM fields, further study was most beneficial to women who studied Natural and Physical Sciences in 2011 showing the largest difference in proportion between those who had done further study and those who hadn't. Over half of these women (53%) were employed as professionals, compared with 40% of those who didn't do any further study between 2012 and 2015.
- Almost two-thirds (64%) of women without another qualification were employed as professionals if they studied Engineering in 2011. This proportion is lower (55%) for women who completed further study between 2012 and 2015. However, the proportion of professionals is higher for women with qualifications in all other STEM fields when they have completed a further qualification.

Figure 3.11 Women employed in professional occupations by the field of their first qualification, 2016



- Being employed as a health professional is the most common field for those women who did further study with over a third (36%) being employed in this profession
- The most common field for women without a further qualification is 'Design, Engineering, Science and Transport Professionals' with 62% being employed in this field

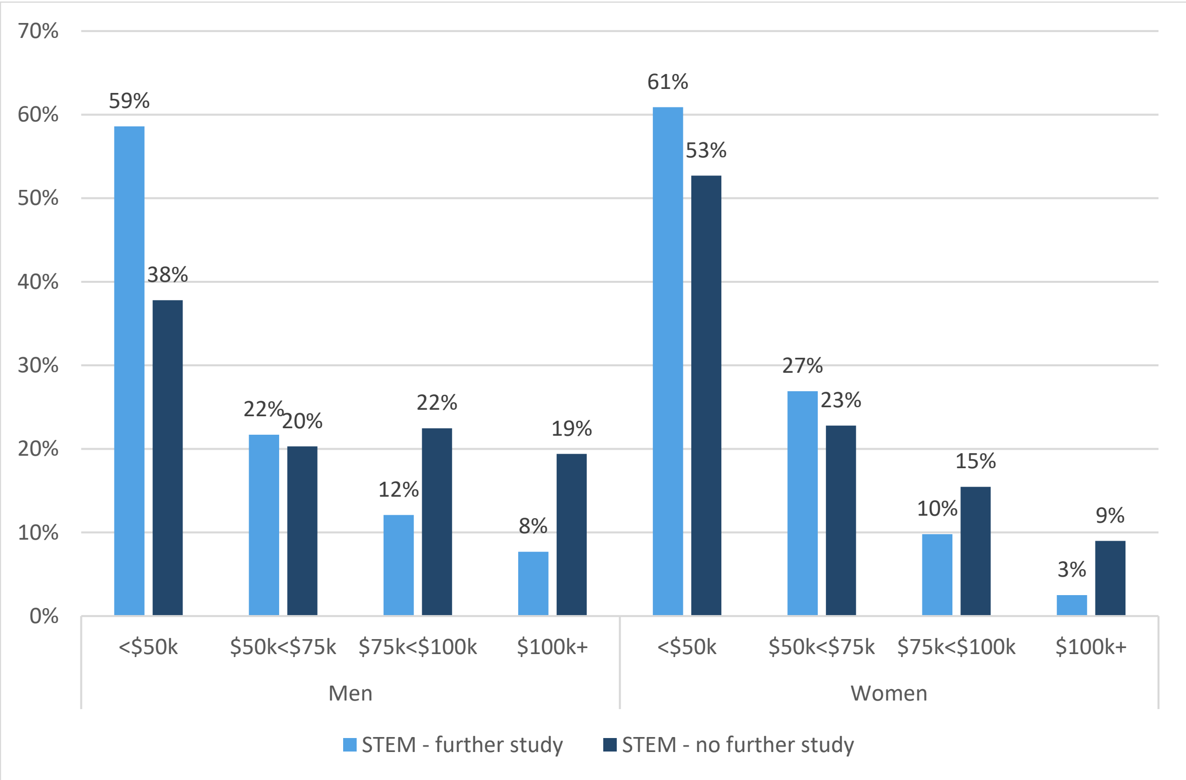
Figure 3.12 Top 5 professional fields of employment for women, 2016



