

STARTING OUT IN STEM

*A STUDY OF YOUNG MEN AND WOMEN IN FIRST
YEAR SCIENCE, TECHNOLOGY, ENGINEERING
AND MATHEMATICS COURSES*

*A REPORT FROM THE IRIS PROJECT
PREPARED FOR AUSTRALIA'S CHIEF SCIENTIST*

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EXECUTIVE SUMMARY

In late 2011, first year university students in science, technology, engineering and mathematics (STEM) courses across Australia were invited to participate in the international *Interests and Recruitment in Science* (IRIS) study. IRIS investigates the influences on young people's decisions to choose university STEM courses and their subsequent experiences of these courses. The study also has a particular focus on the motivations and experiences of young women in courses such as physics, IT and engineering given the low rates of female participation in these fields.

Around 3500 students from 30 Australian universities contributed their views on the relative importance of various school and non-school influences on their decisions, as well as insights into their experiences of university STEM courses so far. It is hoped that their contributions will help improve recruitment, retention and gender equity in STEM higher education and careers.

Evidence presented in this report points to a pressing need for policy makers and stakeholders in the STEM education arena to support the following recommendations:

Recommendations for action at the high school level

1. Develop and/or support effective outreach programs educating Year 9 -12 girls about the opportunities available in STEM fields with traditionally low female representation.

This report highlights recent declines in the proportions of females in many university STEM courses, as well as the low levels of female participation in Physics/astronomy, Information Technology (IT) and Engineering fields. While a number of dedicated “Girls in STEM” type outreach programs have been operating in Australia, only around 1% of the 1565 females in this study recalled having participated in one of these. Yet a number of findings from IRIS clearly point to the need for, and effectiveness of, such programs. First, over 80% of the females who nominated “Girls in STEM” type programs rated these as having been encouraging or very encouraging in their decisions to take a STEM course.

Second, females enrolled in the male-dominated STEM courses were significantly more inclined than those in female-dominated courses to consider outreach activities as having been very important in their decisions to take these courses. Third, support for female-focused outreach programs may well reduce impediments to their participation in such courses, such as the lower levels of self-efficacy identified in this study. The recommendation is also consistent with evidence from a previous study that girls often disregard science careers because they cannot picture themselves as scientists (Lyons & Quinn, 2010).

In terms of models for such outreach programs, two options might be explored: girls-only programs or mixed programs having at least an even balance of boys and girls, and at least an even balance of male and female presenters. The programs should be sustainable over the longer term, preferably with direct industry links and should take place before students commit to their Year 11/12 subject choices. The programs should be properly evaluated and distinct from individual university initiatives designed primarily to increase student numbers. Rather, the programs should have as their principal goal the education of girls about the opportunities and challenges associated with studying and working in these fields.

2. Establish a comprehensive online resource for Careers Advisors, parents and students providing useful, reliable, and current advice on STEM courses and careers.

Careers advisors were rated by students as the least important persons in decisions to take university STEM courses - below teachers, parents, friends and siblings. Given that an earlier study involving Year 10 students also found careers advisors to have little influence in students' Year 11 subject decisions (Lyons & Quinn, 2010), there is clearly a need to establish other complementary sources of advice on pathways to STEM. As with the recommendation above, this resource should be distinct from initiatives by individual universities, instead being developed and maintained by a national professional body (e.g. the Australian Science Teachers Association). While it should be linked to other generic career information sites (e.g. <http://myfuture.edu.au/>) it should distinguish itself from these by being directed at students and parents and by having an explicit focus on STEM courses and careers.

3. Developers of the Australian Curriculum, subsequent state/territory syllabuses and associated teaching resources in science, mathematics and IT should ensure these documents reflect the pre-eminence of personal interest and practical application among the many influences on students' decisions to choose university STEM courses.

The IRIS study found that young people are driven to STEM courses primarily by personal interest. Around 86% of respondents rated interest as having been important or very important in their decisions to choose STEM at university. This finding was strongly supported by students' qualitative explanations for their choices, which communicated their passion and enjoyment. These results applied similarly to males and females and across STEM fields.

Allied with this was the high value students placed on school lessons showing the practical application of their subjects, with around 67% believing this to have been important or very important in their decisions. Again there was close agreement on this priority between males and females and among those in different STEM fields. These findings send a clear message to curriculum and resource developers about the need to nurture students' interest by ensuring that scientific, technological and mathematical principles and skills are taught with reference to practical, relevant and exciting applications.

4. Teachers should appreciate that they often have a greater impact than they imagine on students' decisions about choosing STEM courses and careers.

The IRIS findings reinforce existing evidence about the long-term influence of good teachers. Respondents rated good teachers as the most important individuals in their decisions to take STEM courses; more important than parents and peers. This finding was consistent with earlier research showing that Year 10 students rated their science teachers as having the greatest influence on decisions about taking science in Year 11 (Lyons & Quinn, 2010). However, this earlier study also found that teachers believe their own influence to be less than that of students' friends and parents. Hence teachers need to appreciate their potential for influencing students' career paths and heightening interest in STEM.

5. Increase the number of opportunities for Work Experience placements for prospective STEM students.

IRIS investigated students' experiences of STEM outreach activities and the extent to which these had encouraged them to take university STEM courses. Overall, 1066 respondents (30%) nominated at least one activity in which they had been involved. The most highly rated outreach activity was Work Experience, with around 94% of nominees considering it to have been 'very' or 'extremely' encouraging in their decisions.

At present, work experience is usually an ad-hoc school based arrangement. This would benefit from a coordinated national initiative encouraging STEM-related businesses to offer more opportunities for Year 10 or senior students to undertake work experience or internships.

Recommendations for action at the university level

6. Universities should review and improve the quality of teaching and feedback to students in first year STEM courses.

The study revealed a curious contrast between those aspects of school teaching that initially encouraged students into university STEM courses, and their experiences of these aspects once enrolled. On the one hand, around 73% of students rated feedback from teachers as having been important or very important in their decisions to take STEM at university. On the other, the lack of timely feedback from lecturers and tutors was one of the most criticised aspects of their university experience, with fewer than half the respondents agreeing they received personal feedback from lecturers when needed. This criticism was most evident among students from several Group of Eight universities, less than 40% of whom agreed that timely feedback was forthcoming.

The second contrast was between the high level of influence attributed to school teachers in students' decisions to take STEM, and the relatively poor experiences of university teaching. Whereas 62% of respondents regarded personal encouragement

from their teachers as being important or very important in their initial decisions to take STEM courses, only around 56% of respondents agreed that their university lecturers/teachers actually cared whether or not their students learn. Again, students from some of the Group of Eight universities were among the most critical, with more than one student in five disagreeing that their lecturers/teachers cared about their learning. Given the concerns about declines in STEM enrolments and the resources invested in encouraging students into these courses, it is important that first year teaching staff are aware of the significance of their feedback and personal ‘caring’ to students and that institutional structures allow the necessary time and resources to facilitate these important aspects of teaching.

7. Engineering faculties should review and improve the quality of teaching experienced by their first year students

Engineering students were significantly more inclined than their peers in other STEM courses to rate the quality of university teaching as worse than expected. They were also more inclined than others to disagree that their lecturers cared about their learning and to disagree that they received timely feedback. Further, they were less likely than their peers to agree they could see the relevance of what they were learning, and to agree that they had become more interested in the subject over the year. These findings raise serious questions about student perceptions of the quality of teaching in many first year engineering courses, and warrant further attention.

These perceptions were apparent in the responses of males and females. However, it is reasonable to speculate that any negative impact may be more marked among females given the findings that they attribute higher levels of importance than males to personal encouragement from teachers, and have lower levels of confidence that they are good enough at engineering subjects.

Summary of key findings

1. How important are particular school experiences in students' choice of STEM course?

- Young people are driven to STEM courses primarily by personal interest. Around 86% of respondents rated interest as important or very important in their decisions. This finding was strongly supported by students' qualitative explanations for their choices, in which interest and enjoyment featured prominently;
- STEM students really value feedback on their learning. Around 73% of respondents rated feedback from school teachers as important or very important in their initial decisions to take STEM courses and were very critical of university lecturers and courses when this feedback was not adequate or timely;
- School lessons showing the practical application of related subjects were considered important or very important by around 68% of respondents;
- Students were significantly more likely to rate their most recent classroom experiences (Years 11 & 12) as being very important in their decisions than their earlier high school experiences;
- Females were significantly more inclined than males to regard personal encouragement from teachers as very important in their decisions to take STEM courses;

2. How important are influential others in students' choice of STEM course?

- Overall, good teachers were rated by students as important or very important in their decisions more often than were others, including mothers or fathers;
- Respondents were significantly more likely to rate their parents as being very important in their decisions than their friends or siblings;
- Only 23% of respondents rated school Careers Advisors as being important or very important in their decisions about STEM courses. Around 38% rated school Careers Advisors as being of little or no importance;
- Females were significantly more likely than males to rate mothers as very important in their decisions to choose a STEM course;

- Engineering students rated their fathers as very important in their decisions more often than did their peers in other STEM subjects, particularly IT and physics/astronomy students, though females in Engineering were more inclined than males to rate their mothers as important in their decision.

3. How important are STEM-related media and outreach in students' choice of course?

- Overall, students were more inclined to rate popular science programs such as “Life on Earth” or channels like the Discovery Channel as important (29%) or very important (15%) in their decisions than other nominated media or outreach activities;
- Males were significantly more likely than females to rate popular science books and magazines, science fiction/fantasy books and films, and computer games as very important in their decisions.
- Females were more inclined than males to consider STEM Outreach programs to have been important in their decisions to take Engineering courses.
- There were significant differences in the ways students in different fields rated particular STEM-related media. For example, Biological science students were more inclined than others to rate museums/science centres and popular science TV or radio programs/channels as very important in their decisions, whereas physics/astronomy students were more likely to consider popular science books and science fiction/fantasy films and books to have been very important in their decisions. As might be expected, IT students rated computer games as very important significantly more often than those in other STEM fields, particularly students taking Health or Agricultural/Environmental studies courses. These differences may reflect an interaction effect with sex.

4. How encouraging are specific STEM-related outreach activities in students' choice of course?

- Over a thousand respondents nominated at least one STEM outreach activity in which they participated while at school. Altogether, 172 individual activities were

nominated, of which the most common were the Science and Engineering Challenge (256) and the (Siemens) Science Experience (155);

- In general, students nominating such activities felt these had encouraged them to take a university STEM course. The top 16 outreach activities were all rated as being either extremely encouraging or very encouraging by at least 60% of nominees.
- Of the general outreach categories, Work Experience was considered to have been the most encouraging; rated as very or extremely encouraging by around 95% of nominees. Activities designed to encourage young women into STEM courses and careers were also rated highly, as were enrichment /GAT/accelerated programs.
- Of the individual high profile outreach activities, nominees were most inclined to rate the Honeywell Engineering Summer School, Youth ANZAAS and the National Youth Science Forum as extremely encouraging. However, there are a number of caveats to interpreting these ratings noted in the report

5. What explanations do students give for their decisions to enrol in STEM courses?

- The finding that personal interest was very important in students' decisions to choose a STEM course was strongly supported by qualitative explanations of why they chose their courses. Interest and enjoyment overwhelmingly outweighed other considerations such as career prospects, salaries or the advice of others;
- Career-related motivations were the second most commonly cited reasons for choosing STEM courses.

6. What are students' experiences of their first year university STEM courses?

- Respondents were generally positive about their first year university experiences, with 82% agreeing that their universities offered good working conditions, and only 5% disagreeing;
- Around 78% agreed or strongly agreed that they had become more interested in the subject since they started;

- There were no significant differences in the ways males and females rated aspects of their first year experiences. There was no evidence from the ratings or comments of females in male-dominated STEM courses that they felt discriminated against by fellow students or faculty;
- There were some criticisms of university teaching, however, with fewer than half the respondents agreeing they received personal feed-back from lecturers and teachers when needed, and only 56% agreeing that their lecturers/teachers cared about whether they learned or not. Students attending some of the Group of Eight universities were among those most critical of these two aspects of their experiences.
- Engineering students were especially disparaging of the teaching, disagreeing significantly more than their peers in other STEM courses that they received timely feedback, and that their teachers cared about whether they learned anything;
- Engineering students were also significantly less likely than others to strongly agree they could see the relevance of what they were learning, that the course suited them, and that they had become more interested in the subject over the year.

7. Have students' first year experiences of STEM courses met their expectations?

Around 90% of respondents considered the course content to have been at least as interesting as they expected, with around 40% rating it better than expected;

- Only about 10-12% of respondents indicated that their overall course experience and the quality of university teaching was worse than expected;
- There were no significant differences in the ways males and female rated items relating to this question;
- Engineering students were significantly more likely than their peers in other STEM courses to rate the quality of teaching as worse than expected, and

significantly less likely to rate their overall course experience as better than expected.

8. What are students' perceptions of their self-efficacy and intentions to complete the course?

- Around 65% of respondents agreed that they were very motivated to study their course, with around 13% disagreeing;
- 65% of respondents agreed they will do better than average in the course, and a similar proportion agreed they were confident they are good enough at the subjects. Around 10-12% disagreed on each point;
- Males were significantly more inclined than females to strongly agree they will do better than average in the course, that they are good enough at their subjects, and that they easily learn the subject matter.

9. What explanations are given by students who had considered withdrawing from a STEM course?

- Overall, 486 students (14%) indicated that they had seriously considered withdrawing from their courses;
- The most frequent reason for students considering withdrawing from their course was to change to a different course. Many students explained this in terms of refocusing or re-evaluating their interests and prospects. Overall however, there was quite a wide variety of explanations provided.

10. How do students enrolled in male-dominated STEM courses perceive this sex disparity?

- There was no consensus among women enrolled in male-dominated STEM courses that this sex-disparity needed to change. While around 22% of females in Physics/Astronomy, IT and Engineering courses argued for a more even gender balance, a similar proportion of females (23%) felt that there was no need to change the *status quo*;

- Among males in these courses, 28% saw no need to change the sex-disparity while 20% advocated change;
- Many respondents regarded the current enrolment ratios as a result of individual personal choices. Very few referred to sociocultural or other influences;
- Among those arguing for more equal sex-ratios, the most common argument was that females provide complementary perspectives and bring different skills;
- With regard to strategies to change sex-disparities in some STEM courses, the most common recommendations from women were to encourage targeted outreach programs in schools, affirmative action strategies at university and to change cultural stereotypes;

11. What are STEM students' priorities for the future?

- In terms of their futures, respondents overall were more inclined to prioritise personal considerations over financial matters. The majority of students also prioritised the societal benefits of careers over making money, though getting a secure job was considered relatively important.
- Consistent with their initial motivations, 97% of respondents considered it important or very important to be doing something in the future they are interested in;
- Students also felt overwhelmingly that it was important or very important to use their talents and abilities (95%), and that they are doing something which develops themselves as individuals (92%);
- Females were significantly more inclined than males to consider 'helping other people' and 'working with something important for society' as very important career priorities;
- Females also rated "contributing to sustainable development and protection of the environment" as a very important priority far more often than did males;
- Compared with their STEM peers, significantly more Health studies students rated

“working with something important for society” as very important. IT students were least inclined to rate this item as a very important priority;

- Similarly, Health and Other Natural Science students were significantly more likely to rate “helping other people” as very important, while IT students were the least inclined to rate this item as very important;
- Students in Biological sciences and Agriculture/Environmental studies were far more likely than those in other STEM groups to rate “contributing to sustainable development and protection of the environment” as a very important priority;
- Engineering students were significantly more inclined than other STEM students to regard “opportunities to earn a high income” and “making money as soon as possible” as very important. Physics/Astronomy students were significantly less inclined than others to rate these priorities as very important.
- Females enrolled in Engineering courses were significantly more inclined than males to consider “contributing to sustainable development and protection of the environment” to be very important.

12. What recommendations would students make to those considering enrolling in STEM courses?

- Over 3000 students responded to the question: “If someone you know was thinking about enrolling in your course and asked you about it, what would you say to her or him?”
- Consistent with other findings from the study, by far the most commonly offered piece of advice to intending students was to make sure they were very interested in the general field (900 responses);
- Respondents also frequently advised that prospective students ensure they have taken appropriate subjects and levels in school and that they must be willing to work hard at university;
- Finally, a large number of responses (780) emphasised the positive aspects of STEM courses, particularly enjoyment, interest and general satisfaction.

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1 INTRODUCTION

1.1 Scope of the Report

This report presents findings from a nationwide study of 3496 first year university students' decisions about enrolling in science, technology, engineering or mathematics (STEM) courses. The study comprised the 2011 Australian data collection for the international Interest and Recruitment in Science (IRIS) project.

1.2 Background to the Interests and Recruitment in Science (IRIS) project

The IRIS project is a large-scale international study of student recruitment, retention and gender equity in university science, technology, engineering and mathematics (STEM) courses. The study was developed by a consortium of European universities and funded by the European Commission's 7th Framework Program (FP7) – Science in Society. The initial project has been extended to countries across the world as non-funded associate partners (<http://iris.fp-7.org/about-iris>). The National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia (SiMERR) was invited to collect Australian IRIS data.

1.3 Aim

The IRIS project investigates students' perspectives of the influences on their decisions to choose university STEM courses, their subsequent experiences of those courses and their intentions to continue. It also seeks to identify barriers to young people's participation in these courses, including any that discourage women from entering fields in which female representation is low. It is hoped that findings from the study will contribute to understanding and improving recruitment, retention and gender equity in university STEM courses.

1.4 The IRIS questionnaire

IRIS is collecting data from around the world from first year university students studying STEM courses. The major data collection instrument for IRIS is a survey using predominantly fixed response Likert-type questions with some open response questions. The survey focuses on students' motivations for choosing STEM courses and their experiences of these courses over their first year of university.

1.5 IRIS Australia

IRIS Australia was conducted by a team of researchers from six SiMERR partner universities led by the University of New England. The team comprises:

Dr Terry Lyons	University of New England, NSW
Dr Frances Quinn	University of New England, NSW
Ms Nadya Rizk	University of New England, NSW
Professor Neil Anderson	James Cook University, QLD
Dr Peter Hubber	Deakin University, VIC
Dr John Kenny	University of Tasmania, TAS
Associate Professor Len Sparrow	Curtin University of Technology, WA
Dr Jan West	Deakin University, VIC
Ms Sue Wilson	Australian Catholic University, ACT

The IRIS Australia team has been working in collaboration with the European IRIS consortium led by Associate Professor Ellen Henriksen, University of Oslo, Norway. Other IRIS consortium universities include: King's College London, UK; University of Ljubljana, Slovenia; Associazione Observa, Italy; University of Copenhagen, Denmark; and University of Leeds, UK.

1.6 Research Themes and Questions

IRIS Australia addressed two broad themes concerning participation in university STEM courses: students' initial motivations for choosing these courses and their experiences, expectations, and priorities with respect to these courses. Spanning these themes was an overarching attentiveness to gender differences and perspectives investigated through comparisons between the responses of males and females, particularly those enrolled in traditionally male-dominated and female-dominated STEM fields. A second layer of investigation concerned differences and similarities between the responses of students enrolled in different STEM fields of education.

Results from these investigations are reported with respect to twelve research questions. The first five concerned the theme of students' motivations for choosing their courses, reported in Chapter 4:

1. How important are particular school experiences in students' choice of STEM course?
2. How important are influential others in students' choice of STEM course?
3. How important are STEM-related media and outreach in students' choice of course?
4. How encouraging are specific STEM outreach activities in students' choice of course?
5. What explanations do students give for their decisions to enrol in STEM courses?

Seven questions address the second theme of students' experiences of STEM courses to date, their expectations of completing the course, their views on sex disparities in some STEM courses, and their priorities for the future. Results from these questions are reported in Chapter 5:

6. What are students' experiences of their first year university STEM courses?
7. Have students' first year experiences of STEM courses met their expectations?
8. What are students' perceptions of their self-efficacy and intentions to complete the course?
9. What explanations are given by students who had considered withdrawing from a STEM course?
10. How do students enrolled in male-dominated STEM courses perceive this sex disparity?
11. What are STEM students' priorities for the future?
12. What recommendations would students make to those considering enrolling in STEM courses?

With respect to each question, findings are reported initially in terms of the overall cohort, then by the results of comparisons between males and females and, where relevant, findings concerning females enrolled in male-dominated STEM courses. These are followed by results of comparisons between respondents in different STEM fields.

2 OVERVIEW OF THE LITERATURE

2.1 Patterns of participation in university STEM courses

In his recent report *Unhealthy Science?* Dobson (2012) documents the expansion of university education in Australia over the first decade of the 21st century. He reports that, overall, enrolments in all fields of education increased by an impressive 33%. With respect to STEM courses, participation in Engineering increased by nearly 40% while participation in Health courses increased by 69%. On the other hand, Information Technology suffered a decline of around 34% over this period. Dobson notes that enrolments in the Natural and Physical Sciences (NPS) were slightly below the overall trend, increasing by 30%.

Looking within the broad NPS field however, it is apparent that not all courses contributed evenly to this growth. While cautioning that trends among the NPS narrow fields are difficult to decipher due to university reporting and classification methods, Dobson nevertheless concludes that bachelor level enrolments in mathematical sciences, chemical sciences and physical sciences do not seem to have recovered from the sharp declines during the 1990s. In summary therefore, while it can be claimed that enrolments in university science and engineering overall are reasonably healthy, there are concerns about participation in IT courses and the so-called ‘enabling sciences’ - physics, chemistry and mathematics.

2.2 Women in university STEM courses

While noting the concerns above, of greater interest to the IRIS study are the relative declines in STEM participation among women over this period, along with their considerable underrepresentation in some STEM courses. According to Dobson (2012, p. 32), while the number of women in bachelor level degrees in all fields of education increased by nearly 21% between 2002 and 2009, the increase in the number of women in science courses was only around 11%.

Figure 1 summarises the percentages of female enrolments in STEM fields between 2002 and 2009. Two trends are apparent from this figure. First, women are persistently overrepresented in the Biological sciences and ‘Other natural and physical sciences’ and underrepresented in the Physical sciences (physics and astronomy), IT and Engineering. Second, female representation in most of these fields declined over this period.

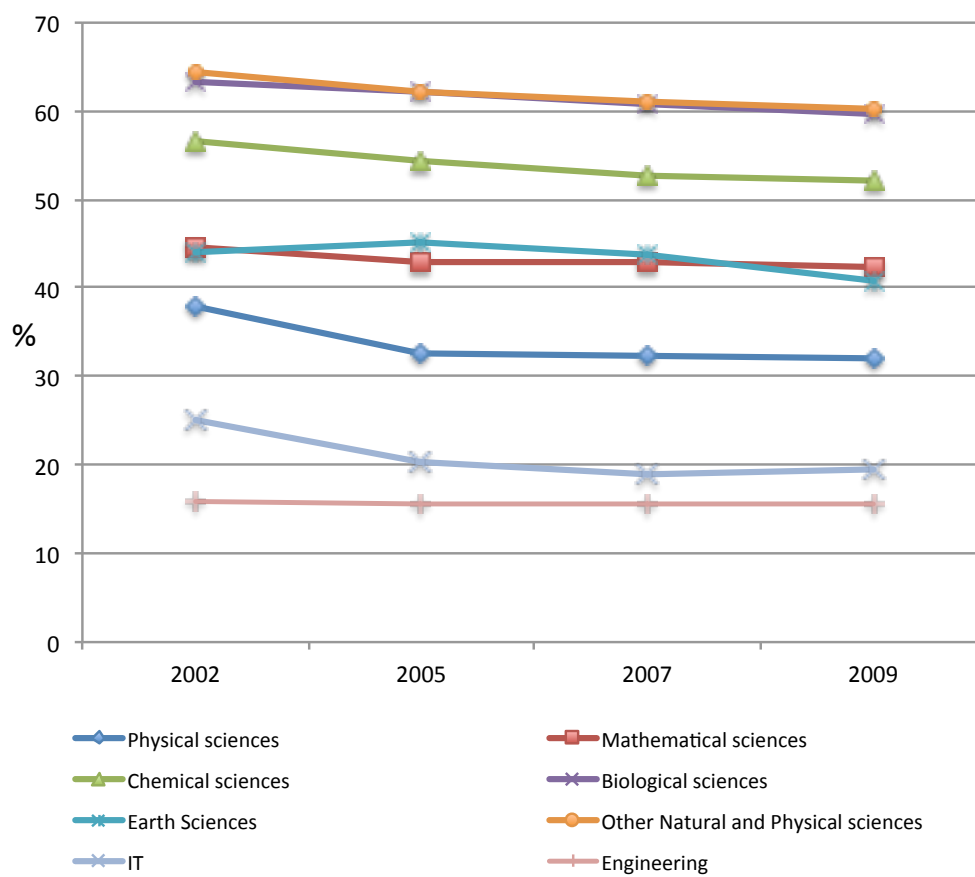


Figure 1: Percentages of female enrolments in Australian university STEM courses - all levels, domestic and overseas students. [Data for IT and Engineering enrolments obtained from DEEWR. Data for other fields are sourced from Dobson (2012). The latter relate to 'student load' (subject enrolments rather than course enrolments), but are still a good indicator of enrolment trends.]

The relatively low proportion of women in Physics/astronomy, IT and Engineering is often accepted as a natural feature of the prevailing education landscape in Australia. However, international comparisons show that such enrolment patterns are not necessarily universal. Figure 2 presents OECD data from an illustrative sample of 15 countries including Australia. The figure compares the percentages of tertiary STEM qualifications awarded to women in these countries in 2009. The variation across countries and courses is quite marked, particularly with respect to mathematics and physical sciences.

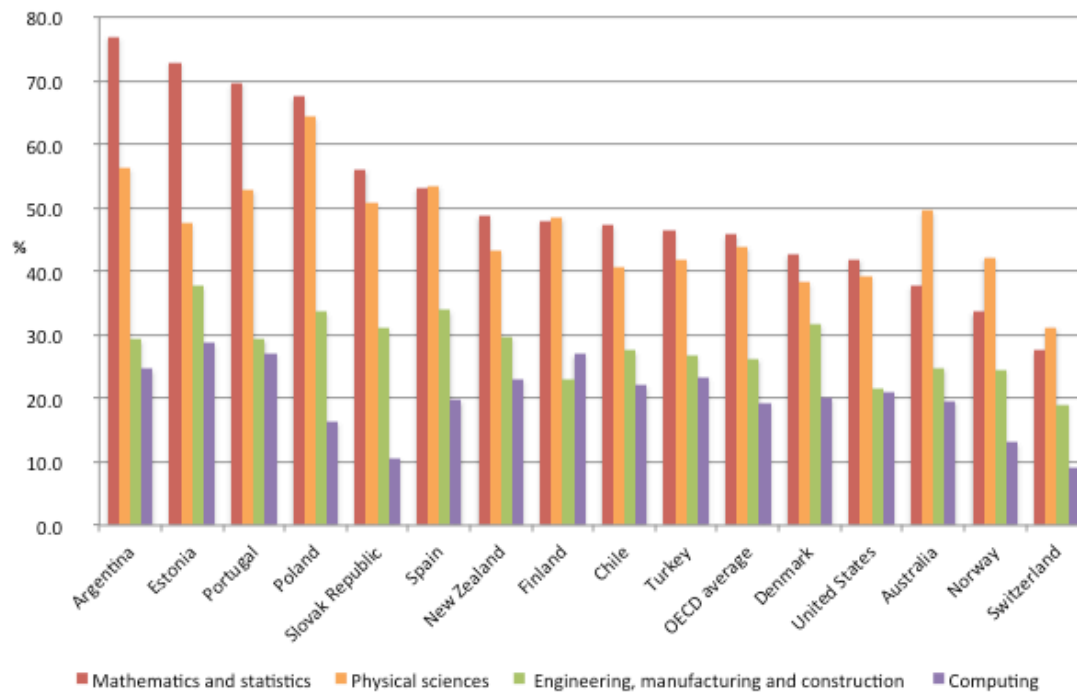


Figure 2: International comparison of percentages of tertiary qualifications awarded to women in tertiary-type A and advanced research programmes, by STEM field of education (2009) (adapted from OECD, 2011).

According to the full OECD dataset of 32 countries, in 2009 Australia ranked 26th in terms of the proportion of university qualifications awarded to women in mathematics and statistics. In engineering, manufacturing and construction, Australia ranked 20th and in computing, 17th. Women were however awarded 49% of all physical science (in this case physics and chemistry) qualifications in Australia, ranking 7th of 32 countries.

These data demonstrate that participation rates for women in STEM fields vary considerably from country to country and therefore cannot simply be dismissed as a function of sex-related predispositions. Rather, much of the literature around this area implicates prevailing sociocultural mores and structures as influencing opportunities, priorities and decisions (e.g. Bøe, et al., 2011; Eccles, Barber & Jozefowicz, 1999). One of the principal aims of IRIS is to explore differences in the influences on males and females choosing STEM courses and their subsequent experiences in these courses, particularly those with traditionally low female representation.

3 METHODOLOGY

3.1 IRIS Survey Instrument design

The IRIS Australia questionnaire was based primarily on the ‘IRIS Q’ questionnaire developed and piloted by the European IRIS partners. IRIS Q was designed to address a number of important questions that have emerged from the research literature over the past decade or so. The online questionnaire consisted for the most part of three question types. First, a range of questions for gathering demographic data about respondents, their backgrounds, their university courses and subjects. The second question type comprised banks of Likert-type items to which students responded by indicating a position on three-point or five-point scales anchored at either end; for example, from ‘Not important’ to ‘Very important’ (or ‘Strongly disagree’ to ‘Strongly agree’). The intermediate points were not labelled in the original ‘IRIS Q’ questionnaire developed by the consortium partners – a decision made in part to avoid the difficulties of inconsistent interpretations of these points when translating into different languages.

The third item type was the open-ended question, with respondents encouraged to elaborate on their ratings, provide reasons for particular decisions or to otherwise expand on issues addressed in the questionnaire.

3.1.1 Additional questions for IRIS Australia

While adhering to the IRIS Q format and guidelines, there was scope in the study for countries to add questions relevant to local contexts or research interests. The IRIS Australia team included a number of questions designed to identify:

- whether respondents were of Aboriginal or Torres Strait Islander background;
- the types and sectors of respondents’ high schools, and whether these were located in metropolitan, regional or remote areas;
- whether respondents were Australian citizens or international students;
- which school years respondents considered most important in their decisions about taking STEM courses;
- which STEM outreach activities respondents had participated in while at school, and how encouraging they felt these had been.

3.2 Administration of the survey

Ethics approval to conduct the study was gained initially from the University of New England Research Ethics Committee and then from each of the IRIS team universities. The Australian Council of Deans of Science (ACDS) and the Australian Council of Engineering Deans (ACED) promoted the study among relevant Deans and Associate Deans at each university. The IRIS Australia team members then liaised with nominated university contacts in their respective states and territories to publicise the online survey among staff and students and invite participation.

The Australian version of the questionnaire was constructed using Qualtrics survey software and hosted at UNE. The online survey was open to first year university STEM students from 5 September to 14 November 2011.

3.3 Sample

3.3.1 *Definition of the Sample*

The target population for IRIS international consists of students in the second half of their first year in university STEM courses. Courses were identified with reference to the Australian Standard Classification of Education (ASCED). Data were collected from students enrolled in the following five ASCED Broad Fields of Education:

- 01 Natural and Physical Sciences
- 02 Information Technology
- 03 Engineering and related technologies
- 05 Agriculture, Environmental and Related studies
- 06 Health

Details of the discipline areas included in these fields are available from the Australian Bureau of Statistics (<http://www.abs.gov.au/ausstats/abs@.nsf/mf/1272.0>).

3.3.2 *Sample characteristics*

Data integrity was checked by examining the data file for responses outside the target population, incomplete responses or multiple responses from the same person.

Responses were deleted as invalid if they were duplicated or if the respondent did not answer sufficient questions. Individual cases were assigned ASCED broad and narrow Field of Education codes based on the course and majors specified by the respondents.

Cleaning the 4091 raw responses identified 3718 valid responses. Of these, 3496 fell into STEM disciplines as defined by ASCED codes 01, 02, 03, 05 and 06 and comprise the sample used in this report. The remaining 222 respondents included students undertaking a behavioural science or applied science courses from the ASCED 09 Society and Culture category (e.g. Psychology). Cases from this category are excluded for the purposes of this report.

The sex breakdown of the study sample was 54.8% males (N= 1916) and 44.8% females (N= 1565). Fifteen respondents (0.4%) did not specify their sex. International students (N=486) comprised 13.9% of the sample. These respondents were included in analyses relating to university experiences but excluded from analyses of school background influences. Broad descriptors of the Australian respondents' high school backgrounds are shown in Table 1.

Table 1: Percentage breakdown of Australian respondents by school characteristics during all or most of their high school years

High school characteristics	Categories	% of sample
Location	In a capital city	52.4
	In a large, non-capital city (population greater than 25000)	19.9
	In a rural city or large town (population between 10000 and 25000)	18.6
	In a small rural or remote town (population less than 10000)	9.1
School Type	Co-educational	79.7
	Single Sex	20.3
School Sector	Government	57.7
	Catholic system	21.4
	Independent	22.9

The numbers and percentages of valid responses from participating universities are shown in Table 2. The distribution indicates that most Australian universities from all states and territories except for NT are well represented and the data are sourced from a wide sample of Australian tertiary institutions.

Table 2: Number and percentage of respondents from each participating university, with percentage breakdown of females and males.

State/ Territory	University	Number of respondents	% of sample	% females	% males
ACT	Australian National University	285	8.3	34.4	65.6
	University of Canberra	39	1.1	17.9	82.1
NSW	Charles Sturt University	23	0.7	78.3	21.7
	Macquarie University	184	5.3	43.5	56.6
	University of New England	90	2.6	63.3	36.7
	University of New South Wales	196	5.7	48.0	52.0
	University of Newcastle	12	0.3	25.0	75.0
	University of Sydney	117	3.4	37.6	62.4
	University of Technology Sydney	77	2.3	45.5	54.5
	University of Western Sydney	126	3.7	47.6	52.4
	University of Wollongong	135	3.9	25.9	74.1
QLD	Bond University	1	0.0	100	0
	Central Queensland University	1	0.0	0	100
	Griffith University	39	1.1	64.1	35.9
	James Cook University	31	0.9	29.0	71.0
	Queensland University of Technology	46	1.3	52.2	47.8
	University of Queensland	324	9.4	57.1	42.9
SA	University of Adelaide	420	12.2	40.2	59.8
	University of South Australia	76	2.2	17.1	82.9
TAS	University of Tasmania	209	6.1	39.7	60.3
VIC	Deakin University	113	3.3	58.4	41.6
	La Trobe University	105	3.0	64.8	35.2
	Monash University	141	4.1	59.6	40.4
	RMIT	45	1.3	64.4	35.6
	Swinburne University of Technology	48	1.4	62.5	37.5
	Victoria University	15	0.4	13.3	86.7
WA	Curtin University of Technology	145	4.2	23.4	76.6
	Edith Cowan University	60	1.7	71.7	28.3
	Murdoch University	166	4.8	65.1	34.9
	University of Western Australia	180	5.2	27.8	72.2
	Unspecified	47	1.3		
	Total	3496	100	44.8%	54.8%

A breakdown of the sample across Level I and Level II ASCED Field of Education codes is shown in Table 3.

Table 3: Numbers and percentages of male and female respondents enrolled in each of the ASCED broad and narrow fields (N=3496)

ASCED Broad field Level I	ASCED Narrow field Code (Level II)	ASCED Narrow Field Descriptor	Total valid respondents*	% total	% females	% males
01 Natural and Physical Sciences	0101	Mathematical Sciences	150	4.4	36.0	64.0
	0103	Physics and Astronomy	142	4.2	25.4	74.6
	0105	Chemical Sciences	151	4.4	40.4	59.6
	0107	Earth Sciences	101	2.9	48.0	52.0
	0109	Biological Sciences	652	19.1	71.9	28.1
	0199	Other Natural and Physical Sciences [#]	426	12.5	70.2	29.8
		Level II not identified	3			
Total 01			1625	46.5		
02 Information Technology	0201	Computer Science	251	7.2	19.5	80.5
	0203	Information Systems	42	1.2	21.4	78.6
	0299	Other Information Technology	11	0.3	0	100
		Level II not identified	16			
Total 02			320	9.2		
03 Engineering and related technologies	0301	Manufacturing Engineering and Technology	79	2.3	12.7	87.3
	0303	Process and Resources Engineering	193	5.5	29.3	70.7
	0307	Mechanical and Industrial Engineering and Technology	215	6.1	15.0	85.0
	0309	Civil Engineering	256	7.3	26.0	74.0
	0313	Electrical and Electronic Engineering and Technology	295	8.4	17.4	82.6
	0315	Aerospace Engineering and Technology	50	1.4	10.0	90.0
	0399	Other Engineering etc.	40	1.1	43.6	56.4
		Level II not identified	7			
Total 03			1135	32.5		
05 Agriculture, Environmental and related studies	0501	Agriculture	27	0.8	66.7	33.3
	0503	Horticulture and Viticulture	7	0.2	57.1	42.9
	0509	Environmental Studies	142	4.1	58.2	41.8
	0599	Other Agriculture, Environmental and Related studies	0			
		Level II not identified	41			
Total 05			217	6.2		

06 Health	0601	Medical studies	6	0.2	66.7	33.3
	0603	Nursing	11	0.3	100	0
	0605	Pharmacy	11	0.3	63.6	36.4
	0607	Dental studies	10	0.3	80.0	20.0
	0609	Optical Science	12	0.3	50.0	50.0
	0611	Veterinary studies	55	1.6	90.9	9.1
	0613	Public Health	1	0	100	0
	0617	Rehabilitation Therapies	13	0.4	46.2	53.8
	0699	Other Health	75	2.1	78.7	21.3
		Level II not identified	5			
Total 06			199	5.7		
Total			3496	100	44.8	54.8

*Discrepancies between totals in this table and the overall totals are due to a small number of students not identifying their course to Level II.

Other Natural and Physical sciences include medical sciences (e.g. medicinal chemistry, medical mathematics, medical bioscience, medical biotechnology, etc.), forensic sciences, food science and biotechnology, pharmacology, laboratory technology, nuclear science and technology, among others.

As shown by Table 3, the sample included substantial sex disparities within many ASCED fields, with high male-to-female ratios in Physics/astronomy, Information Technology and most narrow fields of Engineering, and high female-to-male ratios in the Biological Sciences, Other Natural and Physical Sciences, Agriculture, and most Health fields. These sex differences in the sample broadly reflect enrolment patterns in the undergraduate STEM population more generally (Dobson, 2012; Office of the Chief Scientist, 2012).

Table 4 shows the distribution of STEM related Year 12 subjects taken by respondents in each of the narrow ASCED fields. Overall, about 54% of the sample had taken physics in Year 12, 60% had taken chemistry and nearly two thirds had studied advanced or extension Mathematics. For the most part there was reasonable articulation between the subjects studied in Year 12 and the courses chosen at university. For example, around 88%, 87% and 83% of respondents enrolled in mathematics, physics, and chemistry courses respectively had completed the appropriate Year 12 subjects in these areas. Likewise, with the exception of Electrical and Electronic Engineering, between 86% and 96% of engineering students had completed Year 12 physics (depending on the engineering field) and between 83% and 86% completed Year 12 advanced or extension mathematics.

Table 4: STEM-related Year 12 subject choices of respondents within each ASCED code, expressed as percentages

			Year 12 STEM-related subjects completed									
			% Physics	% Chemistry	% Biology	% Human Biology	% Earth and/or Environmental Science	% Advanced or extension mathematics	% Other mathematics	% Senior science or multistrand science	% No science subjects	% No mathematics subjects
ASCED Field of Education		Total %	54.2	59.8	38.6	6.3	6.2	62.5	40.3	4.9	7.9	4.7
0101	Mathematical Sciences	4.4	68.0	59.3	26.7	1.3	3.3	88.0	37.3	3.3	5.3	2.7
0103	Physics & Astronomy	4.1	87.3	68.3	19.0	2.8	2.1	76.8	35.2	2.1	3.5	3.5
0105	Chemical Sciences	4.4	57.0	82.8	38.4	8.6	2.6	66.2	35.8	6.6	5.3	4.6
0107	Earth Sciences	2.9	43.6	45.5	37.6	1.0	19.8	44.6	40.6	8.9	12.9	13.9
0109	Biological Sciences	19.0	23.9	54.3	70.4	6.9	10.9	43.7	44.9	5.4	10.1	7.1
0199	Other Natural & Physical Sciences	12.4	40.4	71.8	65.0	11.0	4.5	56.8	41.8	3.5	8.2	4.2
0201	Computer Science	7.3	51.8	42.6	21.5	6.4	5.6	65.7	37.1	4.8	16.7	6.8
0203	Information Systems	1.2	38.1	40.5	28.6	4.8	4.8	50.0	52.4	11.9	11.9	4.8
0301	Manufacturing Engineering & Technology	2.3	91.1	72.2	8.9	2.5	3.8	86.1	38.0	2.5	3.8	1.3
0303	Process & Resources Engineering	5.6	87.6	87.0	23.8	6.7	2.1	82.9	40.9	2.1	1.0	1.0
0307	Mechanical & Industrial Engineering & Technology	6.3	87.0	72.1	10.2	1.9	2.8	83.7	40.5	4.7	4.7	3.3
0309	Civil Engineering	7.5	86.3	63.7	13.3	4.7	2.3	85.5	34.4	4.3	3.1	0.8
0313	Electrical & Electronic Engineering & Technology	8.6	73.9	55.6	19.7	2.4	5.4	76.6	38.0	6.8	6.8	4.4
0315	Aerospace Engineering & Technology	1.5	96.0	70.0	14.0	2.0	4.0	86.0	36.0	4.0	2.0	2.0
0501	Agriculture	0.8	29.6	48.1	55.6	7.4	11.1	48.1	48.1	7.4	3.7	3.7
0503	Horticulture and Viticulture	0.2	28.6	14.3	28.6	14.3	0	28.6	42.9	14.3	14.3	14.3
0509	Environmental Studies	4.1	22.5	32.4	50.0	8.5	20.4	29.6	53.5	4.9	21.1	11.3

Table 4 (cont.)		Year 12 STEM-related subjects completed										
		Total %	% Physics	% Chemistry	% Biology	% Human Biology	% Earth and/or Environmental Science	% Advanced or extension mathematics	% Other mathematics	% Senior science or multistrand science	% No science subjects	% No mathematics subjects
0601	Medical studies	0.2	66.7	83.3	66.7	0	0	83.3	16.7	0	16.7	0
0603	Nursing	0.3	18.2	45.5	27.3	45.5	9.1	45.5	54.5	9.1	9.1	9.1
0605	Pharmacy	0.3	63.6	100	72.7	18.2	0	90.9	27.3	0	0	0
0607	Dental studies	0.3	30.0	70.0	60.0	10.0	0	40.0	40.0	10.0	20.0	10.0
0609	Optical Science	0.4	75.0	83.3	25.0	0	0	91.7	16.7	0	0	0
0611	Veterinary studies	1.6	34.5	67.3	70.9	7.3	5.5	52.7	58.2	10.9	3.6	0
0617	Rehabilitation Therapies	0.4	23.1	30.8	53.8	15.4	0	53.8	38.5	7.7	15.4	7.7
0699	Other Health	2.2	25.3	42.7	56.0	25.3	2.7	38.7	56.0	8.0	9.3	5.3

Other fields of education had less articulation with assumed high school knowledge. For example, only 70% of those enrolled in biological science courses had completed Year 12 biology. Of those enrolled in Earth Science courses, 13% took no science in Year 12 and 14% took no mathematics. About 21% of students enrolled in Environmental science courses took no science in Year 12. Only 74% of respondents enrolled in Electrical and Electronic Engineering had taken Year 12 physics, while only 77% took advanced or extension mathematics. Nearly 7% had taken no Year 12 science.

3.4 Data analysis

3.4.1 Quantitative data analysis

The raw data stored in the Qualtrics database were entered into SPSS 20 and cleaned. In terms of analysis, responses were explored across four layers: the entire cohort; for

males and females separately; within and between male and female-dominated courses; and across different STEM fields of education.

Courses were classified as male-dominated where according to national higher education enrolment statistics more than two-thirds (66%) of commencing students in an applicable STEM field of education were male (DEEWR, 2009; Office of the Chief Scientist, 2012). These comprised Physics/Astronomy, Information Technology and Engineering (Phys/IT/Eng). Courses were classified as female-dominated where more than two-thirds of commencing students were female. These courses included Biological Sciences, Other Natural and Physical Sciences and most narrow fields of Health. Table 5 summarises the IRIS sample falling into these two categories.

Table 5: Respondents enrolled in STEM fields of education classified as male-dominated or female-dominated for the purposes of IRIS comparisons.

Male-dominated courses	Total	% females	% males
Physics/astronomy	142	25.4	74.6
Information Technology	320	19.7	80.3
Engineering	1135	21.2	78.8
Female-dominated courses			
Biological sciences	652	71.9	28.1
Other natural and physical sciences	426	70.2	29.8
Health	199	77.9	22.1

Many of the responses to Likert-type items in this report are summarised as bar charts of percentage ratings. With respect to the five point response scales used in many items, we have made the conventional assumption that respondents' selection of the unlabelled rating point on the "very important" side of the midpoint indicates some degree of importance, and selection of the unlabelled rating point on the "not important" side of the midpoint indicates little importance. Similar assumptions were used with respect to the unlabelled points on the five-point "agree-disagree" scale, and we have indicated this interpretation on the relevant figures.

Where responses were explored across variables such as sex, high school characteristics or fields of education, mean ratings are used as concise visual summaries of the data. However, as we were unwilling to assume interval level measurement given the unlabelled intermediate Likert points, we did not explore

mean differences using data reduction techniques such as factor analysis. Rather, ratings on individual items were analysed using more conservative and robust non-parametric techniques of crosstabulations and chi-squared contingency table tests.

Given the large sample size and the number of tests conducted, a stringent level of significance of $p < 0.001$ was adopted when reporting results for the overall cohort to safeguard against erroneous claims of significance. For comparisons within and between the smaller subsets of respondents in male-dominated and female-dominated STEM fields, results up to the $p < .005$ level are reported as strongly suggestive of a relationship between the relevant variables. One important implication of this conservative approach to analysis is that many associations at the 0.01 probability level existing within the data are not addressed in this report.

In addition to the stricter level of significance, results are reported only where they are also meaningful, that is, where the differences are large enough to have a practical, meaningful utility. Cramer's V was used as a measure of Effect Size to determine whether any significant differences were meaningful. Cramer's V statistics were interpreted as indicating small, medium or large Effect Sizes according to Cohen's criteria (1988 cited in Gravetter & Wallnau, 2005 p. 475), detailed in Table 6.

Table 6: Interpretation criteria for Cramer's V measure of Effect Size for chi-squared contingency tables. (Source: Gravetter & Wallnau, 2005 p. 475; Volker, 2006)

Degrees of freedom ^a	Cramer's V statistic	Effect size
1	0.10 < V < 0.30 0.30 < V < 0.50 V > 0.50	small medium large
2	0.07 < V < 0.21 0.21 < V < 0.35 V > 0.35	small medium large
3	0.06 < V < 0.17 0.17 < V < 0.29 V > 0.29	small medium large
4	0.05 < V < 0.15 0.15 < V < 0.25 V > 0.25	small medium large

^a In this context, $df = (x-1)$ where x is the number of cells in the row (r) or column (c), whichever is smaller. Elsewhere in the report, $df = (r-1)(c-1)$.

Significant differences below the threshold of a “small” effect are not reported, as these are unlikely to reflect meaningful differences. It should be remembered that a “small” Effect size does not mean that the difference is unimportant. Statistics for all tests revealing meaningful significant results are reported as footnotes.

Where meaningful significant differences were found, adjusted standardised residuals (ASR) were used to evaluate the sources of the differences detected by significant chi-squared relationships. ASRs greater than +3.30 or less than -3.30 indicate (at 99.9% probability level) that individual cell counts are significantly different to those expected if there was no association between the variables. The magnitude of the ASR (in either + or - direction) reflects the size of the difference between observed and expected counts. Only absolute values of the ASRs are reported in the footnotes.