3.2.4 Income of students with further study

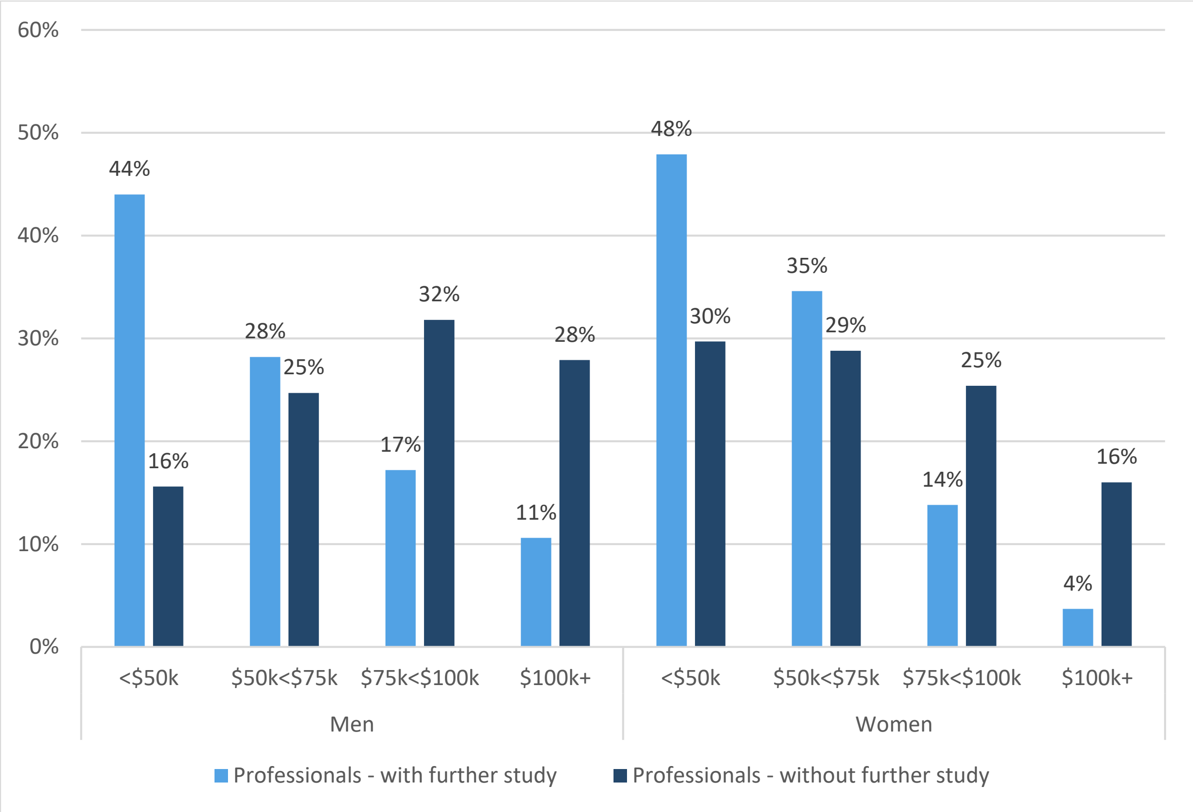
- Note that it may be too soon to see an improvement from further study on income levels as some people may not have gained employment in an occupation relevant to their study or they may still be on a graduate level wage after their second qualification, particularly if their qualification was only completed in 2015 as the outcomes are measured in the 2015/16 financial year
- Most 2011 STEM qualified men (59%) and women (61%) were earning below $50,000 if they had done further study
- However, just over half (53%) of women earnt under $50,000 if they didn't do any further study compared with 38% of men who didn't do further study
- 2011 STEM qualified women with further study were more likely to earn between $50,000 and $75,000 (27%) than their peers who didn't continue with study (23%)

Figure 3.13 Income of 2011 STEM qualified persons who did further study in all occupations, 2016



- Of STEM qualified professionals, 60% of men and 41% of women without further study were earning above $75,000 in 2016
- In comparison, the proportion earning above $75,000 for all occupation types where no further study had been completed was 41% of men and a quarter of women (24%)
- However, the proportion of STEM qualified men and women employed as professionals earning above $75,000 is much lower for those who had completed further study. Just over a quarter of these men (28%) and 18% of the women earnt above $75,000.

Figure 3.14 Income of 2011 STEM qualified Professionals who did further study, 2016

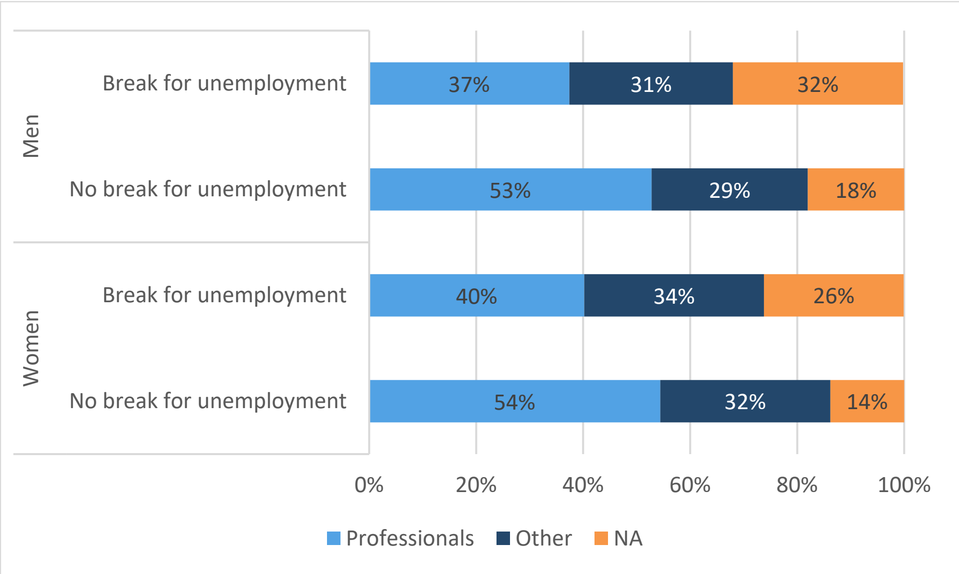


3.3 The effect of a period of unemployment

3.3.1 The effect of unemployment on having a professional occupation

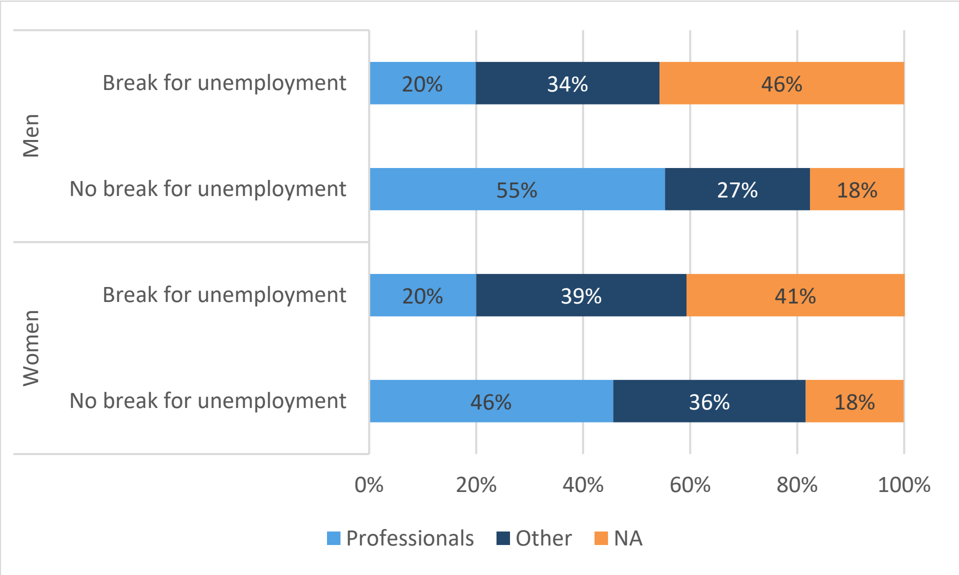
- Note that this analysis uses the unemployment indicator developed for the 'Career Breaks Analysis' provided to DISER in 2020
- Over half of men (53%) and women (54%) who did further study and did not experience any unemployment were employed as professionals by 2016
- A smaller proportion of both men (37%) and women (40%) who did further study were less likely to be employed as professionals if they had taken a break for unemployment

Figure 3.15 STEM graduates who did further study and their occupation type in 2016 by whether or not they took a break for unemployment



- Over half of men (55%) and 46% of women who did not do further study and did not take a break for unemployment were employed as professionals by 2016
- However, a notable difference is found for those who did not do further study and took a break for unemployment as only one in five men or women ended up employed in a professional occupation by 2016

Figure 3.16 STEM graduates who didn't do further study and their occupation type in 2016 by whether or not they took a break for unemployment



CHAPTER 4: COMPLETION RATE ANALYSIS - 2012-16 COHORT

4.1 Higher education outcomes from undergraduate commencements

The MADIP longitudinal study of women in STEM begins with 9,960 women STEM graduates from a broader group of 161,100 higher education completions in 2011. Because 2011 is the starting point for the MADIP data asset, it is not possible to trace this cohort from the commencement of their undergraduate careers. However, examining the qualification outcomes for the cohort who began as undergraduates in 2012 provides some important context for the undergraduate STEM journey of women and men relative to other fields.

4.2 Population of interest

The following information is based on the cohort of higher education enrolments commencing in 2012. Because the aim is to understand outcomes from the start of the higher education journey this population was restricted to people:

- Not enrolled in higher education 2011
- Enrolled in an undergraduate program in 2012
- Aged less than 25 years in 2012

This gives a commencement cohort of almost 140,000 undergraduate students whose study participation was measured over the five years 2016 to determine completion rates.

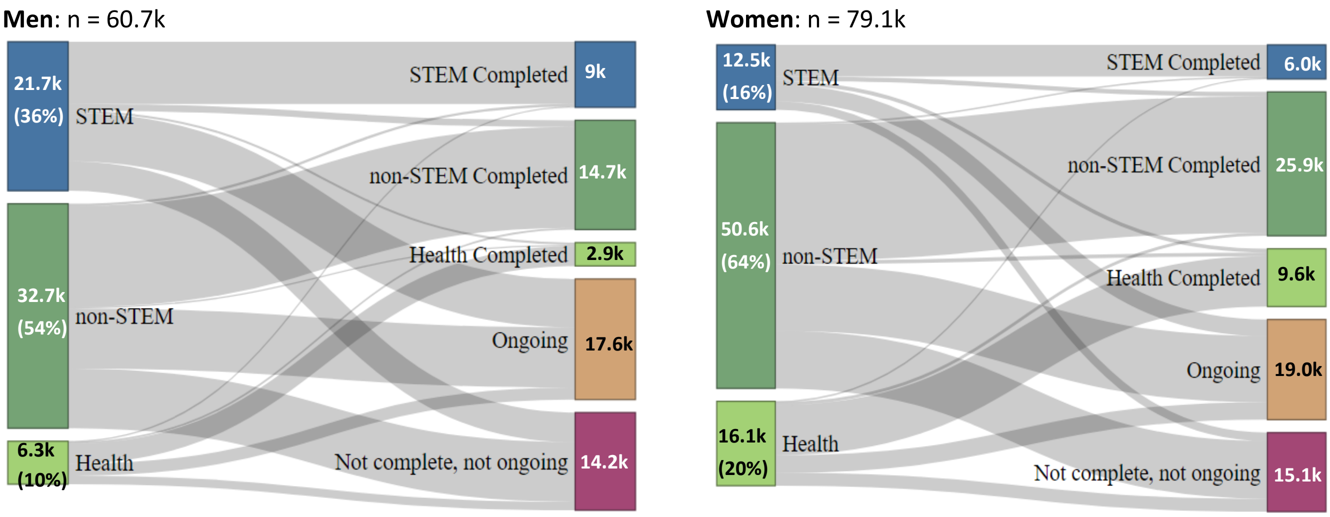
The specific questions addressed include:

- What proportion of young STEM students (aged under 25) who started their bachelor's degree studies in 2012 had completed their studies by 2016?
- What field did they start and finish their studies in?
- What proportion were still studying in 2016?