3.4.2 Qualitative data analysis

The IRIS questionnaire provided several open response options for respondents to expand on their ratings or otherwise provide qualitative responses. These were analysed, collated and coded using the constant comparative method (Maykut & Morehouse, 1994). This process involved two researchers independently identifying, coding and categorising themes from samples of 100 responses to each question. The researchers compared interpretations and reached a consensus on the final sets of codes used to analyse the remaining responses. Results are presented in figures showing theme frequency and are accompanied by representative comments.

4 CHOOSING A STEM COURSE

4.1 Q 1. How important are particular school experiences in students' choice of STEM course?

IRIS was especially interested in those school experiences that encourage or discourage participation in STEM courses and whether the importance attributed to different experiences varies for males and females, or among those choosing different STEM fields. As these items relate to experiences within the Australian education system, data from overseas students were excluded from these analyses.

4.1.1 Overall results for importance of school experiences

Students were asked to rate on a five point Likert-type scale the importance of a range of high school experiences in choosing their university courses. Figure 3 shows the percentage breakdown of ratings on these items by Australian respondents (N=2988).

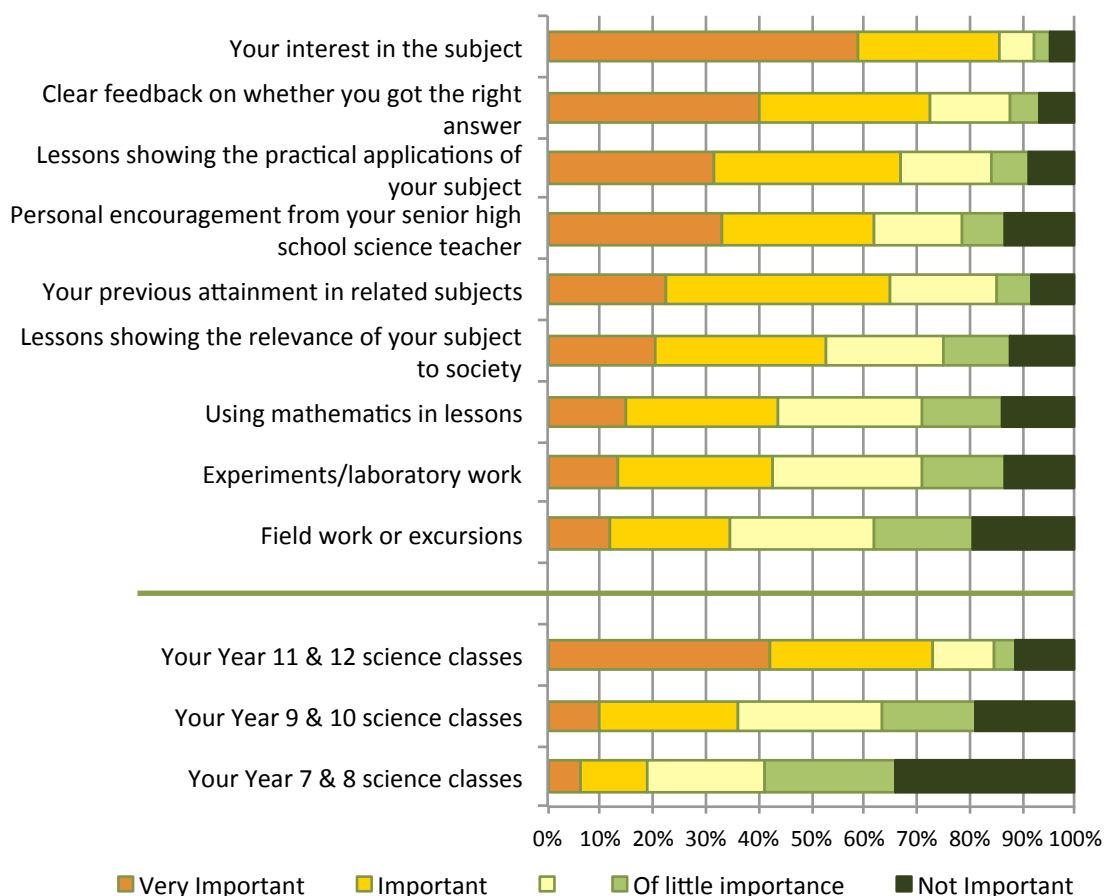


Figure 3: Percentage breakdown of responses to items relating to the question: "How important was each of the following school experiences in choosing your course?"

Figure 3 shows that students considered interest in the subject to be the most important of these items, with around 86% of the cohort rating it as important or very important. Fewer than 8% of students believed interest to have been of little or no importance in their decisions. With respect to items relating to pedagogy, respondents tended to consider feedback from teachers to be the most important influence, along with lessons showing the practical applications of their subjects and personal encouragement by teachers. On the other hand, using mathematics in lessons and experiments/laboratory work were not considered to be as influential, with only around 15% of respondents rating each of these activities as very important. Likewise, fieldwork and excursions were only considered very important influences by around 12% of respondents, while 38% rated these experiences as of little or no importance to their decisions. As might be expected, students' ratings on these three items varied with the fields of education in which they were enrolled (see Figure 5).

In order to determine students' perceptions of the relative influence of different stages of their schooling, they were also asked to rate the importance of their Year 7-8, Year 9-10 and Year 11-12 science classes in their decisions. As shown in the lower section of Figure 3, respondents overwhelmingly believed their Year 11-12 science classes to have been the most important influence on their choice of university STEM course, with around 73% rating this stage as either important (31%) or very important (42%). Year 7-8 classes were considered to have been the least influential with only 19% of respondents rating these as important or very important. Since Queensland, WA and SA include Year 7 as part of primary rather than secondary school, additional analyses were conducted for this subgroup and compared with ratings by NSW, Tasmanian, Victorian and ACT students. The patterns of ratings within each group were almost identical, indicating that this structural difference did not affect the result.

The finding that university students consider their most recent school experiences to have been far more important than earlier high school experiences in their decisions to choose a STEM course appears to challenge the body of literature stressing the importance of early school experiences in career formation. However, in interpreting this result, it is necessary to keep in mind the range of complicating factors possibly in play, including the prominence of more recent experiences in students' memories and the possibility that respondents are downplaying the value of ideas and experiences they had when younger. It should also be kept in mind that this study concerns only those students undertaking university STEM courses, not high school graduates more

generally. The findings also tell us nothing about the relative influences of science classes at different stages on the very many students who had opted out of science.

Notwithstanding this important caveat, the findings are consistent with those reported by Lyons and Quinn (2010) who found that regardless of whether or not they were intending to take science subjects in senior school, Year 10 students considered their most recent school science experiences to have been significantly more influential in enrolment decisions than earlier experiences.

4.1.2 Sex differences in ratings of school experiences

Figure 4 presents the mean ratings of Australian males and females on the school experience items. The figure suggests that males and females were similarly inclined to regard interest in the subject as the most important influence.

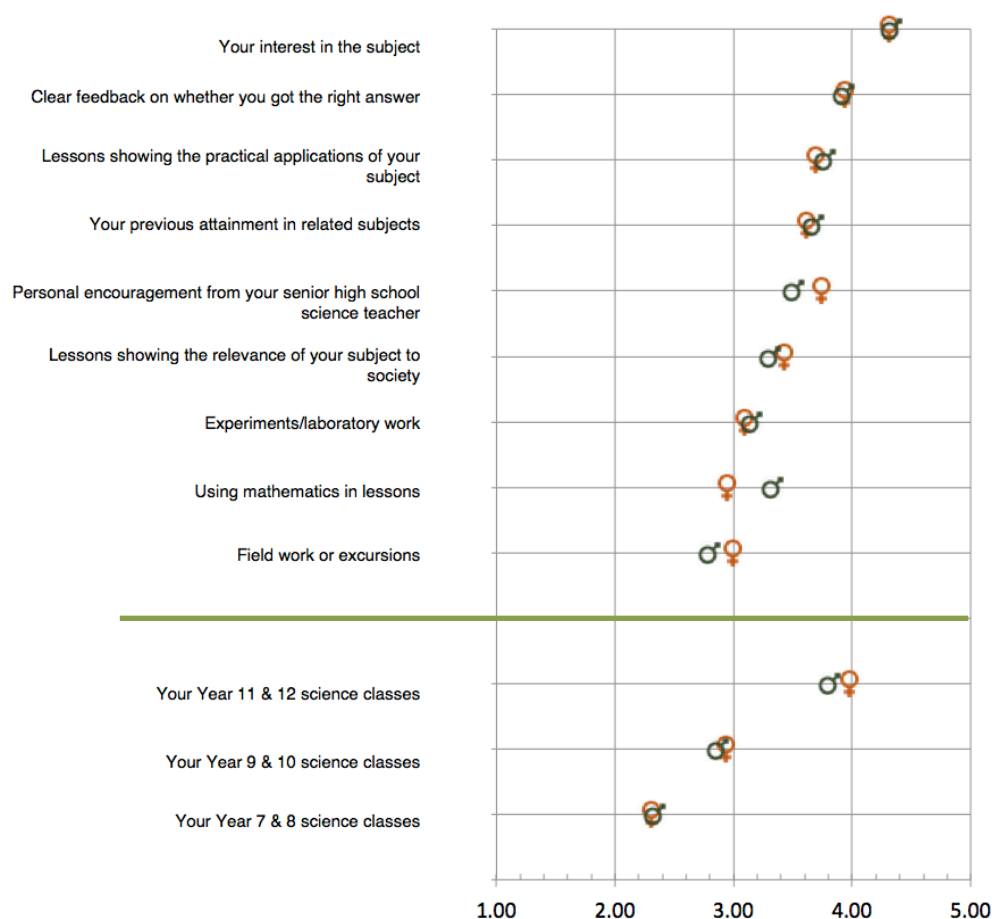


Figure 4: Mean ratings of male and female respondents on items relating to the question: “How important was each of the following school experiences in choosing your course?”

Chi-squared contingency table tests showed that two items were significantly associated with sex of respondent. First, there was a significant association between sex and the importance of personal encouragement from science teachers¹. This is mainly due to significantly more females than expected rating this encouragement as very important. This association had a small Effect Size.

Second, there was a significant association² between sex and the importance of using mathematics in lessons, due mainly to significantly more females than expected rating mathematics as not important in their decisions, and significantly more males than expected rating it as very important. The association had a small Effect Size. This association could also relate to the higher representation of males in mathematics-rich courses such as physics and engineering.

4.1.3 Influence of school experiences on females in male-dominated STEM fields

As noted above, IRIS had a particular interest in exploring the perspectives of female students enrolled in three male-dominated STEM fields: Physics/astronomy, IT and Engineering (Phys/IT/Eng). This exploration was conducted by comparing the responses of females enrolled in each of these fields with those of males in these fields. In addition, the responses of Phys/IT/Eng females were compared with those of females enrolled in the female-dominated STEM fields; Biological sciences, Other Natural and Physical sciences and Health.

Analysis of responses from males and females in Phys/IT/Eng courses revealed that the significant sex difference in ratings of the importance of encouragement from science teachers reported in section 4.1.2 was less marked among students in Physics/astronomy and IT courses, though still strongly suggestive among Engineering students³. The significant association between sex and the importance of mathematics in lessons reported in section 4.1.2 was not evident among respondents enrolled in Phys/IT/Eng courses.

Comparing the responses of females in male-dominated and female-dominated STEM courses revealed two notable differences. First, there was a significant association between the type of STEM field and the importance of using mathematics in lessons.

¹ $\chi^2(4) = 51.33$; $p < 0.001$; Cramer's $V = 0.131$, ASR = 6.3

² $\chi^2(4) = 83.11$; $p < 0.001$; Cramer's $V = 0.167$, ASR = 5.5

³ $\chi^2(4) = 16.87$; $p < 0.001$; Cramer's $V = 0.122$, ASR = 3.1

This was due to significantly more females in Phys/IT/Eng courses rating the use of mathematics as very important in their decisions, and a high than expected number females in female dominated STEM fields rating this as not important⁴. The Effect Size was medium. It appears therefore that interactions between sex and course type underlie the significant overall sex-difference on this item reported in section 4.1.2.

4.1.4 Field of Education differences in ratings of school experiences

Respondents' mean ratings of school experience items are depicted across ASCED fields of education in Figure 5. Chi-squared tests of expected and actual ratings revealed some interesting associations between ASCED codes and the importance attributed to particular school experiences. First, significantly more Earth science⁵ and Agricultural/Environmental studies students⁶ than expected rated interest as not important in their choice of course. The Effect Size was small.

Second, significantly more Engineering students than expected rated their previous attainment in related subjects as very important in their decisions⁷, with fewer than expected rating this as not important (ASR=6.2). In contrast, significantly more Agriculture/ Environmental studies students than expected rated this item as not important⁸ while significantly fewer than expected rated it as very important (ASR=4.1). The Effect Size was small.

Several other results were consistent with what might be predicted given the relationship between characteristics of the individual courses and some specific high school experiences. For example, Chi-squared tests revealed a significant association between Field of Education and ratings of the importance of Experiments/Laboratory work, due primarily to significantly more Chemical Science students than expected rating Experiments/ Laboratory work as very important⁹, and significantly more Agriculture/ Environmental studies students rating this as not important¹⁰. The Effect Size was small.

⁴ $\chi^2(4) = 125.70$; $p < 0.001$; Cramer's $V = 0.311$, ASR = 8.0

⁵ $\chi^2(36) = 129.78$; $p < 0.001$; Cramer's $V = 0.104$, ASR = 3.6

⁶ $\chi^2(36) = 129.78$; $p < 0.001$; Cramer's $V = 0.104$, ASR = 4.7

⁷ $\chi^2(36) = 174.93$; $p < 0.001$; Cramer's $V = 0.121$, ASR = 4.2

⁸ $\chi^2(36) = 174.93$; $p < 0.001$; Cramer's $V = 0.121$, ASR = 7.5

⁹ $\chi^2(36) = 132.47$; $p < 0.001$; Cramer's $V = 0.105$, ASR = 4.6

¹⁰ $\chi^2(36) = 132.47$; $p < 0.001$; Cramer's $V = 0.105$, ASR = 5.3

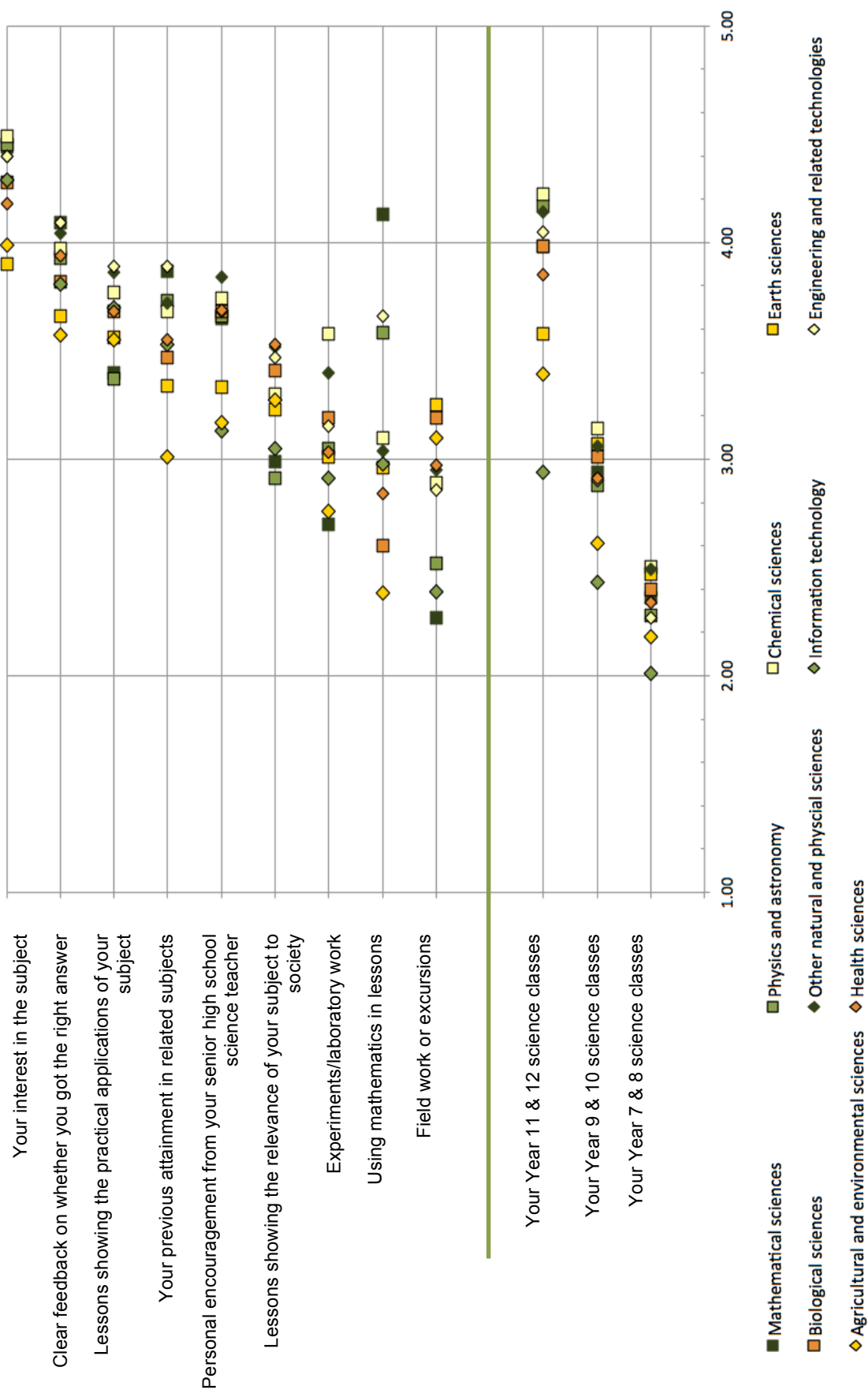


Figure 5: Mean ratings of responses across different Fields of Education to the question: “How important was each of the following school experiences in choosing your course?”

Likewise, significantly more mathematics students¹¹ and engineering students¹² considered the use of mathematics in lessons as very important to their decisions – and significantly fewer rated it as not important - than would be expected were there no relationship between these variables. In contrast, significantly fewer Agriculture/Environmental studies students¹³ and biological studies students¹⁴ than expected rated this as very important in their decisions, while significantly more than expected rated it as not important. The Effect Size of these differences was medium.

Figure 5 also suggests potential differences in the importance of fieldwork to students' decisions. Exploration of this relationship by chi-squared contingency table tests indicated that whereas significantly more biological science students than expected rated fieldwork as very important¹⁵, significantly more IT students¹⁶ and mathematics students¹⁷ than expected rated this as not important in their decisions. These differences had a small Effect Size.

It was apparent from the chi-squared tests that IT and Agriculture/Environmental science students were more inclined than others in the cohort to rate personal encouragement from their senior science teachers as 'not important'. However this is not remarkable as the opinions of science teachers were not necessarily relevant to students in these two fields.

The lower part of Figure 5 illustrates the importance attributed by respondents to science classes at different stages of their schooling. The low mean ratings by IT and (for Years 11 & 12) by Agriculture/Environmental science students are to be expected, as school science experiences are less likely to be relevant to decisions about these fields than school IT or Agriculture experiences.

¹¹ $\chi^2(36) = 534.81$; $p < 0.001$; Cramer's $V = 0.211$, ASR = 9.0

¹² $\chi^2(36) = 534.81$; $p < 0.001$; Cramer's $V = 0.211$, ASR = 8.2

¹³ $\chi^2(36) = 534.81$; $p < 0.001$; Cramer's $V = 0.211$, ASR = 6.5

¹⁴ $\chi^2(36) = 534.81$; $p < 0.001$; Cramer's $V = 0.211$, ASR = 7.2

¹⁵ $\chi^2(36) = 198.43$; $p < 0.001$; Cramer's $V = 0.129$, ASR = 5.2

¹⁶ $\chi^2(36) = 198.43$; $p < 0.001$; Cramer's $V = 0.129$, ASR = 3.7

¹⁷ $\chi^2(36) = 198.43$; $p < 0.001$; Cramer's $V = 0.129$, ASR = 5.0

4.2 Q 2. How important are influential others in students' choice of STEM course?

4.2.1 Overall results for importance of influential others

Students were asked to rate the importance of key persons in their decisions about STEM courses. Figure 6 summarises the rating patterns for Australian students (N=2999¹⁸). It is clear from the figure that students considered good teachers to have been the most important individuals in their decisions, with 58% rating them important (33%) or very important (25%). Note however that this applies to “good” teachers – a modifier specified in the original IRIS Q - rather than teachers more generally. Nevertheless, the importance attributed to teachers was consistent with previous studies, including the *Choosing Science* project (Lyons & Quinn, 2010), which reported that Year 10 students enrolling in Year 11 science considered their science teachers (good or otherwise) to have been by far the most influential individuals in helping them make this decision.

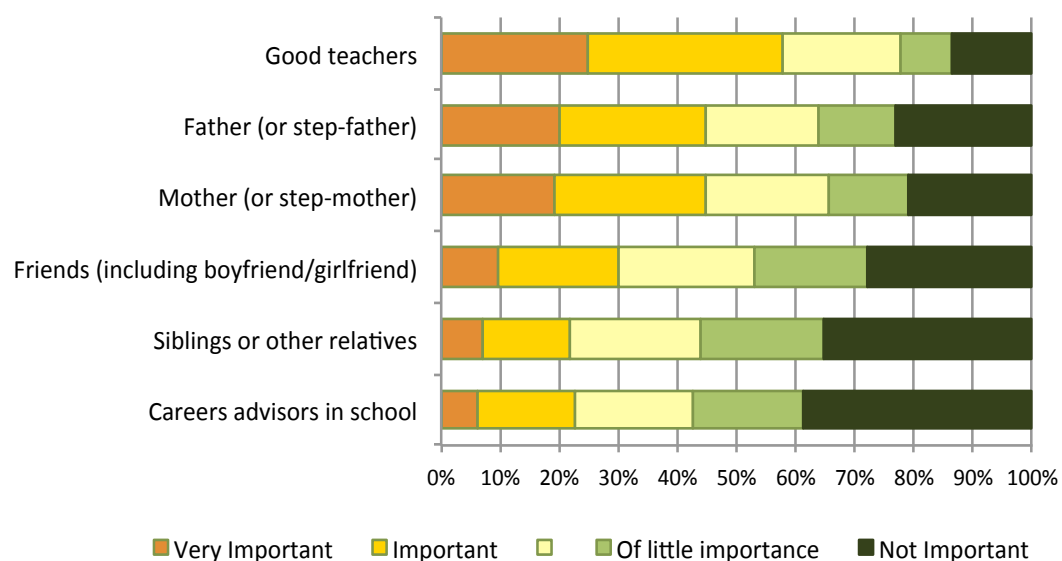


Figure 6: Percentage breakdown of responses to the question “How important were the following persons in choosing your course?”

Students tended to rate the importance of their mothers and fathers similarly. Both were considered important or very important in these decisions by around 45% of respondents. Again, the relatively high importance attributed to parents was consistent

¹⁸ Ratings of influential others by international respondents differed significantly from those of Australian respondents.

with previous studies, including Lyons and Quinn (2010). Respondents were less likely to rate friends as important in these decisions than parents, with only around 10% regarding friends as very important in their choice of course. The influence of siblings or other relatives was lower still, with only 7% of respondents regarding input from this source as very important.

Students regarded school careers advisors as having had little importance in their decisions to take STEM courses. Only 6% of respondents considered their influence very important, while around 57% believed that they were of little or no importance in their decisions. This finding is in line with other Australian studies arguing that school careers advisors are seen as having less influence than others on students' decisions about taking science at senior school or university (Anlezark, Lim, Semo & Nguyen, 2008; Lyons & Quinn, 2010).

4.2.2 Sex differences in ratings of the importance of influential others

Figure 7 reports the mean ratings of Australian male and female respondents on the importance of influential others in decisions about their STEM course (N=2965). Exploration of sex differences by chi-squared tests showed that significantly more female students than expected rated their mothers as very important in their course choices¹⁹. The Effect Size is small.