4.3 Overall completion rates of the 2012 cohort

- More than half (57%) of the women who had started undergraduate study in 2012 had completed a bachelor's degree by 2016, compared with just under half (48%) of the men
- Women made up a majority (61%) of completions by 2016. The higher proportion of women's completions was in part due to women comprising the greater share of 2012 commencements (57%) in addition to the higher completion rate by women.
- Around one in five women (19%) and almost one in four men (23%) who started in 2012 had not completed their qualification and were no longer enrolled in study in 2016. This left 24% of women and 29% of men classified as 'ongoing' in 2016 (not complete but still enrolled).
- STEM graduates comprised 15% of the women's and 33% of the men's completions by 2016

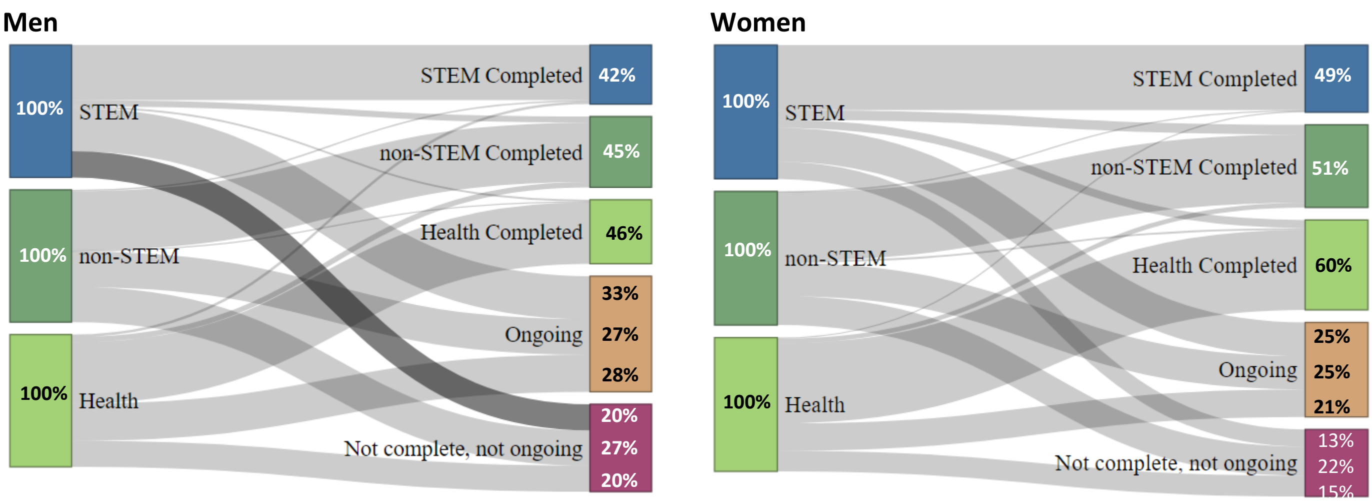
Figure 4.1: 2012 Undergraduate enrolments and 2016 completion outcomes, by STEM, Health and non-STEM fields



4.4 Higher education completions – proportions by STEM, Health and non-STEM fields

- Almost half (49%) of the women who started in a STEM field in 2012 had completed by 2016, compared with 42% among men
- Just 13% of women who commenced in STEM in 2012 had failed to complete by 2016 compared with 20% of men who started in STEM
- Health was the field with the highest rates of completion among women undergraduates with 60% completing by 2016, followed by non-STEM with 51%

Figure 4.2: Proportion of 2012 undergraduate enrolments and 2016 completion outcomes, by STEM, Health and non-STEM fields