4.2.3 The influence of others on females in male-dominated STEM fields

Comparisons between the ratings of males and females enrolled in Phys/IT/Eng courses revealed that the sex difference reported in section 4.2.2 was not significant among Physics/astronomy students or IT students. The association was however suggestive among Engineering students²⁰ due to a greater than expected number of female Engineering students rating their mothers as very important in decisions to take their courses. Hence the significant sex difference reported in section 4.2.2 does not apply equally across all STEM fields. There were no significant or suggestive differences between females in male-dominated STEM courses and those in female-dominated courses in terms of ratings of the importance of significant others.

¹⁹ $\chi^2(4) = 37.71$; $p < 0.001$; Cramer's $V = 0.113$, ASR = 4.9

²⁰ $\chi^2(4) = 15.01$; $p < 0.005$; Cramer's $V = 0.116$, ASR = 2.7

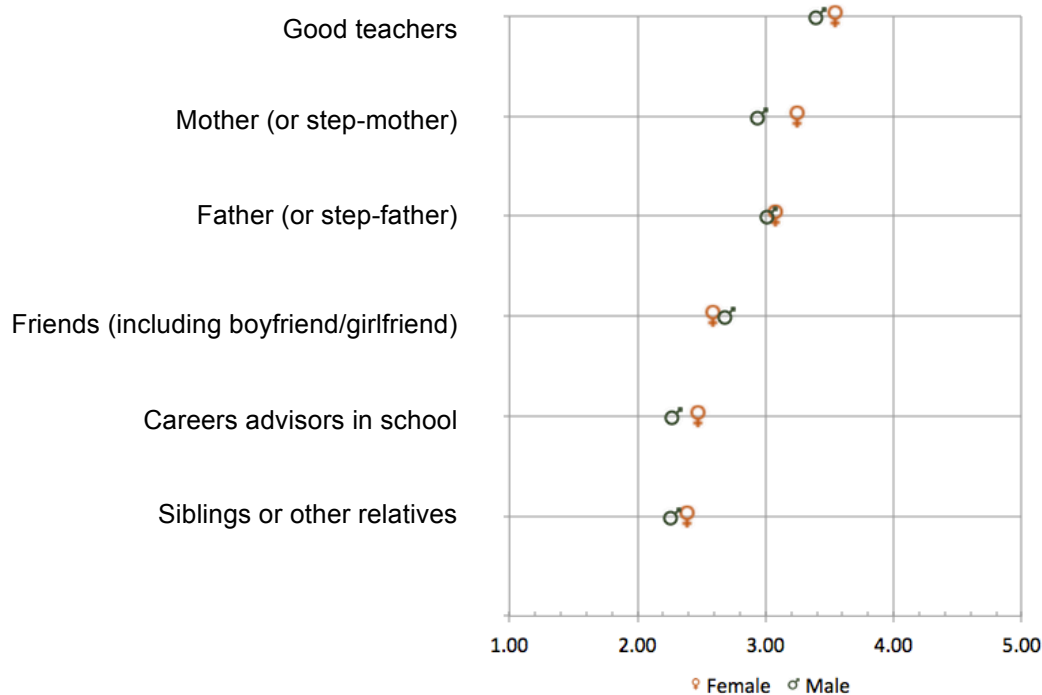


Figure 7: Mean ratings of male and female respondents on items relating to the question: “How important were the following persons in choosing your course?”

4.2.4 Field of Education differences in ratings of the importance of influential others

A breakdown of Australian students’ ratings on these items by Field of Education is shown in Figure 8. With respect to the importance of good teachers, while the figure shows low mean ratings by IT students, the results of chi-squared tests were not significant. However, significantly more Agricultural/Environmental science students than expected rated good teachers as not important²¹. The Effect Size was small.

Fewer than expected respondents taking Engineering courses²² and Health courses²³ rated their mothers as not important in their decision. On the other hand, more Physics/Astronomy students rated their mothers as not important than would be expected if these variables were not associated.²⁴ These associations were significant with a small Effect Size.

²¹ $\chi^2(4) = 109.12$; $p < 0.001$; Cramer’s $V = 0.096$, ASR = 5.4

²² $\chi^2(36) = 113.87$; $p < 0.001$; Cramer’s $V = 0.097$, ASR = 4.3

²³ $\chi^2(36) = 113.87$; $p < 0.001$; Cramer’s $V = 0.097$, ASR = 3.6

²⁴ $\chi^2(36) = 113.87$; $p < 0.001$; Cramer’s $V = 0.097$, ASR = 4.6

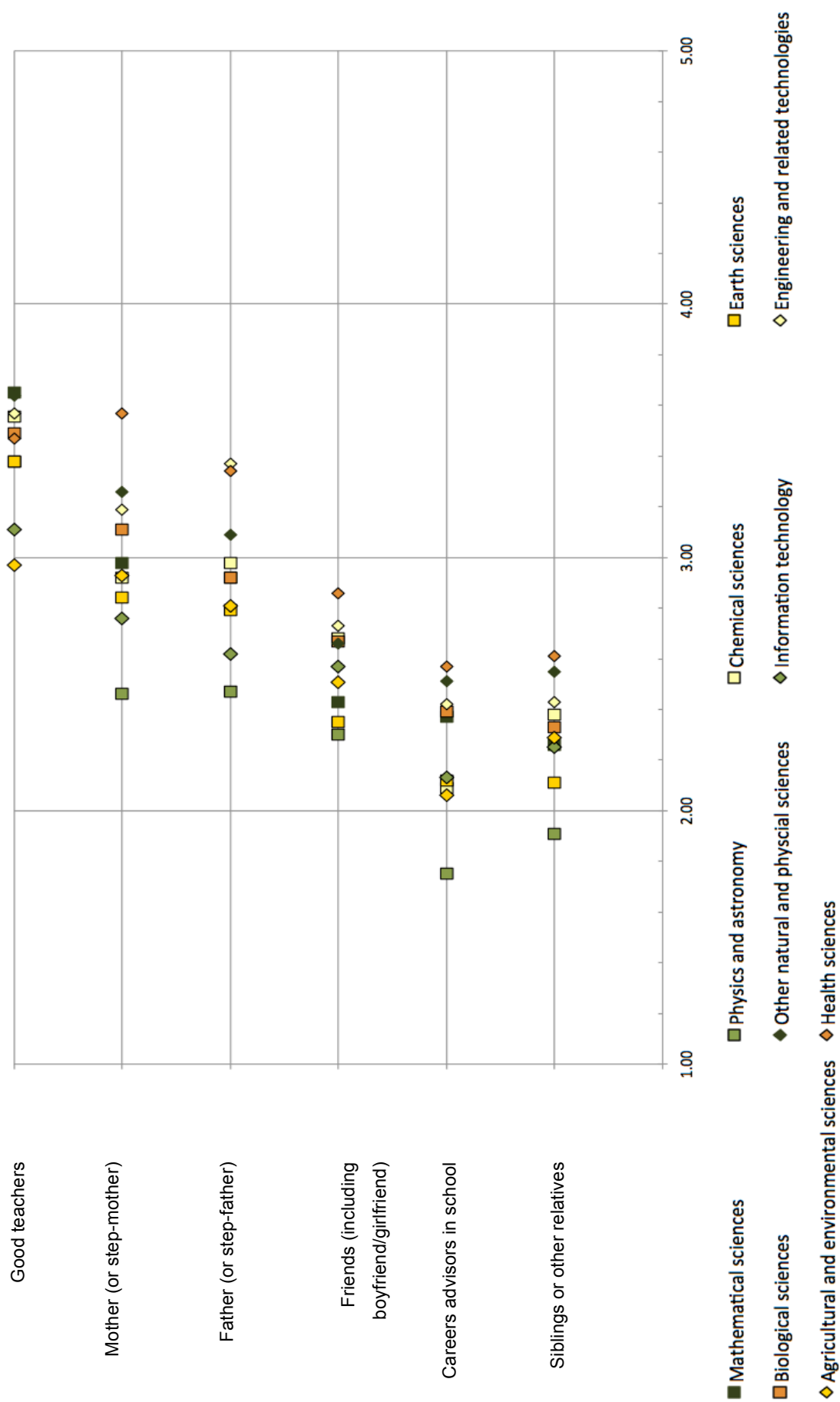


Figure 8: Mean ratings of responses across different Fields of Education to the question “How important were the following persons in choosing your course?”

Significantly more Engineering students than expected rated their fathers as very important²⁵ in their decisions, while fewer than expected rated them as not important (ASR=7.2). In contrast, fewer than expected IT students rated their fathers as very important²⁶, while more than expected rated them as being of little importance (ASR=4.1). Physics/Astronomy students were also more likely than expected to rate their fathers as not important in their decisions²⁷. These differences were significant with a small Effect Size.

None of the differences in ratings of the importance of friends or siblings by students in different STEM fields were significant. However, significantly more than expected physics/Astronomy students rated Careers Advisors as not important to their decisions²⁸. The Effect Size was small.

4.3 Q 3. How important are STEM-related media and outreach in students' choice of course?

4.3.1 Overall results for importance of STEM-related media and outreach

The IRIS project is interested in the relative importance of extra-curricular or non-school STEM related experiences in students' choice of university course. Figure 9 summarises ratings by the Australian respondents (N=2999) of the importance of a selection of common science-related media and generic outreach programs. A separate analysis of ratings by international respondents (N=486) mirrored the pattern in Figure 9, though the mean ratings on all items were substantially higher.

As shown in the figure, popular science television or radio programs were considered the most important, with around 44% of respondents regarding these as either important (29%) or very important (15%) to their decisions, and 21% considering them not important. Museums and science centres were rated as important by 21% and very important by around 7% of respondents. There was little variation among the other items, all of which were regarded as not important by at least 41% of respondents, with computer games being regarded as unimportant by more than 55% of respondents. As will be shown later, this response varied substantially according to

²⁵ $\chi^2(36) = 142.49$; $p < 0.001$; Cramer's $V = 0.109$, ASR = 4.7

²⁶ $\chi^2(36) = 142.49$; $p < 0.001$; Cramer's $V = 0.109$, ASR = 3.5

²⁷ $\chi^2(36) = 221.44$; $p < 0.001$; Cramer's $V = 0.138$, ASR = 4.2

²⁸ $\chi^2(36) = 172.29$; $p < 0.001$; Cramer's $V = 0.122$, ASR = 4.3

sex and Field of Education. Outreach activities were rated as important or very important by around 27% of respondents and not important by nearly 40%. Additional details about outreach activities are presented in section 4.3.4 below.

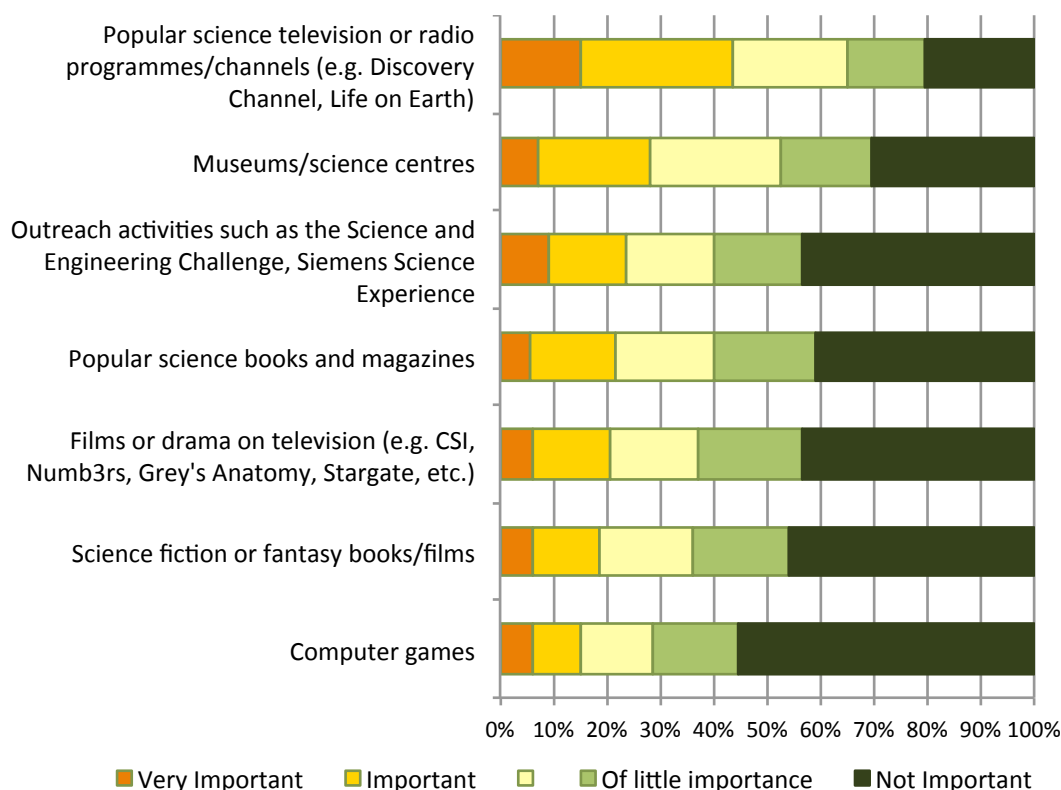


Figure 9: Percentage breakdown of responses to the question “How important was each of the following when choosing your course?” with items relating to STEM-related media and outreach.

4.3.2 Sex differences in ratings of the importance of STEM related media and outreach

Figure 10 presents ratings by Australian male and female respondents on the importance of STEM-related media and outreach in their decisions about university courses. In contrast to the mean ratings of the importance of school experiences shown in Figure 4, mean ratings for nearly all of the items in Figure 10 were below the scale midpoint, indicating that the students tended to regard school-based experiences as more important to their decisions than the media and outreach items in this section.

As suggested by the figure and confirmed in chi-squared tests, significantly more males than expected rated popular science books and magazines as very important in

their decisions²⁹, and significantly fewer rated these as not important than would be the case if there was no association between these variables. The Effect Size was small. Likewise, significantly more males than expected rated science fiction or fantasy books/films as very important³⁰ in their course choice, while significantly fewer than expected rated these as not important. Again, the Effect Size was small.

The largest difference was found in ratings of the importance of computer games on students' choice of courses. Significantly fewer females³¹ than expected rated these as very important, while significantly more that expected rated them as not important (ASR=14.7). There was a medium Effect Size.

There were no significant differences (at the 0.001 level) between males and females with regard to the importance of outreach activities, popular science TV or radio programs or television dramas related to STEM fields.

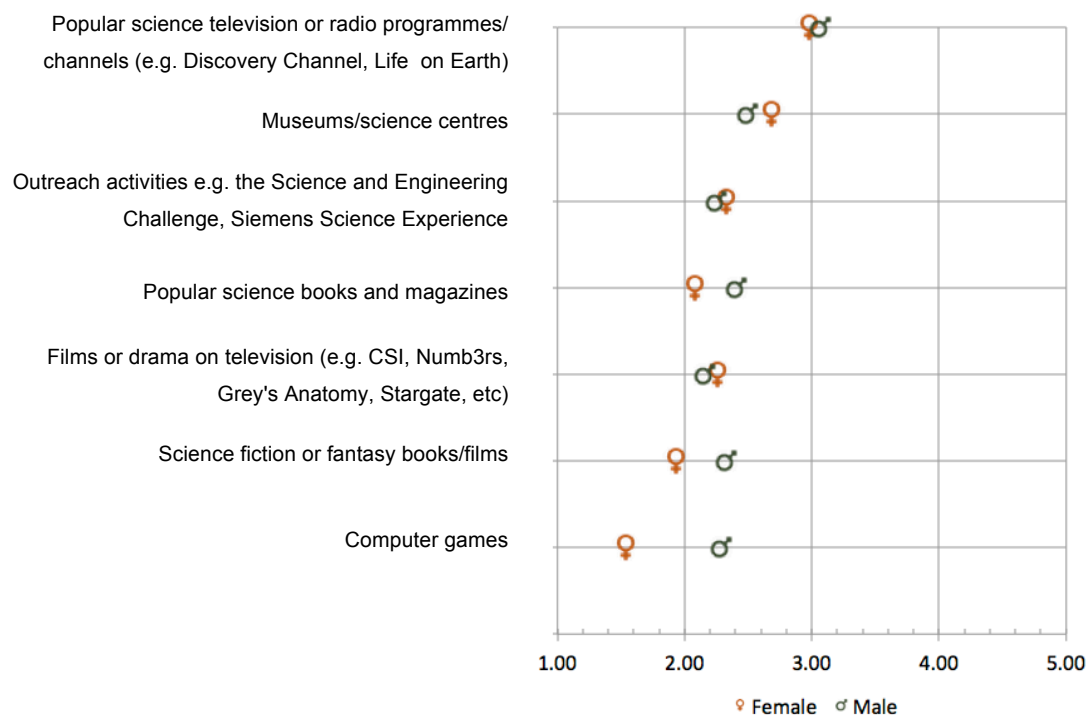


Figure 10: Mean ratings of male and female respondents on items relating to the question: "How important was each of the following when choosing your course?" with items relating to STEM-related media and outreach

²⁹ $\chi^2(4) = 54.91$; $p < 0.001$; Cramer's $V = 0.136$, ASR = 5.0

³⁰ $\chi^2(4) = 75.46$; $p < 0.001$; Cramer's $V = 0.159$, ASR = 5.2

³¹ $\chi^2(4) = 263.76$; $p < 0.001$; Cramer's $V = 0.30$, ASR = 9.0

4.3.3 Ratings of the importance of media and outreach influences by females in male-dominated STEM fields

The significant associations with sex found in the overall cohort were not found to be significant or suggestive among those choosing physics/astronomy courses, indicating that males and females in these courses did not place substantially different degrees of importance on the influence of popular science books/magazines, science fiction or fantasy books/films or computer games in their decisions. There were however significant differences between male and female Engineering students with respect to the importance of computer games³² and suggestive differences in the importance attributed to science fiction or fantasy books/films³³, with more females than expected rating these items as not important. Nevertheless, females in male-dominated STEM courses were significantly more inclined than those in female-dominated courses to rate computer games as very important in their decisions³⁴, while the latter were more inclined to rate these as not important.

While there were no significant differences in students' ratings of the importance of outreach activities overall, comparisons between females and males in Engineering courses revealed a suggestive association between sex and the importance of these activities, with more females than expected rating outreach programs as important and more males than expected rating them as not important.³⁵ Further comparisons between females in male and female-dominated STEM courses revealed a significant association between STEM field and the importance of outreach activities in enrolment decisions. This association was due to a greater than expected number of females in male-dominated courses rating outreach activities as very important and a greater than expected number of females in female-dominated STEM courses rating them as not important³⁶. These two findings suggest strongly that outreach activities are an important influence on decisions by females to enrol in some male-dominated STEM courses.

³² $\chi^2(4) = 53.79$; $p < 0.001$; Cramer's $V = 0.219$, ASR = 6.3

³³ $\chi^2(4) = 15.22$; $p < 0.004$; Cramer's $V = 0.116$, ASR = 2.8

³⁴ $\chi^2(4) = 35.57$; $p < 0.001$; Cramer's $V = 0.169$, ASR = 4.3

³⁵ $\chi^2(4) = 27.19$; $p < 0.001$; Cramer's $V = 0.147$, ASR = 4.1

³⁶ $\chi^2(4) = 34.64$; $p < 0.001$; Cramer's $V = 0.147$, ASR = 3.5

4.3.4 *Field of Education differences in ratings of the importance of STEM related media and outreach*

Figure 11 presents the mean ratings of Australian students in different Fields of Education on the importance of selected STEM related media and outreach.

Notwithstanding the relatively low mean ratings overall, the figure suggests that students in different fields attribute different levels of influence to different media.

These apparent differences were explored using chi-squared contingency table tests, which revealed a significant association between STEM field of education and ratings of the importance of popular science TV or radio programmes/channels such as the Discovery Channel and Life on Earth. Significantly more Biological sciences students than expected rated these as very important³⁷, while significantly fewer rated them as not important (ASR=4.6). By comparison, significantly more IT students³⁸ and Mathematics students³⁹ than expected rated these programmes as not important.

As suggested by Figure 11, chi-squared tests also revealed a meaningful association between Field of Education and importance of Museums and Science Centres. Significantly more Biological sciences students than expected rated these as very important⁴⁰, and significantly fewer rated them as not important (ASR=6.9). In contrast, significantly more IT students⁴¹, Mathematical science students⁴² and Agriculture/Environmental studies students⁴³ than expected rated these resources as not important. The Effect Size was small, but just under the medium range.

It was found that significantly more physics/astronomy students rated popular science books and magazines as very important⁴⁴ than would be expected if there was no association, while significantly more than expected Health students⁴⁵ and Mathematical sciences⁴⁶ students rated these as not important to their decisions.

³⁷ $\chi^2(36) = 153.14$; $p < 0.001$; Cramer's $V = 0.113$, ASR = 3.6

³⁸ $\chi^2(36) = 153.14$; $p < 0.001$; Cramer's $V = 0.113$, ASR = 6.3

³⁹ $\chi^2(36) = 153.14$; $p < 0.001$; Cramer's $V = 0.113$, ASR = 4.9

⁴⁰ $\chi^2(36) = 249.24$; $p < 0.001$; Cramer's $V = 0.145$, ASR = 7.8

⁴¹ $\chi^2(36) = 249.24$; $p < 0.001$; Cramer's $V = 0.145$, ASR = 5.6

⁴² $\chi^2(36) = 249.24$; $p < 0.001$; Cramer's $V = 0.145$, ASR = 4.3

⁴³ $\chi^2(36) = 249.24$; $p < 0.001$; Cramer's $V = 0.145$, ASR = 3.8

⁴⁴ $\chi^2(36) = 112.76$; $p < 0.001$; Cramer's $V = 0.097$, ASR = 4.9

⁴⁵ $\chi^2(36) = 112.76$; $p < 0.001$; Cramer's $V = 0.097$, ASR = 4.3

⁴⁶ $\chi^2(36) = 112.76$; $p < 0.001$; Cramer's $V = 0.097$, ASR = 3.9

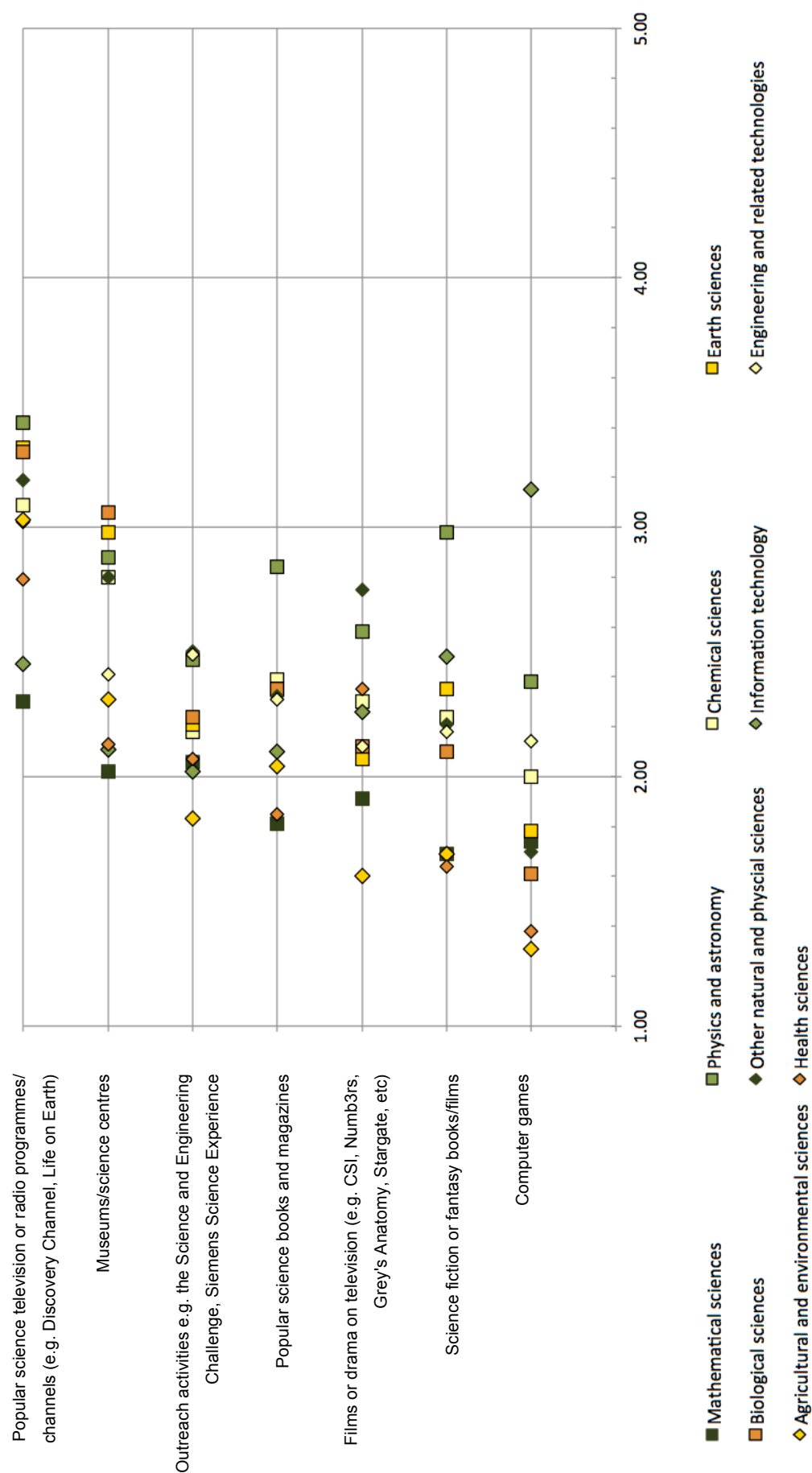


Figure 11: Mean ratings of responses across Fields of Education to the question “How important was each of the following when choosing your course?” with items relating to STEM-related media and outreach.

Physics/Astronomy students also appeared to be more influenced than their peers by science fiction/fantasy books or films, with significantly more than expected rating these as very important⁴⁷ and significantly fewer than expected rating them as not important (ASR=4.8). In contrast, significantly more Health students⁴⁸ and Agriculture/environmental studies students⁴⁹ than expected rated these as not important.

As suggested by Figure 11, there was a significant association between Field of Education and the level of importance attributed to computer games in students' course choices. Far more IT students rated these as very important⁵⁰, and far fewer as not important (ASR= 10.9) than would be expected if these variables were not associated. Fewer Engineering⁵¹ and Physics/Astronomy⁵² students than expected rated computer games as not important, while more Health⁵³ students and Agriculture/Environmental studies⁵⁴ students than expected rated computer games as not important in their decisions. These associations were significant with a medium Effect Size.

4.4 Q 4. How encouraging are specific STEM outreach activities in students' choice of course?

A wide-range of STEM-related outreach opportunities is available to school students across Australia. These include initiatives such as summer schools, competitions, activity days, science fairs and accelerated programs organised by industry, professional associations, universities, education authorities and others. Students were asked to nominate up to three outreach experiences in which they had been involved, and to rate the degree to which they felt these experiences had encouraged them to choose their current courses. Students who had not participated in or could not recall any outreach activities were asked to skip this question.

⁴⁷ $\chi^2(36) = 173.69$; $p < 0.001$; Cramer's $V = 0.121$, ASR = 6.7

⁴⁸ $\chi^2(36) = 173.69$; $p < 0.001$; Cramer's $V = 0.121$, ASR = 5.1

⁴⁹ $\chi^2(36) = 173.69$; $p < 0.001$; Cramer's $V = 0.121$, ASR = 5.1

⁵⁰ $\chi^2(36) = 476.69$; $p < 0.001$; Cramer's $V = 0.200$, ASR = 14.1

⁵¹ $\chi^2(36) = 476.69$; $p < 0.001$; Cramer's $V = 0.200$, ASR = 5.3

⁵² $\chi^2(36) = 476.69$; $p < 0.001$; Cramer's $V = 0.200$, ASR = 4.7

⁵³ $\chi^2(36) = 476.69$; $p < 0.001$; Cramer's $V = 0.200$, ASR = 5.6

⁵⁴ $\chi^2(36) = 476.69$; $p < 0.001$; Cramer's $V = 0.200$, ASR = 7.4

4.4.1 Overall results for effectiveness of STEM-related outreach activities

Student responses demonstrated the sheer variety of STEM outreach activities available. Overall, 1066 students (30%) nominated at least one activity in which they had been involved. As several of the activities reported by international students are not available in Australia, this section concerns only the Australian cohort (N=2999). Table 7 shows the frequency of nomination by Australian males and females of the activities reported by seven or more respondents.

Table 7: Alphabetical listing of STEM outreach activities most frequently nominated by Australian students.

Outreach activity	Female	Male	Total
Australian (Westpac) Mathematics Competition	16	15	31
CSIRO (Crest, Helix, etc.)	7	11	18
Engineering competitions (various generic)	12	16	28
Enrichment programs, including GAT or accelerated courses (various)	20	29	49
Fairs, Expos, Exhibitions, University Open Days etc.	27	40	67
Honeywell Engineering Summer School	2	7	9
IT competitions	5	14	19
Mathematics competitions (various)	23	31	54
National Youth Science Forum	35	36	71
Olympiads	18	14	32
Other (Clubs, Visits to particular sites, Awards schemes etc.)	55	45	100
RACI Titration Competition	16	20	36
Rio Tinto Big Science	3	5	8
Science and Engineering Challenge	112	144	256
Science competitions (various)	29	40	69
SciTech	6	1	7
Seminars, Forums, Conferences, Workshops, etc.	17	9	26
Siemens Science Experience	75	80	155
Summer schools or Summer camps (various)	52	56	108
Tournament of the Minds	5	9	14
Women in STEM events or programs (various)	21	0	21
Work Experience (working in industry, volunteering, internships, etc.)	21	15	36
Youth ANZAAS	7	0	7
Total	584	637	1221

The table lists specific ‘high-profile’ activities (e.g. Honeywell Engineering Summer School, Australian [Westpac] Mathematics Competition⁵⁵), along with categories that include more generic activities or programs mentioned by fewer than seven respondents. The activities nominated most frequently were the Science and Engineering Challenge (N=256) and the Siemens Science Experience⁵⁶ (N=155).

Discounting entries which were irrelevant or too generic to be identifiable, students nominated a total of 172 individual outreach activities, consisting of 86 science related activities, 19 technology related activities, 27 engineering related activities, 11 mathematics related activities and 29 non-specific STEM activities. A full list of the identifiable activities is included in the Appendices.

4.4.2 Sex differences in outreach experiences

There were no meaningful differences in the proportions of males and females nominating at least one outreach activity. With the exception of the Youth ANZAAS program and those focusing on women in STEM, there were no substantial sex differences in the types of activities nominated.

4.4.3 High school location differences in outreach experiences

Table 8 shows the percentages of respondents nominating at least one outreach activity by the location of their high schools. These percentages are very consistent with the overall representation within each location category, suggesting that distance from a major centre was not a factor in access to some outreach opportunities. There were, however, noticeable differences in the types of activities nominated by students from different locations. For example, 30 of the 31 students nominating the Australian (Westpac) Mathematics Competition attended schools in large cities, while all but one of the 32 students nominating an Olympiad did likewise. Only 7% of those nominating any of the miscellaneous engineering competitions were located in the two rural categories. In contrast, around 28% of those nominating the Science and Engineering Challenge attended schools in rural or remote locations, and half those nominating the Honeywell Summer School came from remote schools. Students from rural and remote locations were likewise well represented among those nominating work experience opportunities.

⁵⁵ Now known as the Australian Mathematics Competition after Westpac withdrew as major sponsor.

⁵⁶ Now known as “The Science Experience” after Siemens withdrew as major sponsor.

Table 8: Percentages breakdown of Australian respondents nominating one or more outreach activity, by location of high school attended.

	In a capital city	In a large non-capital city	In a rural city of large town	In a small rural or remote town
% respondents nominating at least one outreach activity	53	21.6	17.1	9.1
% respondents in each location category	53.4	20.3	18.1	8.1

4.4.4 Respondent ratings of outreach activities

Respondents were asked to rate the degree to which the outreach activities they nominated had encouraged them in choosing their STEM course. Figure 12 shows the percentage breakdowns of respondents' ratings for each activity. Overall, the most noticeable feature is that most of the outreach activities were considered to have been quite encouraging in students' decisions. The top 16 activities were regarded as having been either extremely encouraging or very encouraging by at least 60% of those nominating them and 'not encouraging' by less than 16%.

In terms of the generic outreach categories, the figure shows that students tended to rate Work Experiences as the most encouraging, with about 94% of nominees considering these to have been either very or extremely encouraging. Seventeen of the 21 females nominating various Women in STEM activities considered these experiences to have been 'very' or 'extremely' encouraging. Students participating in enrichment or accelerated programs also rated them highly, with about 47% considering them extremely encouraging and a further 31% rating them as very encouraging. Likewise, engineering-related competitions were rated as very encouraging or extremely encouraging by around 89% of those nominating them. Of the high-profile programs, the Honeywell Engineering Summer School was highly rated, as was the Youth ANZAAS program run by the Australian and New Zealand Association for the Advancement of Science, and the National Youth Science Forum hosted by Rotary and other National Science Summer School Inc. partners.

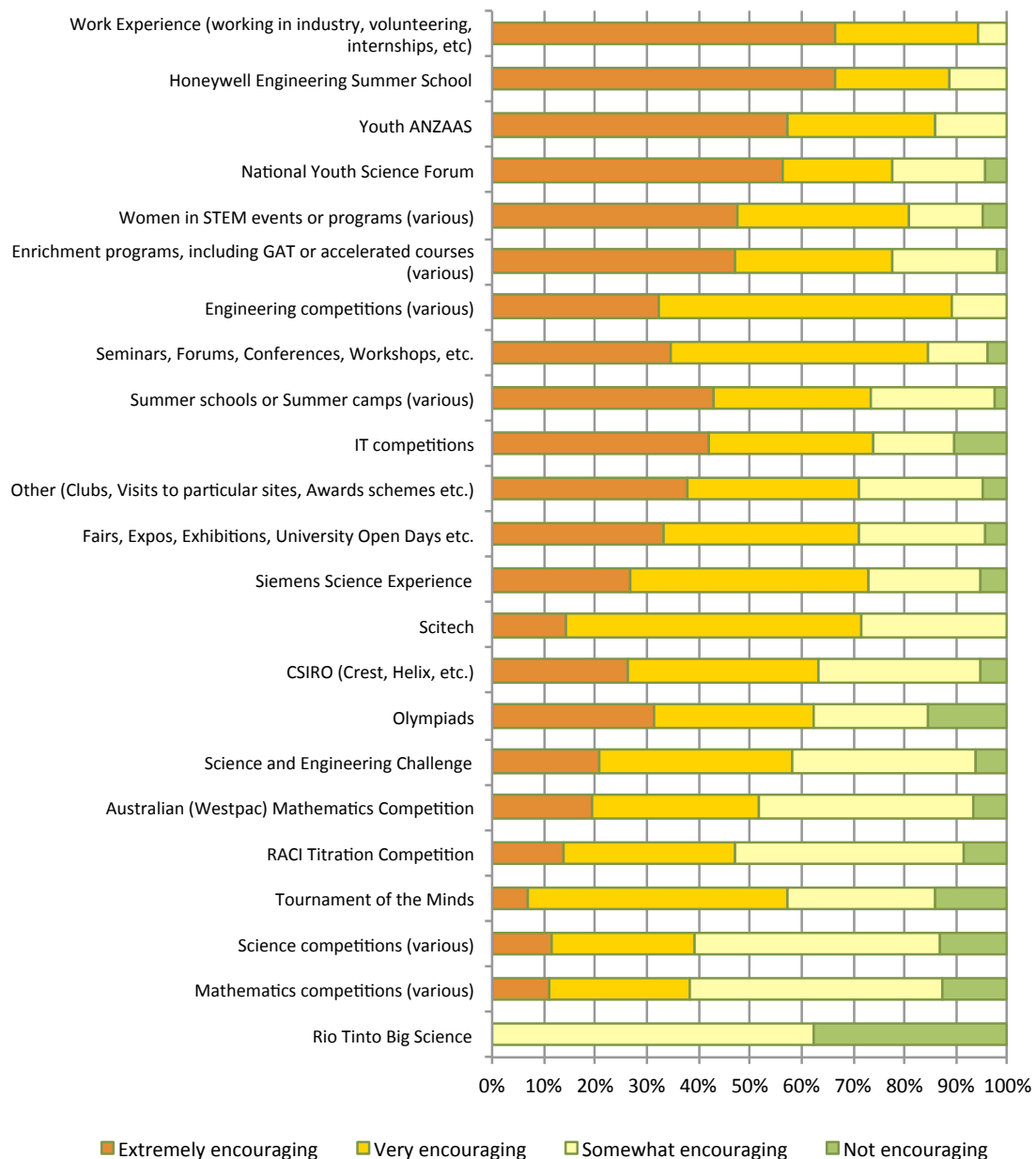


Figure 12: Percentage breakdown of Australian respondents' ratings of how much the outreach activity they nominated encouraged them to choose their current course.

There are of course several caveats to be considered in interpreting Figure 12. First, the ratings should be interpreted with reference to frequency of nomination (Table 7), as ratings with smaller frequencies have less external validity than those with larger frequencies. Second, some of these activities may have been experienced in junior high school and others in senior high school, a difference that may affect students' perceptions of motivational value. Third, some of these activities are designed

primarily to encourage enrolment in senior high school or university STEM courses, whereas others do not have this as their principal aim. Hence an activity receiving a relatively low rating on ‘encouragement’ may have more positive outcomes in characteristics not measured by this question, such as improvement of skills or knowledge. Fourth, some activities are well resourced and mature in their development, while others may have fewer resources or be in an early stage of development. Finally, the nature, focus and sponsorship of some activities may have changed since being experienced by the IRIS cohort.

4.5 Q 5. What explanations do students give for their decisions to enrol in STEM courses?

Students were invited via an open-ended question to: “describe how you came to choose the STEM course in which you are enrolled”. There were 3205 responses to this question. Many individual responses covered several distinct aspects of that student’s experience and so were subdivided into “explanatory units”. The units were coded into themes and subthemes using constant comparative analysis based on interpretations agreed among the researchers. The thematic coding resulted in 6589 individual explanatory units. A summary of the themes and subthemes used to categorise these units is provided in Figure 13. For the purposes of this report, only subthemes containing 50 or more units are shown in the figure to facilitate interpretation of the key messages that emerged from the data.

As indicated by Figure 13, by far the most common reason students gave for choosing their course was interest in and enjoyment of the general field, whether through school or other unspecified experiences. Over 2,000 students referred to the importance of interest/enjoyment in their decision. For example:

I've always found science to be interesting and enjoyable, and as I was not 100% certain on exactly what kind of science I'd like to study, I enrolled into the BSc (Advanced). – Chemical Sciences

Science appealed because I always enjoyed it, found it interesting and it something I was good at. – Civil Engineering

My father took me to his shop in TV/video/computer repair as a child and from there I developed a keen understanding and interest in computing. I'd always played games as a kid and teen and had always been interested in the work done to make games and other programs. When choosing a course, for me it was a no brainer, I both enjoy and am good with computers. – Computer Sciences

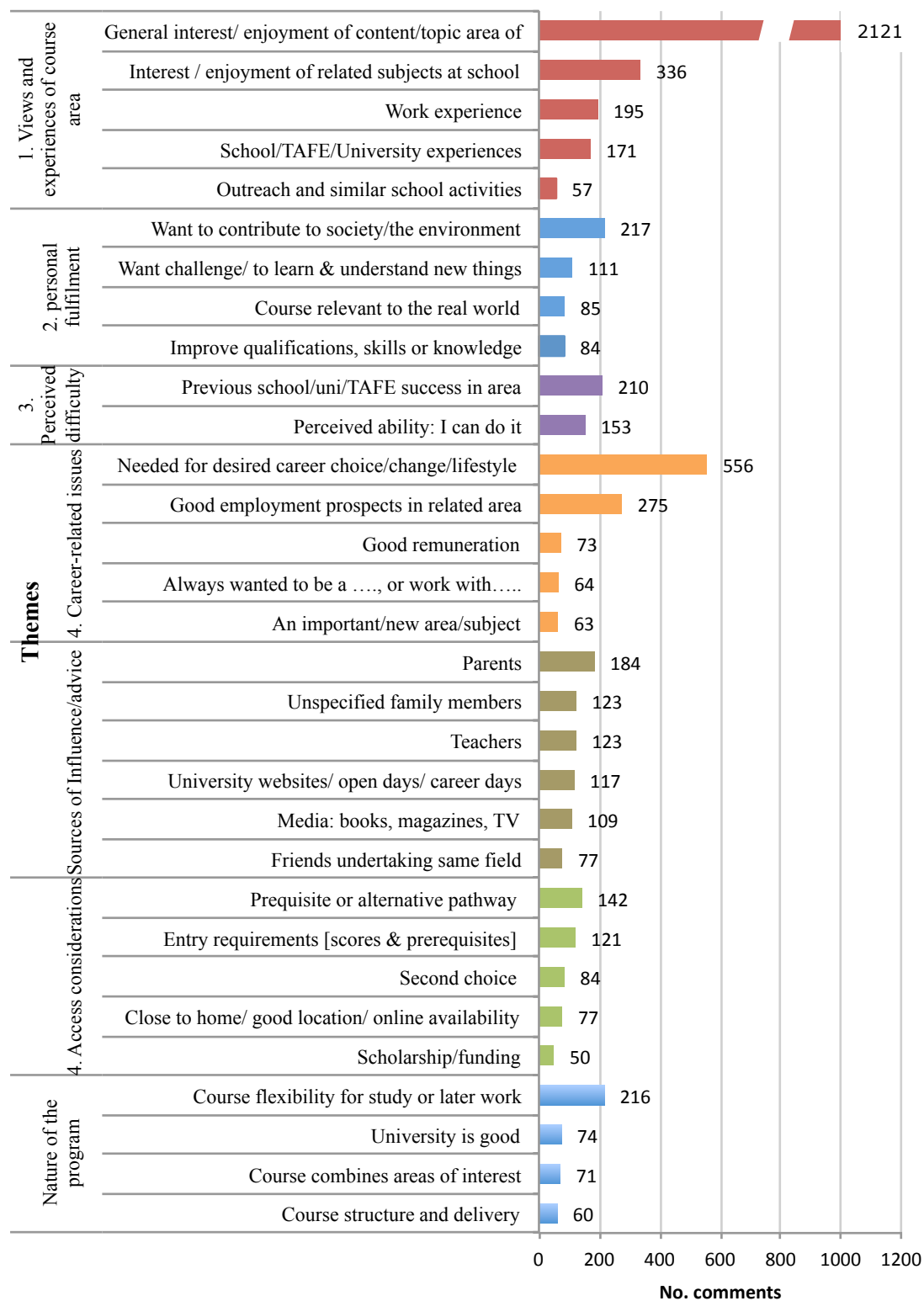


Figure 13: Frequency of student responses to the question “Describe how you came to choose the course in which you are enrolled?” (N= 6589 explanatory units from 3205 respondents).

This result is not surprising given what we know about the importance of interest in students' subject choices, but the extent of the difference between personal interest and career considerations is notable. There were about twice as many responses referring to interest and enjoyment as there were in all career-related sub-themes combined. Some representative comments referring to the importance of career considerations include the following:

I have always wanted to do Geology as a career. A BSc was the most flexible course with subject choice and it would eventually lead me on to doing Geology as a major. – Other Natural and Physical Sciences

I chose my course as I was advised of its high employment opportunities both nationally and internationally, as well as the fact that it was related to the practical application of mathematical and physical principles in working towards a more developed society. - Civil Engineering

Of the different sources that students identified as influencing their course choice, parents were the most frequently cited: for example:

I sought advice from university advisers but, from an academic background, I found their advice heavily clouded with persuasion. Out of chemistry and civil engineering, I sat down with my parents, and I realised my fundamental passions lie with mathematics and design-work, which led me to civil engineering - I am happy with this decision. - Civil Engineering

The next most frequent category was unspecified family members (which likely included some parents) and then teachers were the next most influential category. This is an interesting result when compared to the findings of the *Choosing Science* study (Lyons & Quinn, 2010, p. 80), where Year 10 students mentioned teachers more frequently than parents as influential in their choices to study science in Year 11. This comparison suggests that in relation to choosing science at school, teacher influence might outweigh parental influence; however, in later university choices parents may be more directly influential than teachers. Nonetheless the indirect influence of teachers on students' university choices is still likely to be considerable through their contribution to students' interest and enjoyment of the area.

Friends were less influential than media or information coming from universities, and other sources of information such as school careers advisers individually were represented by fewer than 50 responses.

5 STUDENTS' EXPERIENCES, EXPECTATIONS AND PRIORITIES REGARDING UNIVERSITY STEM COURSES

5.1 Q 6. What are students' experiences of their first year university STEM courses?

5.1.1 Overall results for students' experiences of university STEM courses

Students were asked to rate their agreement with a range of statements about their first year experiences of STEM courses. Data from Australian and International students are combined for the purpose of these analyses (N=3496). Figure 14 summarises respondents' overall ratings of agreement with these statements.

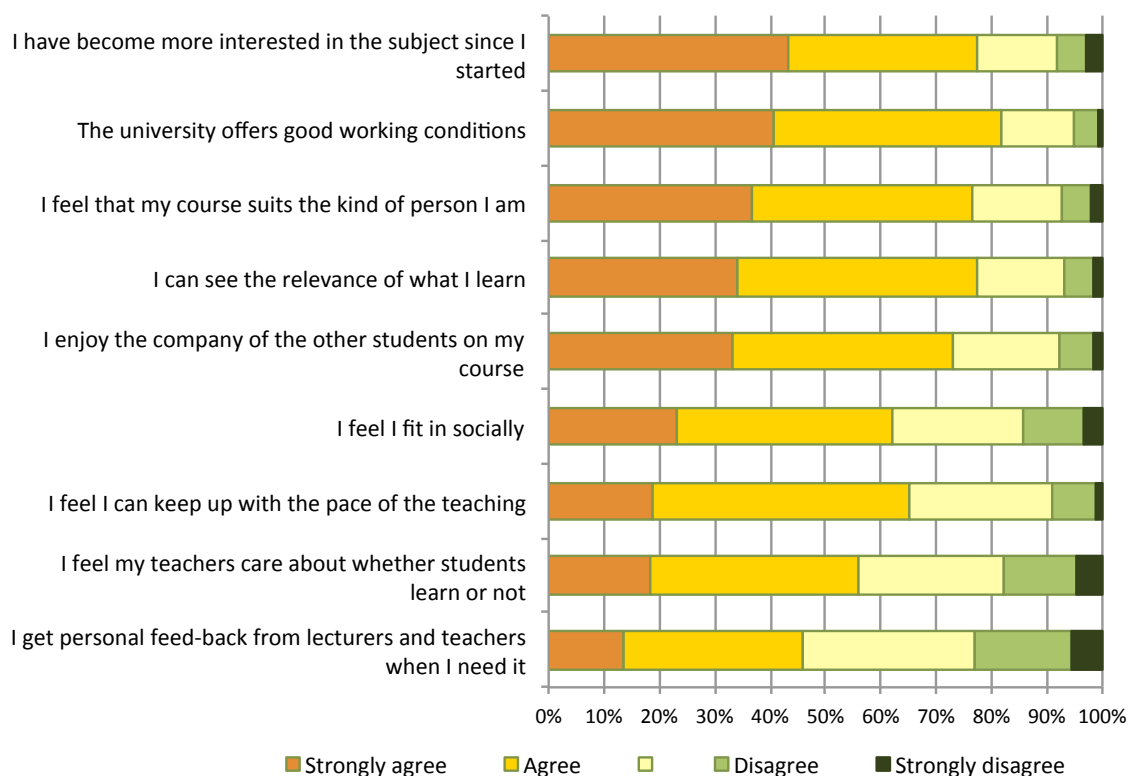


Figure 14: Percentage breakdown of responses to items relating to the question “To what extent do you agree with the following statements about your experiences as a university student so far?”