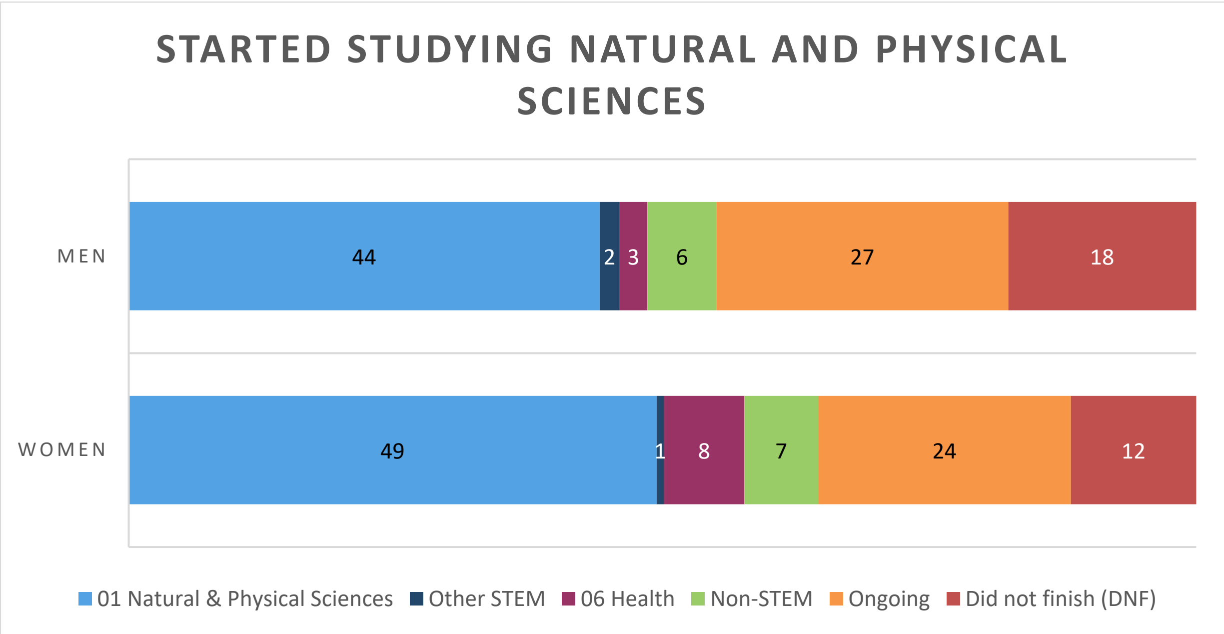


4.5 Completion rates of STEM fields from 2012 commencements

Natural and Physical Sciences

- Around half of the women (49%) who started in Natural and Physical Sciences had completed that degree by 2016, which was slightly higher than the rate for men (44%)
- A further 16% of women and 12% of men had completed a degree in another field giving an overall completion rate of 65% for women compared with 56% for men

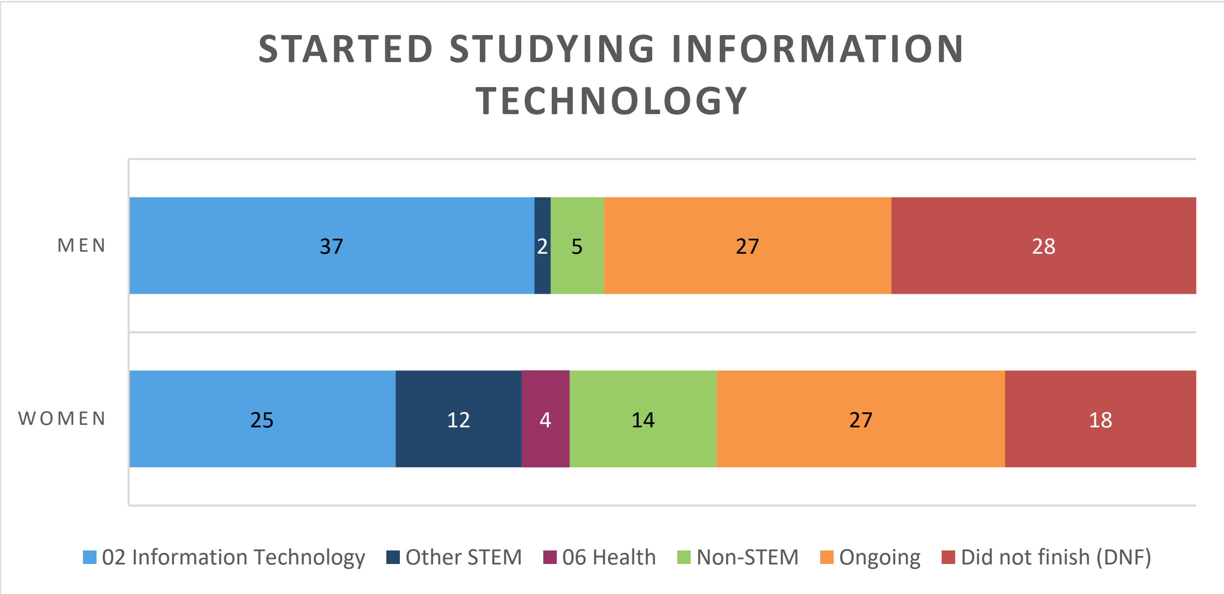
Figure 4.3 Started in Natural and Physical Sciences



Information Technology

- Of people who started an undergraduate degree in IT in 2012, men were considerably more likely than women (37% and 25%) to have graduated with an IT degree by 2016
- Although women had significantly lower completion rates for IT than men, women who started in IT in exceeded men's overall completion rates with 56% having completed a qualification by 2016 compared with 45% of men
- 14% of women who pivoted from IT completed a non-STEM qualification and 12% completed another STEM qualification, mainly in Natural and Physical Sciences (10%)
- An equal proportion (27%) of both men and women had not completed but were still enrolled in 2016

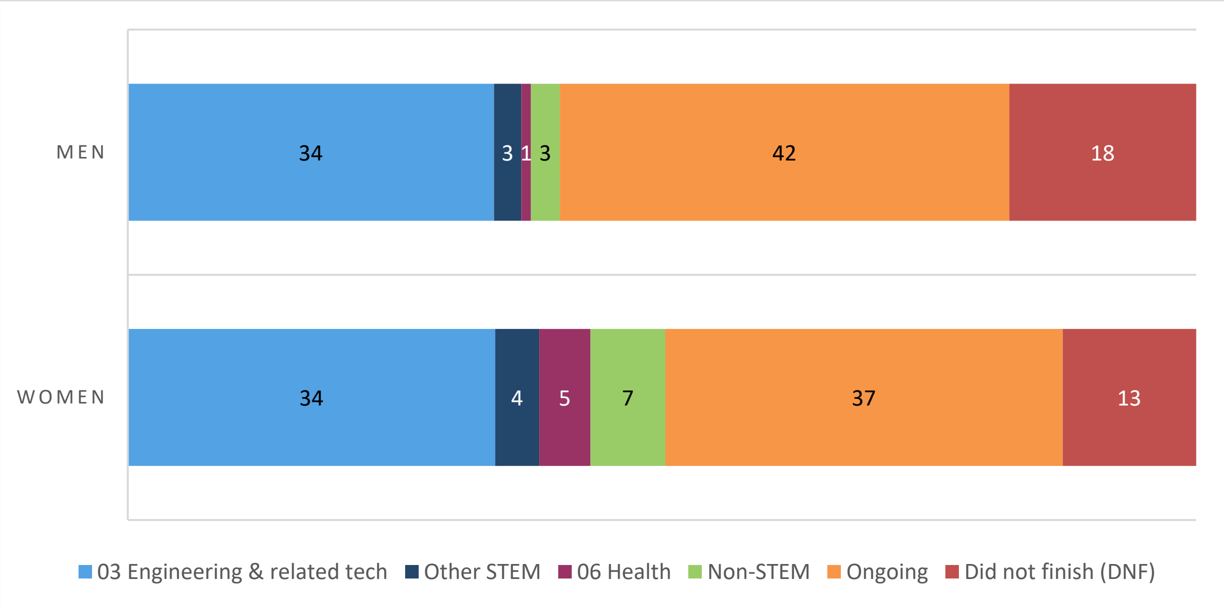
Figure 4.4 Started studying in Information Technology