Overall, respondents were inclined to agree with most of the items, indicating a generally positive response to their experiences. Around 78% of respondents agreed they had become more interested in their subjects since starting the course, while

about 82% agreed that their universities offered good working conditions. Only around 5% of respondents disagreed with this statement, suggesting a high rate of satisfaction with this aspect of their courses. Respondents were inclined to agree that their choice of university and course was a good fit. Around 77% agreed that their courses suited their personalities, while a similar proportion believed that they saw the relevance of what they were learning.

Respondents were less positive about their interactions with and support from teaching staff, however. Only 56% agreed that their teachers cared about whether they learned or not, while fewer than half (46%) believed they received personal feedback from lecturers and teachers when needed. Around 23% of respondents disagreed that this had been their experience. Ratings on these two items differed considerably depending on the university attended. However, rather than identifying individual universities in this report, responses are presented with respect to five university categories based on recognised networks or alliances (see Appendix 3). Figure 15 summarises the perceptions of respondents in different university networks as to whether their lecturers/teachers cared if students learned or not.

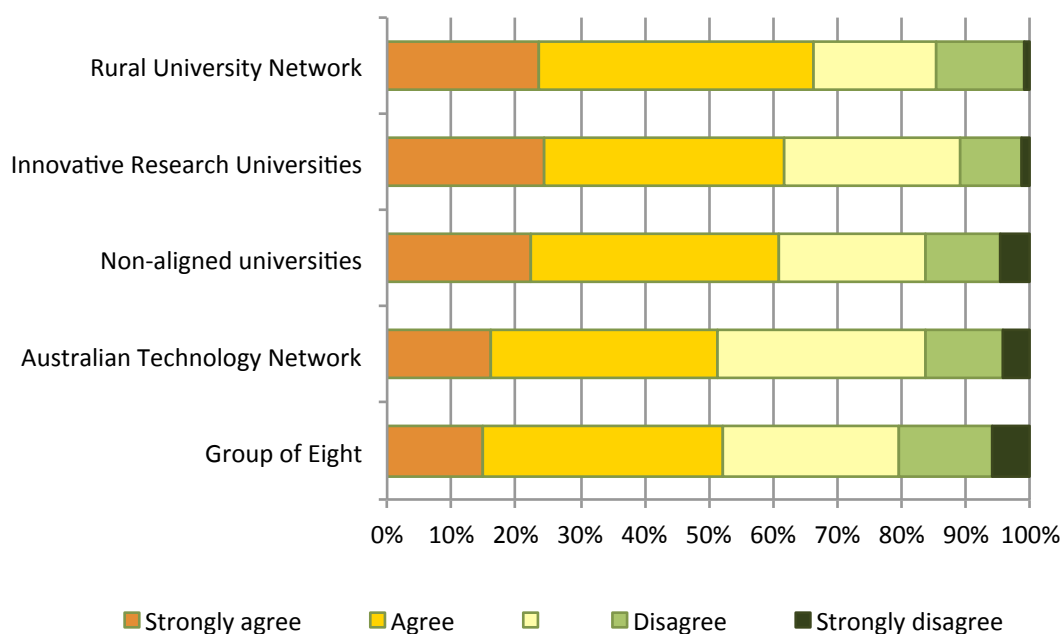


Figure 15: Percentage breakdown of responses to the statement “I feel my teacher/lecturers care about whether students learn or not”, by students in different university networks.

The figure shows that more than one in five respondents in Group of Eight (G8) universities disagreed that their lecturers cared whether they learned or not, while

only 15% strongly agreed this was the case. Contingency table analyses revealed that this association between university group and students' perceptions of whether their lecturers cared whether they learn or not was statistically significant. The association was due primarily to significantly fewer than expected students from the G8 strongly agreeing that their teachers cared, and significantly more than expected students from several other networks agreeing or strongly agreeing that this was the case⁵⁷. The Effect Size was small. This result does not however apply to all seven of the G8 universities represented in the IRIS study, with ratings by students from three of these contributing most to the relatively low rating.

Figure 16 summarises the views of students in different university networks as to whether they receive personal and timely feedback from lecturers and teachers.

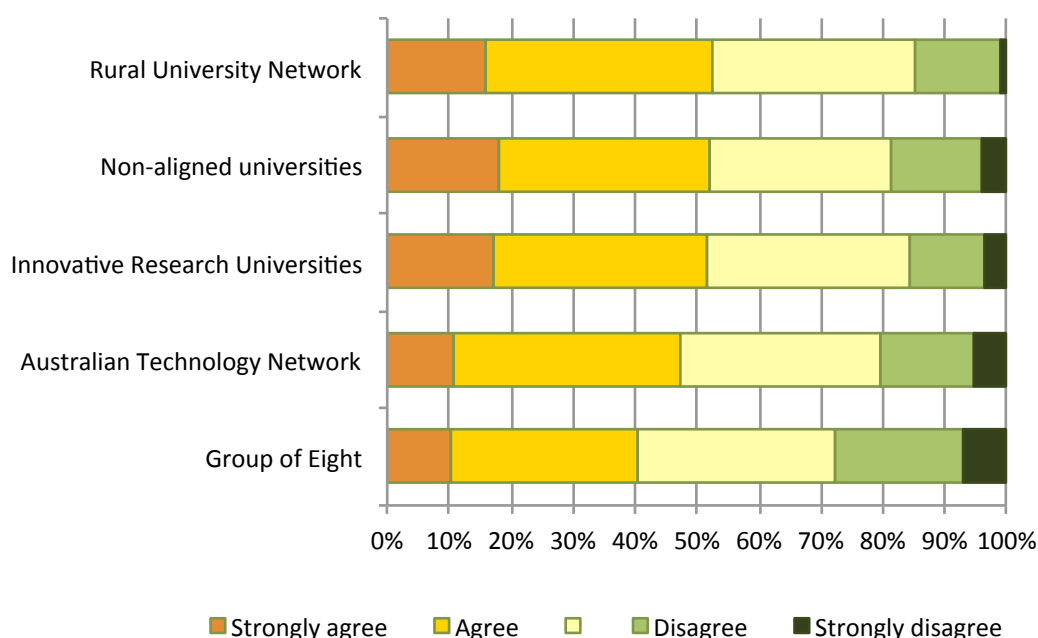


Figure 16: Percentage breakdown of responses to the statement “I get personal feedback from lecturers and teachers when I need it”, by students in different university networks.

As with the previous result, students in G8 universities were more inclined than their peers in other networks to disagree - and less inclined to agree - that they received personal feedback when needed. Chi-squared analyses of crosstabulations revealed a significant association between university network and agreement with this statement, due primarily to significantly more students than expected from the Group of Eight universities disagreeing that they received personal feedback from lecturers and

⁵⁷ $\chi^2(4) = 66.81$; $p < 0.001$; Cramer's $V = 0.07$, ASR = 4.8

teachers, and significantly more students than expected disagreeing.⁵⁸ The Effect Size was small. Respondents from four of the G8 universities contributed most to the relatively low rating.

5.1.2 Sex differences in students' experiences of university STEM courses

Figure 17 illustrates the mean ratings of male and female respondents' agreement with statements about their experiences. The figure shows a great deal of similarity in the ratings of male and female students across the items, and there were no significant differences detected by chi-squared tests.

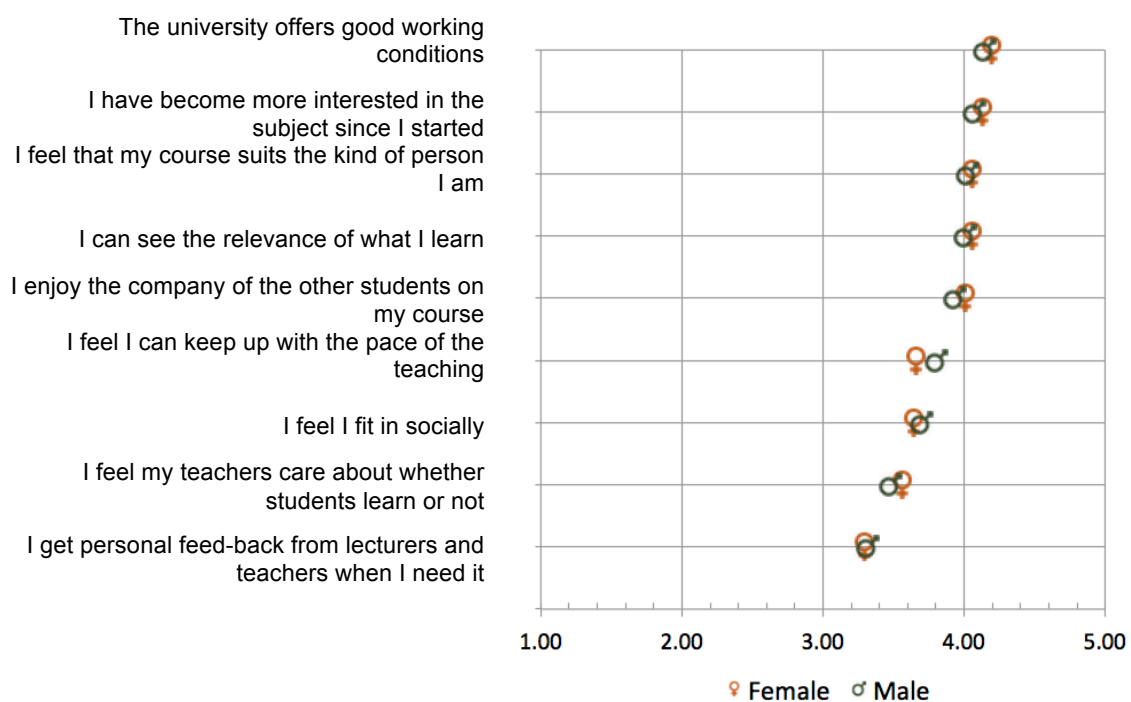


Figure 17: Mean ratings of male and female respondents on items relating to the question: “To what extent do you agree with the following statements about your experiences as a university student so far?”

5.1.3 University experiences of females in male-dominated STEM fields

Comparisons between females and males in male-dominated STEM courses revealed no significant differences in their ratings of university experience items. Bearing in mind any attrition that may have occurred prior to the survey, females still enrolled at this stage of their first year do not appear to be adversely affected by their minority status in these courses; at least with respect to these individual items.

⁵⁸ $\chi^2(4) = 79.77$; $p < 0.001$; Cramer's $V = 0.077$, ASR = 4.9

However, among females there was a strongly suggestive association between type of STEM course and agreement that teachers/lecturers cared whether students learn or not. This association was due to fewer than expected females in male-dominated courses strongly agreeing that their teachers/lecturers cared about their learning, and more than expected females in female-dominated courses strongly agreeing that this was the case.⁵⁹

5.1.4 Field of Education differences in students' experiences of university STEM courses

Figure 18 shows the breakdown of mean ratings on respondents' agreement with each "experience" item by Field of Education. The figure shows a high level of consistency across the fields of education. Nevertheless, Engineering students were less positive about many of their first year experiences than their peers in other STEM courses.

Chi-squared tests indicated that significantly more Engineering students than expected strongly disagreed that they received personal feedback from lecturers and teachers⁶⁰ and significantly fewer strongly agreed (ASR 5.9) this was the case. The Effect Size was in the small range.

Further, significantly more Engineering students than expected strongly disagreed that their lecturers and teachers cared about whether or not they learned anything⁶¹, and significantly fewer than expected strongly disagreed (ASR=4.9). Again, there was a small Effect Size.

Chi-squared tests also indicated that significantly fewer Engineering students than expected strongly agreed that they could see the relevance of what they were learning⁶², that the course suited the kind of person they were,⁶³ or that they had become more interested in the subject since they started⁶⁴. All of these results were significant with small Effect Sizes.

⁵⁹ $\chi^2(4) = 17.08$; $p < 0.002$; Cramer's $V = 0.118$, ASR = 3.2

⁶⁰ $\chi^2(36) = 88.18$; $p < 0.001$; Cramer's $V = 0.080$, ASR = 3.9

⁶¹ $\chi^2(36) = 126.80$; $p < 0.001$; Cramer's $V = 0.096$, ASR = 4.9

⁶² $\chi^2(36) = 94.54$; $p < 0.001$; Cramer's $V = 0.083$, ASR = 5.0

⁶³ $\chi^2(36) = 76.25$; $p < 0.001$; Cramer's $V = 0.075$, ASR = 5.6

⁶⁴ $\chi^2(36) = 97.23$; $p < 0.001$; Cramer's $V = 0.084$, ASR = 6.2

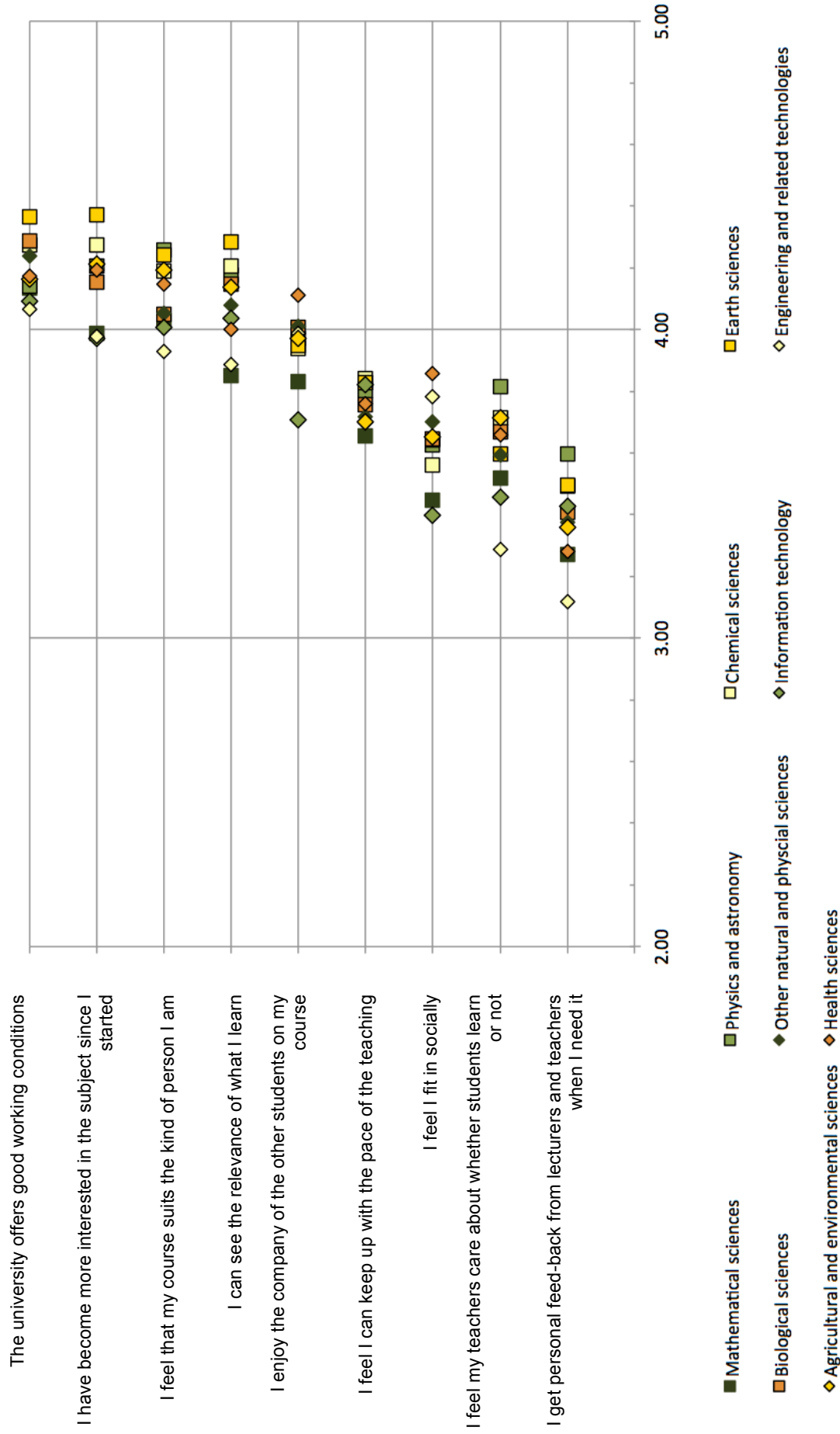


Figure 18: Mean ratings by respondents in different Fields of Education on items relating to the question: “To what extent do you agree with the following statements about your experiences as a university student so far?”

5.2 Q 7. Have students' first year experiences of STEM courses met their expectations?

Students were asked whether aspects of their university experiences had met their expectations. They responded via a three point scale indicating whether each aspect had been “better than expected”, “as expected” or “worse than expected”.

5.2.1 Overall results for students' expectations

Respondents' ratings of how well five aspects of their university experiences have met their expectations are shown in Figure 19. The figure indicates that around 90% of students considered the course content to have been at least as interesting as expected, with about 40% rating it better than expected. Likewise, around 37% of respondents considered the overall course experience to have been better than expected, while only 10% thought it worse than expected. Around 88% of respondents considered the quality of teaching to have been at least as good as expected, though 12.5% thought it worse than expected. Finally, around a third of respondents believed the amount of effort expended on studying had been greater than anticipated, though around 13% had found it easier. Differences in ratings between university networks were not significant at $p < .001$.

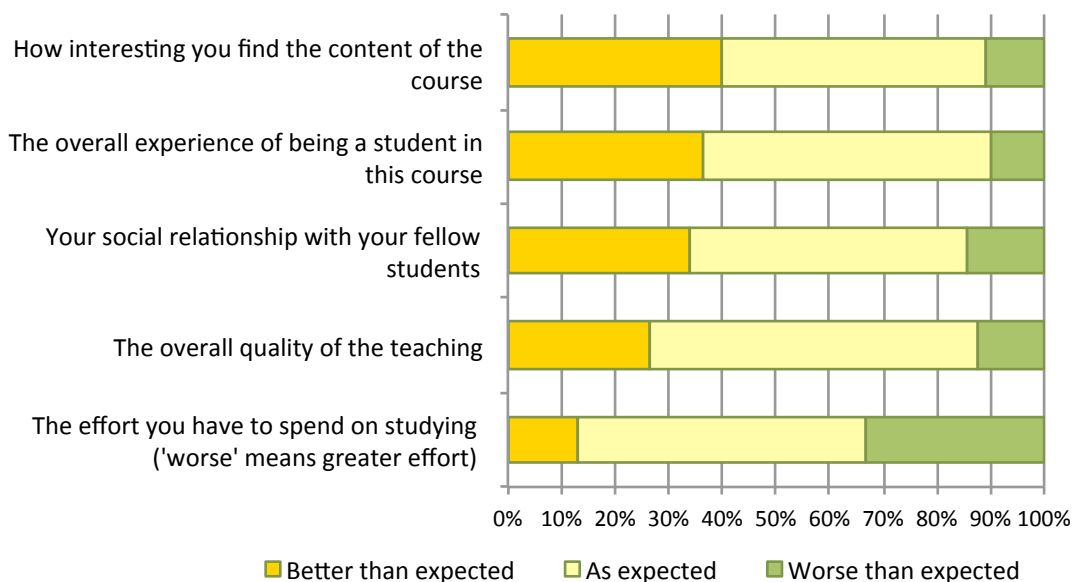


Figure 19: Percentage breakdown of responses to items relating to the question: “Have the following aspects of your everyday life as a university student been as expected, better than expected or worse than expected?”

5.2.2 Sex differences in students' expectations

Figure 20 compares the mean responses of males and female students to the items exploring their expectations and subsequent experiences. Chi-squared tests detected no significant meaningful sex differences in students' ratings.

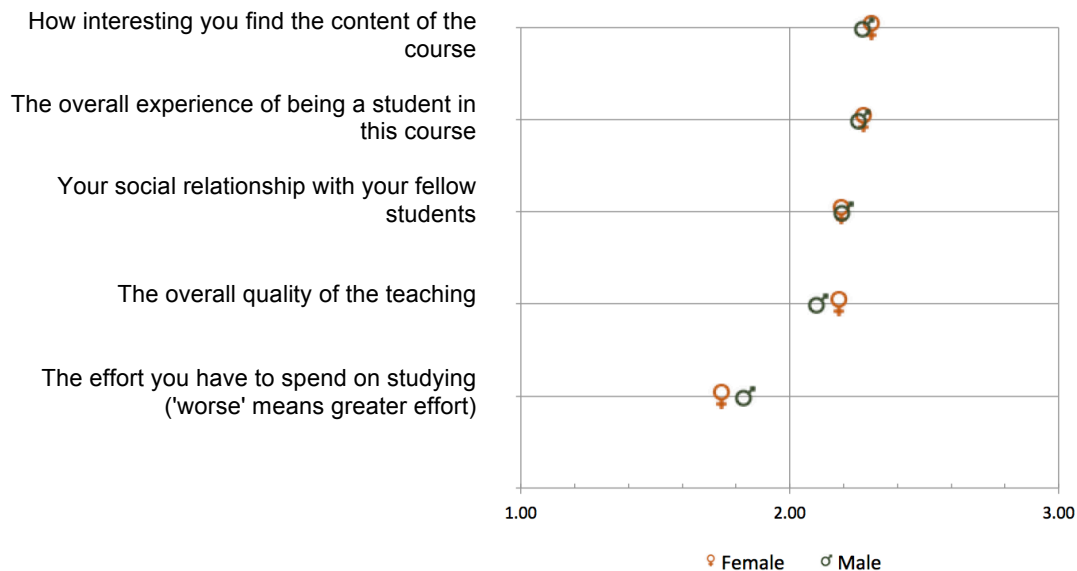


Figure 20: Mean ratings of male and female respondents on items relating to the question: “Have the following aspects of your everyday life as a university student been as expected, better than expected or worse than expected?”

5.2.3 Expectations of females in male-dominated STEM fields

Comparisons between males and females in male-dominated courses revealed no meaningful associations between sex and how well expectations about university had been met. However, compared with females in female-dominated STEM fields, those in male-dominated fields were significantly more inclined to rate the overall quality of teaching as worse than expected⁶⁵. The Effect Size of this difference was small. As will be seen below, this result most likely relates to the greater tendency among engineering students to rate the quality of their teaching as worse than expected.

5.2.4 Field of Education differences in students' expectations

Figure 21 presents the mean responses of students in different fields of education to the items exploring their expectations and subsequent experiences.

⁶⁵ $\chi^2(4) = 21.71$; $p < 0.001$; Cramer's $V = 0.133$, ASR = 3.9

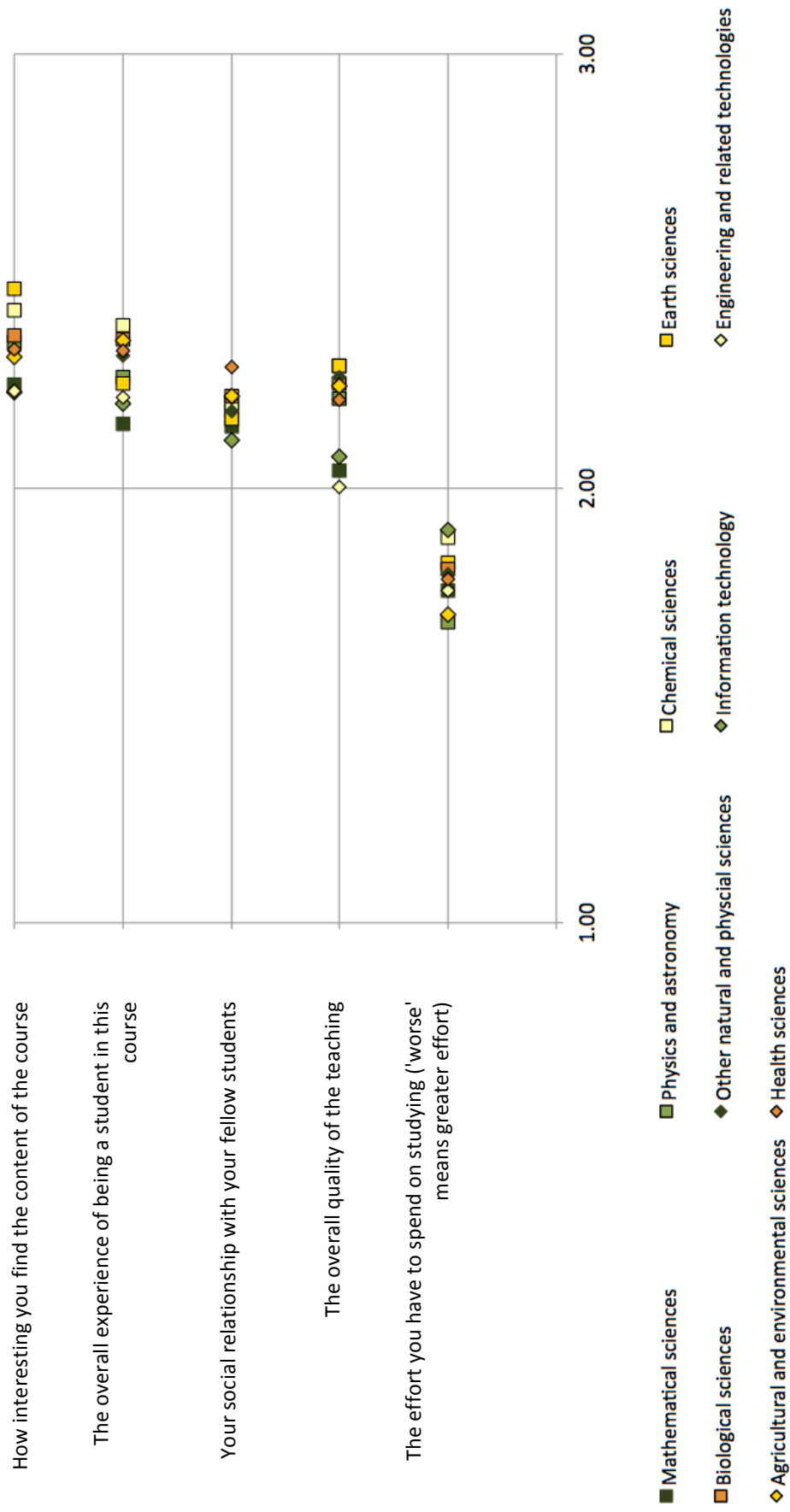


Figure 21: Mean ratings of respondents in different Fields of Education on items relating to the question: “Have the following aspects of your everyday life as a university student been as expected, better than expected or worse than expected?”

There are few features of interest, except to note that as might be expected given results reported above, the Chi-squared contingency table test revealed a significant association between the two variables, due primarily to significantly more Engineering students than expected rating the quality of the teaching as worse than expected⁶⁶ and significantly fewer rating it better than expected (ASR=6.7). Likewise, significantly fewer than expected Engineering students rated their overall experience of being a student in their courses as better than expected⁶⁷. The Effect Sizes for these associations were small.

5.3 Q 8. What are students' perceptions of their self-efficacy and intentions to complete the course?

The study explored questions of attrition and retention in STEM courses by asking students about their self-efficacy, motivation and intentions to complete the course. Students responded by indicating their levels of agreement with five items on a five point Likert-type scale. In addition, those who had at any stage considered withdrawing from their courses were invited to give their reasons in an open-ended response.

5.3.1 *Overall results for students' self-efficacy and intention to complete the course*

Figure 22 provides a percentage breakdown of respondents' ratings of their agreement with the five items. Overall, respondents tended to rate the top three items in similar ways, suggesting a consistency between motivation, expected achievement and confidence. Around 65% of respondents agreed or strongly agreed with these statements, with between 10-13% disagreeing.

Just under 50% of respondents believed they easily learn the subject matter in their course, with about 19% disagreeing. In terms of intention to continue, about 9% of respondents agreed they would probably leave the course before completion, while 82% disagreed.

⁶⁶ $\chi^2(18) = 134.57$; $p < 0.001$; Cramer's $V = 0.141$, ASR = 8.1

⁶⁷ $\chi^2(18) = 46.32$; $p < 0.001$; Cramer's $V = 0.083$, ASR = 4.1

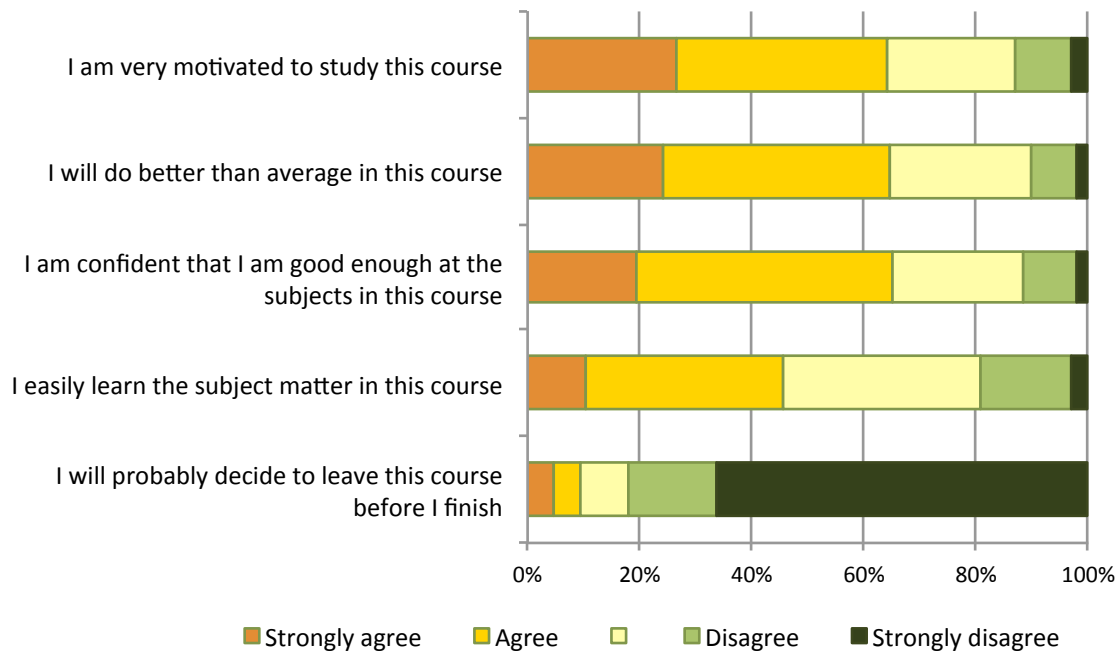


Figure 22: Percentage breakdown of respondents' agreement with items relating to self-efficacy and intention to complete the course

5.3.2 Sex differences in students' self-efficacy and intentions to complete the course

Figure 23 presents the mean ratings of male and female students on their agreement with the self-efficacy, motivation and retention items. Chi-squared tests for these items revealed significant associations between sex and ratings on three items concerning perceptions of achievement. Significantly more males than expected strongly agreed that they will do better than average in the course⁶⁸, that they are good enough at the various subjects⁶⁹ and that they easily learn the subject matter⁷⁰. Significantly more females than expected disagreed with each of these statements. These results are consistent with research elsewhere showing lower levels of self-efficacy among females considering or undertaking STEM subjects at school and university (Lyons & Quinn, 2010; Thompson & De Bortoli, 2010), although some researchers argue that self-efficacy is not a substantial impediment to female participation in male-dominate STEM courses (see Machina & Gokhale, 2010).

⁶⁸ $\chi^2(4) = 62.01$; $p < 0.001$; Cramer's $V = 0.136$, ASR = 7.2

⁶⁹ $\chi^2(4) = 67.68$; $p < 0.001$; Cramer's $V = 0.142$, ASR = 6.5

⁷⁰ $\chi^2(4) = 53.86$; $p < 0.001$; Cramer's $V = 0.126$, ASR = 5.3



Figure 23: Mean ratings of agreement by male and female respondents with items relating to self-efficacy, motivation and intention to complete the course.

5.3.3 Self-efficacy of females in male-dominated STEM fields

A comparison of ratings on these items by males and females enrolled in male-dominated STEM courses revealed no significant or suggestive sex differences among Physics/astronomy students or IT students. However, among Engineering students there was a strongly suggestive association between sex and feeling confident they were good enough in the subject⁷¹. This association was due to more males than expected strongly agreeing that they were good enough at the course. The Effect Size of this association was small. There were no significant or suggestive differences in ratings on these items between females in male-dominated courses and those in female-dominated courses.

5.3.4 Field of Education differences in students' self-efficacy and intention to complete the course

Figure 24 illustrates the mean ratings by students in different STEM fields on the items concerning their self-efficacy and intention to complete the course. There were no meaningful differences.

⁷¹ $\chi^2(4) = 16.45$; $p < 0.002$; Cramer's $V = 0.123$, ASR = 3.0

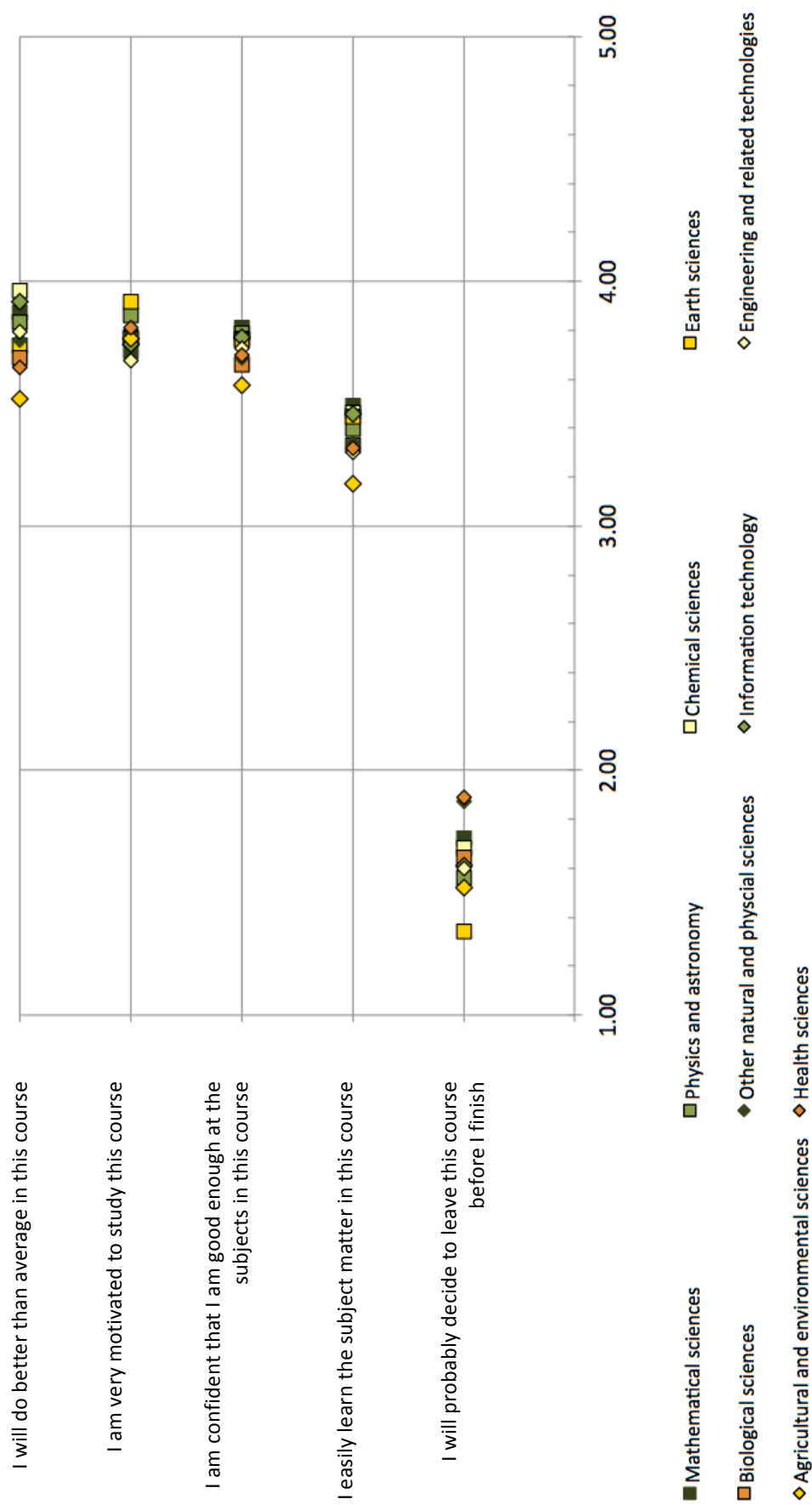


Figure 24: Mean ratings of respondents in different Fields of Education on items relating to the question: “Have the following aspects of your everyday life as a university student been as expected, better than expected or worse than expected?”

5.4 Q 9. What explanations are given by students who had considered withdrawing from a STEM course?

Students were invited to respond to the open-ended question: “If you have seriously considered withdrawing from your course, could you please say why?”. Responses to this question indicated that at least 468 respondents had seriously considered withdrawing from their courses but had persisted. This equates to about 13% of the entire cohort in the study. This number does not include students who had already withdrawn from their courses and who are therefore not represented in this survey. Coding of these responses resulted in 664 “explanatory units” that were categorised thematically. The resulting themes and subthemes are summarised in Figure 25, with categories containing fewer than 10 responses suppressed.

The most frequent reason for students considering withdrawing from their course (Figure 25) was to change to a different course. Some fluidity and exploration of different options is to be expected and welcomed in first year, as these developing adults refine their study/career objectives; for example:

I didn't know what I wanted to do when I chose my course in year 12. Over the course of this year I am more sure, and plan to move to a course I prefer. - Chemical Sciences

Several comments reflect the influence of perceived career prospects, for example:

I have considered swapping to a double degree that still includes science because my interest has diminished, I want to study a subject outside of science and I am unsure of my career prospects in science. - Physics and Astronomy

I am considering moving to occupational therapy- a field where there are many options for work and the course will be very practical and hands on. - Other Health

I may transfer to social science with environmental management. Science has been really hard and I'm not sure I want to get into research therefore a more general environmental degree maybe better suited. - Biological Sciences

Yes, because I was worried I wouldn't receive employment after I finish my degree/post grad. I was considering studying a different degree in the science field. - Environmental Studies

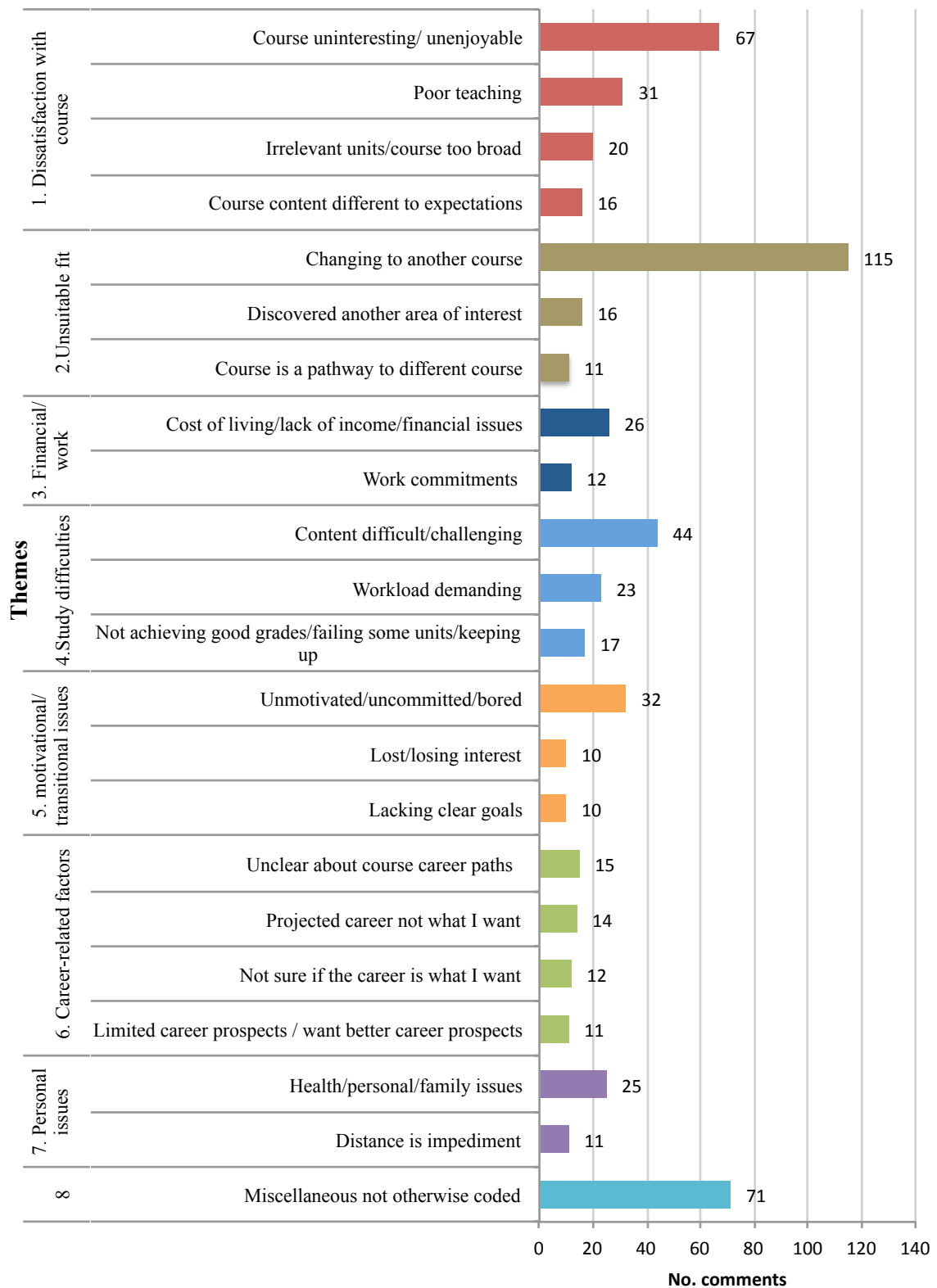


Figure 25: Frequency of comments in response to the question “If you have seriously considered withdrawing from your course, could you please say why?” (N= 664 explanatory units from 468 responses).

From a less positive perspective, some of these students were considering course changes because they found the course uninteresting or unenjoyable, or the content difficult.

I'm 100 percent sure mining engineering is not for me since I really really hate the course. I'll probably switch to another engineering course by the end of the semester. It's my fault for not having thought it through before choosing the course. – Process and Resources Engineering

5.5 Q.10 How do students enrolled in male-dominated STEM courses perceive this sex disparity?

To explore this question students were asked to respond to the item: “Do you see any reason why the situation described above [over representation by one sex] should be changed - and if so, what do you think could be done to change it?” Coding of open responses to this question from students enrolled in courses where more than two thirds (66%) of students were male yielded 2363 explanatory units. These related to two general themes; their views of the sex disparities - including whether change was desirable, and their suggestions about how change might be achieved. To facilitate comparisons between the unequal numbers of males and females in this subsample, results here are expressed in terms of percentages of males and females within the male-dominated subsample (N=1534).

5.5.1 Students' views of male-dominated STEM courses

Students' views about whether the sex disparities in these STEM courses should be changed are summarised in Figure 26. As indicated in the figure, the most frequent response (by a narrow margin) was that there is no need to change the sex disparity in these courses, and only a slightly higher proportion of males (28%) than females (23%) held this view. About the same proportion of females (22%) expressed the opposite position - that changing sex disparities is desirable - with slightly fewer males (20%) expressing this view. It is interesting to note that the proportion of women in these courses arguing that the sex disparities should change was almost identical to the proportion arguing that these disparities did *not* need to change. Further, the percentages of men and women expressing both of these opinions did not differ as greatly as might be expected. Representative samples of students' reasons for these opinions are presented and discussed below.

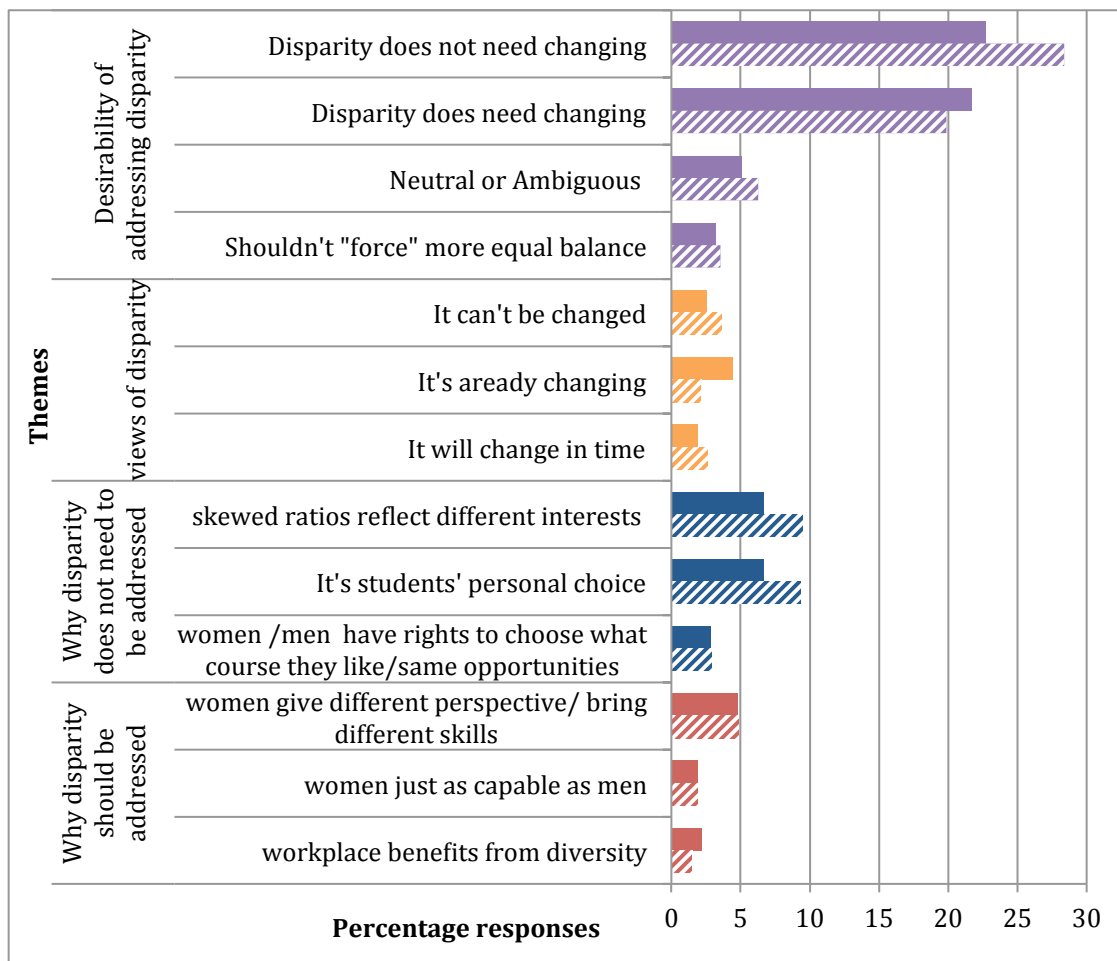


Figure 26: Sex breakdown of responses by students in male-dominated STEM courses relating to the first part of the open question “Do you see any reason why overrepresentation in this course by one sex should be changed?” Females indicated by solid colour, males by diagonal shading.

5.5.1.1 Arguments against changing sex disparities in male-dominated STEM courses

The most common justification for not needing to address sex disparities was that these reflected differences in interests, a claim made by 10% of males and 7% of females enrolled in these courses. This view is illustrated by the following comments:

Apart from making it hard to "meet people" at university I cannot think of any reason why it should be changed, surely the only reason the gap is so large [is] due to lack of interest of engineering in the female populace. I mean there are bound to be feminists saying everything should be equal, but as far as I can see everything is equal except for the numbers, any female that wishes to do engineering in my eyes has no reason not to (Male, Mechanical and Industrial Engineering and Technology).