Engineering and Related Technologies

- Around one-third (34%) of both men and women who started Engineering and Related Technologies in 2012 completed that degree by 2016
- A further 16% of women had managed to complete another qualification compared with the 7% of men who did so
- Men were more likely than women to be either still enrolled (42% and 37%) or have withdrawn from study without a completion (18% and 13%)

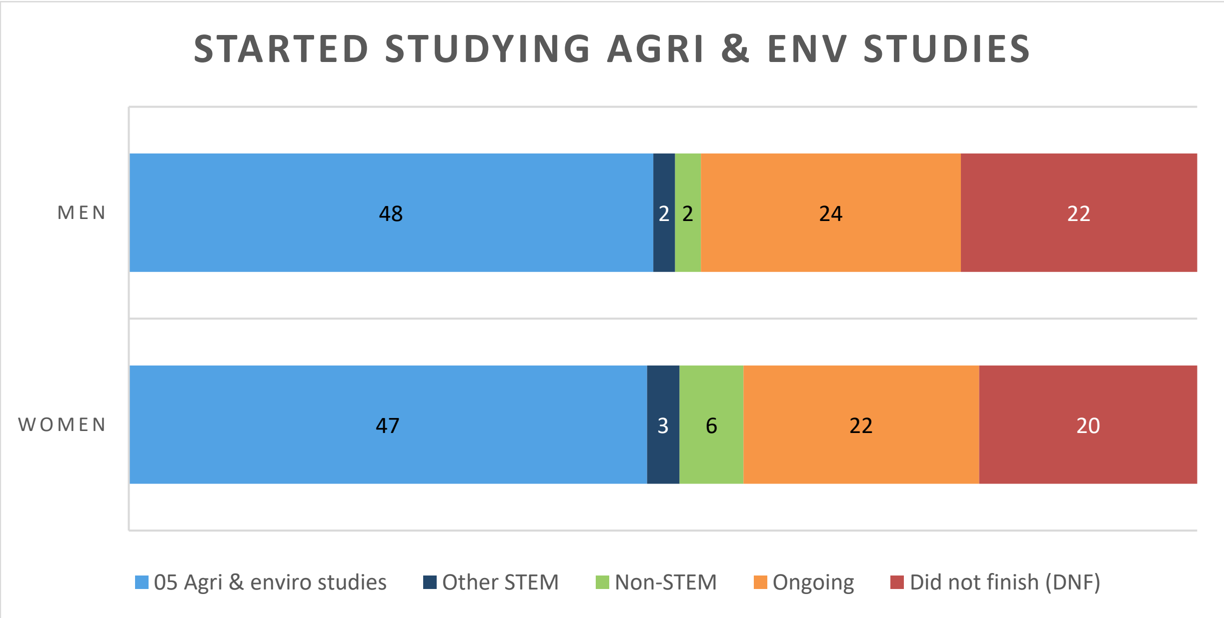
Figure 4.5 Started studying in Engineering and Related Technologies



Agriculture, Environmental and Related Studies

- Just under half of women (47%) and men (48%) who commenced a bachelor's degree in Agriculture, Environmental and Related Studies had completed that qualification by 2016
- A further 11% of women and 6% of men had completed qualifications in other fields, giving an overall completion rate of 58% for women and 54% for men who started their degree in Agriculture, Environmental and Related Studies in 2012

Figure 4.6 Started in Agriculture, Environmental and Related Studies



NEXT STEPS

The outcomes for graduates are in their early stages of analysis and graduate pathways will become clearer as more time periods are added to the analysis. More years of data are required to see graduate pathways for those STEM qualified graduates who have completed further study.

Adding new time points for the 2011 Higher Education cohort when the second and third phases of the longitudinal analysis are run would show outcomes of graduates who completed further study after 10 years and 15 years.

Further exploration of the completion rate analysis over a longer time period would provide more evidence regarding how students transition through their higher education.

Additional sources of data will be available for the next phase of the Women in STEM analysis. Vocational Education and Training (VET) data will enhance the dataset by including the VET sector graduates and their outcomes. Outcomes data will be enriched by linking in Business Longitudinal Data Environment (BLADE) data, which will provide industry related information.

The ABS and DISER can discuss whether there is scope to include this additional analysis alongside the analysis that is already planned. These additional analyses will require additional approval from the MADIP board to use the linked dataset.

The ABS looks forward to the ongoing close collaboration with DISER on the next phases of analysis.

APPENDIX 1 - GLOSSARY

Apprentice and Trainee (AT) data

The Apprentice and Trainee data is derived from the Australian Apprenticeship training contract data. Data are collected for each individual training contract, but derived and made available at the person level. Information is available yearly from 2011 to 2016. The majority of apprentices and trainees in Australia have only one training contract during each calendar year and therefore the information from this contract is used to represent the person during this period. Where persons held more than one training contract during the year (e.g. completed one apprenticeship and started another, changed apprenticeships during the year) information from the most recently commenced contract is used to represent the person for the period.

Census of Population and Housing

The Australian Census of Population and Housing is an official count of population and dwellings, and collects details of age, sex, and other characteristics of that population. The 2016 Census was the 17th national Census for Australia. (ABS, 2016) More information about the data and classifications is available in the ABS publication 'Census Dictionary, 2016' (cat. no. 2901.0).

Higher Education (HIED) data

The information from HIED included in the MADIP modular product are derived from the Higher Education Management System data. This data is available for the calendar years from 2011 to 2016. Data are collected for each individual higher education course, but derived and made available at the person level in this product. HIED data items are derived on a calendar year basis. The majority of higher education students in Australia have only one recorded enrolment during each calendar year and therefore information from this degree is used to represent the person during this period. Where persons had more than one completion or enrolment during the year, information from the highest level course is recorded.

MADIP

The Multi-Agency Data Integration Project (MADIP) is a partnership among Australian Government agencies to develop a secure and enduring approach for combining information on healthcare, education, government payments, personal income tax, and population demographics (including the Census) to create a comprehensive picture of Australia over time. More information is available on the ABS website.

Personal Income Tax (PIT) data

The Personal Income Tax data is all persons that the Australian Tax Office (ATO) determined were Australian residents at any time between 1 July 2010 and 30 June 2015, inclusive and who submitted a tax return for at least one financial year between 2010-11 and 2015-16.

Social Security and Related Information (SSRI) data

The Social Security and Related Information dataset contains all persons who received at least one government payment in the reference period (1 January 2011 to 31 December 2016). Payment flags are derived with reference to the entire calendar year. For example, a person with the value of ‘1’ for ‘Received Age Pension’ indicates that they were a current recipient of the benefit for at least one day during the 2011 calendar year. For more information about eligibility for specific payments please refer to the ‘Guide to Australian Government Payments’ on the Department of Human Services website.

STEM Equity Monitor

The STEM Equity Monitor collects and integrates data from a range of sources and places them into a single website, providing a national data report on girls’ and women’s participation in and engagement with science, technology, engineering and mathematics.

The Monitor is designed to assist policy makers and the STEM sector to understand where progress is being made, and where future investment in programs and policies can be focused to drive greater gender equity in STEM. More information is available on the DISER website.

APPENDIX 2 - ACRONYMS

ABS - Australian Bureau of Statistics

ASCED - Australian Standard Classification of Education

AT - Apprenticeship and Trainee data

ATO - Australian Tax Office

DISER - Department of Industry, Science, Energy and Resources

HIED - Higher Education data

IEO - Index of Education and Occupation

IRSAD - Index of Relative Socio-Economic Advantage and Disadvantage

MADIP - Multi-agency Data Integration Project

NILF – Not in the labour force

PIT - Personal Income Tax

SSRI - Social Security and Related Information

STEM - Science, Technology, Engineering and Mathematics

APPENDIX 3 – REFERENCES

ABS, 2009. ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0, ABS, Canberra.

ABS, 2016. Census Dictionary, 2016, cat. no. 2901.0, ABS, Canberra.

ABS, 2013. Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 Revision 2.0, cat no. 1292.0, ABS, Canberra.

ATO, 2021. Individual income tax rates for prior years, ATO, Canberra, viewed 30 July 2021.

Australian Academy of Science, 2019. Women in STEM Decadal Plan (Australian Academy of Science)

DISER, 2020. STEM Equity Monitor, DISER, Canberra, viewed 10 August 2020.

Office of the Chief Scientist 2016, Australia’s STEM Workforce, Office of the Chief Scientist, Canberra, viewed 10 August 2020.

APPENDIX 4 – DATA DEFINITIONS

DISER's definition of STEM education fields in the Monitor at the 2-digit level ASCED includes:

Table A4.1: STEM education fields

Field code level	STEM education fields
01	Natural and Physical Sciences
02	Information Technology (IT)
03	Engineering and Related Technologies
05	Agriculture, Environment and Related Studies
Source: Office of the Chief Scientist (2016)	

Health qualifications are generally reported separately from the STEM qualifications in the Monitor, so they are reported in a separate category in this analysis. In cases where the 'health' category was not able to be separated due to low numbers in that category, 'health' qualifications have been included with the 'non-STEM' qualifications.

Table A4.2: Health education fields

Field code level	STEM education fields
06	Health
Source: ABS (2001), Australian Standard Classification of Education (ASCED), 2001, cat no. 1272.0	

Table A4.3: University STEM-qualified occupation list

Code	Occupation
1332	Engineering Managers
2330	Engineering Professionals, nfd
2331	Chemical and Materials Engineers
2332	Civil Engineering Professionals
2333	Electrical Engineers
2334	Electronics Engineers
2335	Industrial, Mechanical and Production Engineers
2336	Mining Engineers
2339	Other Engineering Professionals
2340	Natural and Physical Science Professionals, nfd
2341	Agricultural and Forestry Scientists
2342	Chemists, and Food and Wine Scientists
2343	Environmental Scientists
2344	Geologists, Geophysicists and Hydrogeologists
2345	Life Scientists

Code	Occupation
2346	Medical Laboratory Scientists
2610	Business and Systems Analysts, and Programmers, nfd
2613	Software and Applications Programmers
2633	Telecommunications Engineering Professionals
2241	Actuaries, mathematicians and statisticians *Not identified based on Table 3 description, but included due to recognition that core STEM skills are required for this occupation.
Note: Occupations marked with ‘nfd’ (not further defined) denotes responses and occupations which are not classified into the other defined categories by the ABS. Source: ABS (2009), ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0	

Table A4.4: Vocational Education and Training STEM-qualified occupation list

Code	Occupation
2312	Marine Transport Professionals
3123	Electrical Engineering Draftspersons and Technicians
3124	Electronic Engineering Draftspersons and Technicians
3125	Mechanical Engineering Draftspersons and Technicians
3129	Other Building and Engineering Technicians
3200	Automotive and Engineering Trades Workers, nfd
3210	Automotive Electricians and Mechanics, nfd
3211	Automotive Electricians
3212	Motor Mechanics
3220	Fabrication Engineering Trades Workers, nfd
3222	Sheetmetal Trades Workers
3223	Structural Steel and Welding Trades Workers
3230	Mechanical Engineering Trades Workers, nfd
3231	Aircraft Maintenance Engineers
3232	Metal Fitters and Machinists

Code	Occupation
3233	Precision Metal Trades Workers
3234	Toolmakers and Engineering Patternmakers
3240	Panelbeaters, and Vehicle Body Builders, Trimmers and Painters, nfd
3241	Panelbeaters
3242	Vehicle Body Builders and Trimmers
3243	Vehicle Painters
3400	Electrotechnology and Telecommunications Trades Workers, nfd
3411	Electricians
3421	Airconditioning and Refrigeration Mechanics
3422	Electrical Distribution Trades Workers
3923	Printers
3933	Upholsterers
3941	Cabinetmakers
3991	Boat Builders and Shipwrights
3992	Chemical, Gas, Petroleum and Power Generation Plant Operators
Note: Occupations marked with ‘nfd’ (Not further defined) denotes responses and occupations which are not classified into the other defined categories by the ABS.	

Source: ABS (2009), ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0.

Table A4.5: Mixed STEM-qualified occupation list

Code	Occupation
1351	ICT Managers
2300	Design, Engineering, Science and Transport Professionals, nfd*
2310	Air and Marine Transport Professionals, nfd
2311	Air Transport Professionals
2322	Surveyors and Spatial Scientists
2349	Other Natural and Physical Science Professionals
2600	ICT Professionals, nfd
2611	ICT Business and Systems Analysts
2612	Multimedia Specialists and Web Developers
2621	Database and Systems Administrators, and ICT Security Specialists
2630	ICT Network and Support Professionals, nfd
2631	Computer Network Professionals
2632	ICT Support and Test Engineers

Code	Occupation
3100	Engineering, ICT and Science Technicians, nfd
3110	Agricultural, Medical and Science Technicians, nfd
3111	Agricultural Technicians
3113	Primary Products Inspectors
3114	Science Technicians
3120	Building and Engineering Technicians, nfd
3122	Civil Engineering Draftspersons and Technicians
3130	ICT and Telecommunications Technicians, nfd
3131	ICT Support Technicians
3132	Telecommunications Technical Specialists
3423	Electronics Trades Workers
3424	Telecommunications Trades Workers
3620	Horticultural Trades Workers, nfd

Note: Occupations marked with ‘nfd’ (Not further defined) denotes responses and occupations which are not classified into the other defined categories by the ABS.
Source: ABS (2009), ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0.

Table A4.6: Health-qualified occupation list (university, vocational and mixed health)

Code	Occupation
	University
2347	Veterinarians
2511	Nutrition Professionals
2512	Medical Imaging Professionals
2514	Optometrists and Orthoptists
2515	Pharmacists
2521	Chiropractors and Osteopaths
2523	Dental Practitioners
2524	Occupational Therapists
2525	Physiotherapists
2526	Podiatrists
2527	Audiologists and Speech Pathologists \ Therapists
2530	Medical Practitioners, nfd
2531	General Practitioners and Resident Medical Officers
2532	Anaesthetists

Code	Occupation
2533	Specialist Physicians
2534	Psychiatrists
2535	Surgeons
2539	Other Medical Practitioners
2540	Midwifery and Nursing Professionals, nfd
2541	Midwives
2542	Nurse Educators and Researchers
2543	Nurse Managers
2544	Registered Nurses
Vocational	
3613	Veterinary Nurses
4112	Dental Hygienists, Technicians and Therapists
4114	Enrolled and Mothercraft Nurses
4116	Massage Therapists
Mixed health-qualified	
2500	Health Professionals, nfd

Code	Occupation
2519	Other Health Diagnostic and Promotion Professionals
2522	Complementary Health Therapists
4111	Ambulance Officers and Paramedics
4232	Dental Assistants
Source: ABS (2009), ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0	

Table A4.7: ANZSCO Major Groups

Code	Major Group
1	Managers
2	Professionals
3	Technicians and Trades Workers
4	Community and Personal Service Workers
5	Clerical and Administrative Workers
6	Sales Workers
7	Machinery Operators and Drivers
8	Labourers
Source: ABS (2009), ANZSCO - Australian and New Zealand Standard Classification of Occupations, First Edition, Revision 1, cat no. 1220.0	