Not really. Engineering is kind of a guy's field. Generally speaking girls aren't as interested in the topic (Male, Manufacturing Engineering and Technology)

Not really - as a female I don't really mind if other girls don't study the course. I think perhaps girls should be exposed to science and mathematics at a younger age, but if there's no natural interest there's no point trying to force it. I think women should be given a chance to study - which they are - and that's enough. (Female, Physics and Astronomy)

A closely related reason for not changing sex disparities, given by 9% of the males and 7% of the females, was that one's course of study should be a matter of personal choice. This is indicated by the following comments:

For engineering there is potentially a lack of interest that is causing this ratio. There is little to be done because choosing which course you undertake should be based on personal interests and preferences. (Male, Manufacturing Engineering and Technology)

I don't see why the situation should be changed, people get to choose what they want to study in life, and so all courses are open to all people, it just depend on who wants to apply and if there is a larger percentage of males then that's the way that it turns out. (Male, Electrical and Electronic Engineering and Technology)

Students should choose what they believe they are good at and could make a career out of - inequality in gender in this particular field I don't think is something to be concerned about (Female, Computer Science)

Also relating to the repeated themes of personal choice and interest was the point that ratios should not be “forced” to change; an opinion expressed by 4% of the males and 3% of the females. For example:

I don't believe females should be pushed into engineering just for the sake of having a diverse cohort. Aerospace Engineering requires a certain type and level of intellect, and only those possessing it should pursue it. People should pursue their passion regardless of social pressure to enter a certain industry (Female, Aerospace Engineering and Technology)

Gender is irrelevant. Why try and force the ratio to be more equal? This is condescending to everyone involved in the implicit assumption that there IS a difference between the sexes. Let people do science if they want to, and for no other reason. (Male, Physics and Astronomy)

Another point made by 3% of both females and males, often in relation to the previous considerations mentioned, was that no change is necessary as women already have the right to choose what courses they like and have the same opportunities as men:

Nobody is stopping girls from studying computers besides themselves. They can change that whenever they please. (Male, Information Systems)

I think the situation is fine as it is. Women have every right to choose whatever course they want - regardless of their gender - in the present day. Every individual has varying interests, and this is reflected in the course they choose to study. (Female, Process and Resources Engineering)

I don't think it's a problem because there is no reason a girl can't do engineering if she wants to. Everyone within the course gets treated the same. (Female, Manufacturing Engineering and Technology)

There is no reason why this should be changed - if women would like to do physics, there is ample opportunity (such as an abundance of scholarships for women in physics). The lack of women in physics is the result of a lack of interest, NOT a lack in opportunity...(Female, Physics and Astronomy)

Another aspect of the sex disparities alluded to was the likelihood of the *status quo* changing. Some students (3% of females and 4% of males) thought it was unlikely that sex disparities in these courses would ever change. For example:

Guys like maths more than girls. I don't think these numbers will ever change (Female, Civil Engineering)

Impossible to change (Female, Electrical and Electronic Engineering and Technology).

There is no reason for this situation to change. Engineering will most likely always be a male dominated field, but there is no reason to change this; there are no problems with this (Female, Civil Engineering)

I think it should change, but I also think there will always be more males in computing courses. (Male, Electrical and Electronic Engineering and Technology)

Trends of particular learning types across a gender, obviously, cannot be changed - nor should they. A gender disproportion within an area of interest is not 'necessarily' a bad thing. (Male, Physics and Astronomy)

The situation is mostly due to the differences in interests, and mental development. It is not really a problem that there is a gender over-represented in itself as that will always be the case in a way yet it is so extreme in engineering that females feel isolated and this discourages more from joining as they know they will be one of only a handful in their course. (Male, Mechanical and Industrial Engineering and Technology)

In direct contrast, a similar proportion of students (4% of females and 2% of males) were of the opinion that sex ratios are already changing, for example:

Yes I definitely believe that more females should become involved in engineering. In today's society every one [is] equal we all have the potential to strive in many different disciplines and I see no reason why a woman shouldn't be able to have a traditionally male profession. I know that women in engineering is being promoted and there is now a much higher female to male ratio than in the past but I think there is still a long way to go before we see an even male:female ratio. Perhaps even more promotion for women in engineering could be done by holding more events and having more female spokeswomen. (Female, Process and Resources Engineering)

It probably should be addressed, whether it's changeable is a different matter. I think it's already getting there. It just means encouraging children equally in all disciplines from a young age. (Female, Physics and astronomy)

Well it's always good to have mixed opinions in projects as I have discovered in my engineering group assignment this semester. It adds to the dynamics of the team. I personally think instead of pressurizing women to study engineering, it should be left to each individual. It is apparent female involvement is increasing at a steady rate and in time we will have a proper balance in the workforce. Forcing them into it runs the risk of disinterested future engineers coming out of universities. (Male, Process and Resources Engineering)

5.5.1.2 Arguments for changing sex disparities in male-dominated STEM courses

Of those students advocating more equal sex ratios, the most frequent argument put forward by similar proportions of males and females (c. 5%) was that females provide a different, complementary perspective to males and bring different skills, as indicated in the following examples:

Yes I believe that there should be more women in engineering, it is a known fact that women think differently when approaching problems than men, this is an invaluable tool in a work place. I think that increasing the number of women in the course has to come from making the industry and the course more appealing to women, showing them what engineers actually do and raising the profile of women in engineering. (Female, Civil Engineering)

Yes I think the situation should be changed. IT is missing out on a large base of different perspectives by being so male-dominated, and it makes a lot of existing women in the IT field feel like the odd ones out. (Female, computer science)

The more diverse the range of perspectives to a problem you have, often the more things you learn. This has been made apparent in the number of group work activities done. Increasing the number of female engineers will add to the diversity of problem interpretations (Male, Civil Engineering).

I think it is important that females do make up a significant portion of the cohort as they think differently to males and often can offer a different perspective on a problem (Male, Mechanical and Industrial Engineering and Technology).

The next most frequent point in favour of reducing sex disparities in these courses, cited by 2% of females and males, was that women are just as capable as men, as indicated by the following:

I believe that more women should be encouraged to do engineering as they are just as capable as men. (Male, Process and Resources Engineering)

Yes, females are just as good as males at maths and physics, so I can't see why the stereotype of civil engineers can't be changed to suit both genders. (Male, Civil Engineering)

There should be more girls who do engineering. Woman can be just as good at maths and spatial understanding as men. It is just society has different expectations of woman and men. There should be more support in all girls schools for them to do harder maths and science. The focus in schools shouldn't be about getting overall good grades in easy subjects, the focus should be encouraging them to study the harder subjects. (Female, Information Systems)

Females can do anything they want. It is not up to society to say where males and females should work. More females are needed in engineering firms and it needs to [be] shown to the wider community that women can do this job and they can do it well. (Female, Mechanical and Industrial Engineering and Technology)

Finally the third main argument raised by those in favour of reducing sex disparities (2% of women and 1% of men) is that the workplace would benefit from a more diverse workforce; a point clearly related to the previous “women bring different perspectives” argument. Some indicative comments include:

I think having a various different types of people working in the industry will have a huge benefit in the society, since there'll be a variety of ideas, thoughts and opinions coming from people of different backgrounds and gender (Female, Civil Engineering)

I think for employers it would be better for them to have a more equal mix of males and females, however personally I think it was better for me to be of a minority because it helped me to get a scholarship. (Female, Mechanical and Industrial Engineering and Technology).

A gender-biased workforce is not productive in the long run. Continuous effort like what is being done now such as school outreach programs should continue (Female, Mechanical and Industrial Engineering and Technology)

Yes. diversity is important in the workplace, and women think differently to men, so more creative solutions can be attained for group work. High schools and industry groups really need to focus on this problem. It hasn't changed in forever. (Male, Electrical and Electronic Engineering and Technology)

5.5.2 Students' suggestions on strategies to change sex disparities in male-dominated STEM courses

Figure 27 summarises students' suggestions about how to effect change to the sex disparities experienced in male-dominated STEM courses. As shown in the figure students' responses spanned a wide range of suggestions.

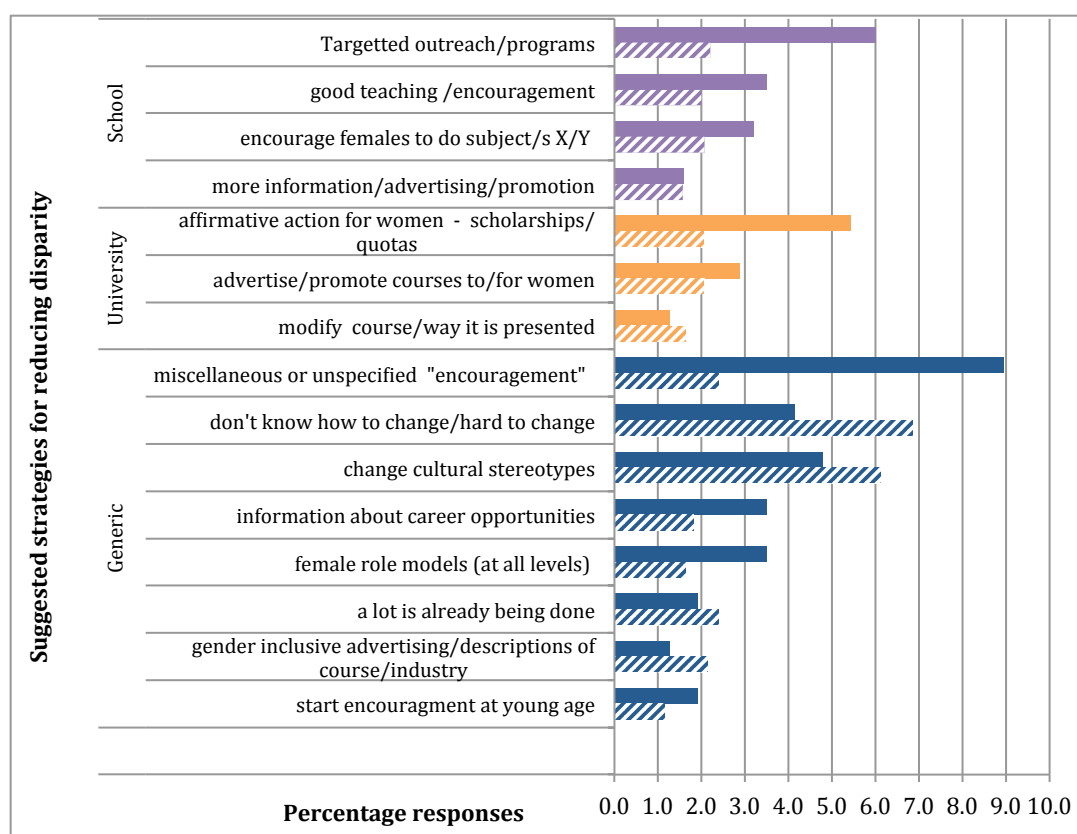


Figure 27: Sex breakdown of responses by students in male-dominated STEM courses relating to the second part of the open question "What do you think could be done to change it [sex disparities in these courses]? Females indicated by solid colour, males by diagonal shading.

Unlike Figure 26 however, there was a consistent marked difference in Figure 27 between male and female students' responses. Females were more inclined to outline

specific strategies than were males, who most frequently responded along the lines of not knowing how to change the situation or commenting that it was very hard to change. As some suggestions focused on strategies at the school level, some at the university level and others more generically, they are reported below under these headings.

5.5.2.1 School-focused initiatives

The most frequent suggestion regarding school-focused initiatives (made by 6% of females and 2.2% of males) was for some kind of targeted outreach programs at school, as indicated by the following comments:

Stereotypes of what women and men should do are gradually changing, but I work in a male dominated industry (Mining) - and it there is still a long way to go to even out numbers, opportunities, pay and conditions. Role models and mentors and getting women from industry into high schools telling girls they can do anything is so important. I once did a talk to a bunch of 13 yo private school girls from Perth on Women in Mining. They had no idea about the opportunities and one girl asked whether she would have to cut off her long hair to work in the mines!! (I have short hair). We have a long way to go. (Female, Biological Sciences and mining background)

Yes. Probably having more groups like Robogals around to show to high school girls that Computer Science is actually a fun a viable future career. (Male, Computer Science)

My solution would be to get both male and female engineers to go in and give talks at school assemblies from early high school. I think that would make a huge difference as I found that receiving talks in Year 11 was hard going as I already had to know what I was aiming for. I had already chosen subjects that would limit my choices for Year 12. (Male, Electrical and Electronic Engineering and Technology)

As well as specific targeted outreach suggestions, a number of respondents (3.5% of females and 2% of males) also highlighted the potential impact of good teaching and encouragement at high school, as indicated by the following comments:

Many girls I know might actually find IT interesting, but its not something that you're exposed to in school so it's easily dismissed by girls – it's not something they'd just pick up in year 11 year 12 without any prior knowledge [it] isn't really seen as a womanish field. Introduce a proper Year 9 year 10 computing subject not those shitty ones now where you learn to use Microsoft word - do that in year 7-8. Introduce people to programming and 'computery' stuff like graphics design and animation and who knows the ratio of men to women might even out. (Male, Computer Science)

I think there is far too little encouragement for girls to get into math and science. I think it is expected of boys and thought of as only an exception for girls. If a girl struggles with math or science, people are much more willing to accept failure. A boy on the other hand is given a much more demanding response. Many of the brightest girls in my year in high school went into arts. Its just not presented to women as a priority. And the sad thing is that female dominated career paths are so poorly paid, e.g. nursing, childcare etc. (Female, Manufacturing Engineering and Technology)

Many respondents (3.2% of females and 2.1% of males) called for specific encouragement for females to do particular subjects at school, usually physical science and/or mathematics, for example:

Yes - more programs in schools to encourage females to study engineering based courses. Encourage females to study extension maths (Female, Civil Engineering).

I think to promote more girls into doing engineering, may need to start during high school years, getting more girls to do physics and maths. (Male, Process and Resources Engineering).

Several students (1.6% each of females and males) referred to the potential advantages of providing more information and advertising of university courses and careers at high school, as indicated by the following comments:

I think that a lot of females are just as talented in maths and physics, and thus engineering, but it isn't really pointed out that this is an option for them. Maybe career advisors at high schools could make engineering seem like an exciting possibility to these students. (Female, Process and Resources Engineering)

There's no particular reason why it should be changed, if people aren't interested in a course they shouldn't be persuaded to do it. However, if the over representation of males is a reason why less females choose this course, due to intimidation or stereotypes, then maybe more information sessions at schools should be given to raise awareness and provide more information to students (Male, Mechanical and Industrial Engineering and Technology).

5.5.2.2 University-focused initiatives

At the university level, the largest category of responses from females (5.4%) related to more affirmative action, including access to targeted scholarships. However, this was a much less popular proposition from males (2.1%). This option is illustrated by the following comments:

As a female, I do not feel that studying in a male-dominated degree is having any negative effects on my learning. However, I have a male friend who would love to see more females in the course!! To increase the number of females in engineering, more advertising about female engineers could be done, and more scholarships and opportunities be made available more females both at university and in later careers. (Female, Electrical and Electronic Engineering and Technology)

There are far more males than females throughout all engineering courses. More female based scholarships and other forms of encouraging females to study engineering would be very beneficial. (Male, Mechanical and Industrial Engineering and Technology).

The next most popular category of suggestions (mentioned by 2.9% of females and 2.1% of males) related to universities was about advertising and promoting university courses to women, as indicated by the following comments:

yes, women make good engineers too. Provide women a insight to the course so they know it could be a subject for them too (Male, Process and Resources Engineering).

Yes specifically target advertising of these units to females, possibly have more females teachers (Male, Computer Science)

Also at the university level, some respondents (1.3% of females and 1.7% of males) suggested modifying the courses and/or the way they were presented. This is indicated by the following comments:

I think it could be more supportive of female learners in that it could offer more discussion based learning, rather than isolated assignments. I learn a lot from talking about things and although there are some guys like this, many just go off and do things by themselves. (Female, Physics and Astronomy).

No. I think the issue is not gender but personality or interest oriented. There seem to be certain common preconceptions about certain fields, I think the boundaries between fields as taught is often obsolete, or different to how it is in reality. These boundaries may limit people's interests. Perhaps some redefining is in order. (Male, Physics and Astronomy).

5.5.2.3 Generic initiatives

The largest category of suggestions to address sex disparities in male-dominated courses referred to miscellaneous or unspecified "encouragement" of women to

undertake studies or careers in male dominated areas. However, the proportion of women expressing this view (8.9%) was nearly four times the proportion of males (2.4%). This category of responses is illustrated by the following responses:

Under-representation is statistical in nature, it is neither right nor wrong. It depends on one's abilities and desires, but when females are interested in engineering, they should get more encouragements and supports to gain more confidence to pursue what they want. (Female, Electrical and Electronic Engineering and Technology)

Yes, More girls should be encouraged to join. I have no idea how. (Male, Process and Resources Engineering)

The next most frequent category of responses to this question was students simply stating that they didn't know how to change it, or that it would be very hard to change. Nearly 7% of males were represented in this category, considerably more than the proportion of women making this point (4.2%). These views are illustrated by the following comments:

It would be nice to see more females, I think society illustrates IT professionals as being primarily a male role, but you can't really change societies perspectives (Female, Computer Science)

It'd be nice to see it change, I don't know if there's anything you can really do though apart from being welcoming to those who wish to try. (Male, Computer Science)

Another suggestion (by about 5% of females and 6% of males) focused on the need for a change in cultural stereotypes, as illustrated by the following responses:

Engineering is for everyone with the motivation to do it, and to get more girls involved by showing them what they can achieve. Mostly showing them at a young age to not rely on men, and show them that it's not bad to get dirty or to use your brain (Female, Electrical and Electronic Engineering and Technology)

Women and men should have equal access careers. Affirmative action like giving scholarships to women in these courses is a good way to attract them more to the course. Advertising aimed at women would also be good. Other than that, society's stereotypes and discriminations need to be challenged in an every-day way by every-day people. (Female, Information Systems)

The next most frequent category of generic responses (3.5% of females and 1.8% of males) highlighted the importance of information about career opportunities, without specifying where this should happen (e.g. at school or university), as illustrated by the following comments:

It should be encouraged for more females to enter the field as they offer differing perspectives and naturally can have different work ethics. I think to promote this awareness needs to be raised about the type of roles that become available when you become an engineer and also that there is scope for women and should not be a male dominated field. (Female, Mechanical and Industrial Engineering and Technology)

I do not think it NEEDS to be changed, I expect it will. There is still a stereotype situation from the past generation in engineering. To change it, clearer outlines of what an engineer can do and does. (Male, Mechanical and Industrial Engineering and Technology)

Another set of suggestions by the students (3.5% of females and 1.7% of males) highlights the perceived importance of female role models at any or all the levels of school, university or career. This category is illustrated by the following comments:

I think more women should be encouraged to study engineering/science degrees, and the view that these are male dominated areas needs to be changed. I think it is changing but to help it change, more successful women in these career areas should be engaging with school aged children to show them that women can, and are successful in these areas, and they are not just male dominated anymore. (Female, Mechanical and Industrial Engineering and Technology).

It should change; why deprive the area of talented and individual minds that are scared away by the "face" of the industry? Whilst there is an unbalanced ratio, it is not as bad as I previously perceived it. Maybe if there was more publicity about successful females in the industry - that would provide the area a better "face": yes, there are females and no, they are not discriminated. (Female, Electrical and Electronic Engineering and Technology)

Greater engagement at a high school level, starting with more female maths and science teachers. In my school, we had no female physics teachers and, out of the 10 maths teachers, just one female maths teacher. Positive role models can be a key way to begin to engage young people and spark an interest (Male, Physics and Astronomy)

About 2% of both females and males acknowledged that a lot is already being done to reduce sex disparities in these courses.

The importance of gender inclusive advertising or descriptions of traditionally male courses or industries was highlighted by about 1% of females and 2% of males, as illustrated by the following comments:

Yes. Half the world [is] female, and it would impact the level of diversity that the field IT needs if this approx. 50% is partially ignored. As I've mentioned above, information about the course should be targeted towards EVERYONE. And the people supplying the information should be conscious of their specific pronouns when giving examples, i.e. 'he/she' should replace 'he' or, amusingly 'she', in examples; if there is more than one person in the example and names are essential to keep the example from being confusing, use a male AND a female. Do not use two males or two females. Keep the diversity up. (Female, Information Systems)

If you want more gals to study Engineering, then try and market to that particular audience, don't ask me how to do that, perhaps you should get a bunch of girls ...and talk to them about their view of Engineering and ask them to suggest ways in which it could be made more appealing (to them). (Male, Mechanical and Industrial Engineering and Technology).

The final category of responses offered by about 2% of females and 1% of males in these courses relates to the importance of starting some encouragement or awareness raising at a young age, as illustrated by the following responses:

Change girls' interests from young, i.e. encourage them to study Maths and Science in Primary School and High school. (Male, Civil Engineering)

Make girls passionate about science from a young age. We need more female science presenters on TV and in the popular media going around showing girls how chemicals can make perfumes etc. instead of men blowing things up! Also, females are better represented in the biological and plant sciences and less so in maths and physics. Perhaps some physics scholarships or outreach programs for women only? Basically, the girls just need more effort putting in to convince them from a young age that science is the coolest and most fun area they could work in when they grow up. If they are determined to have a science career, they will work hard for it! (Female, Physics and Astronomy)

5.6 Q 11. What are STEM students' priorities for the future?

Students were asked to rate the importance of a range of items concerning their priorities for the future. Figure 28 shows the percentage breakdown of respondents' ratings of the importance of each priority item. The figure shows that an overwhelming 97% of respondents considered it important (16%) or very important (81%) to be doing something they are interested in. Other personal priorities such as

using talents and abilities and personal development were considered important by around 96% and 92% respectively.

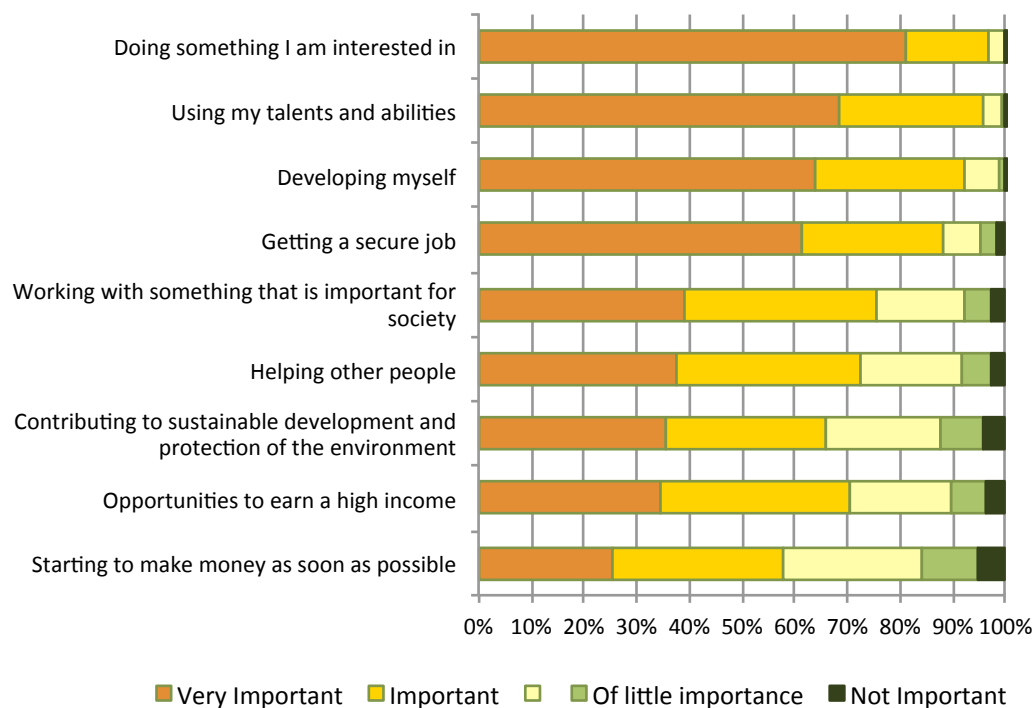


Figure 28: Percentage breakdown of respondents' ratings of items relating to the question: "Regarding your priorities for the future; how important are the following factors to you?"

The three items concerning societal benefits: working on something important to society; helping other people; and contributing to sustainable development, were middle ranked priorities, considered important by between two thirds and three quarters of respondents, but very important by around 35-40%. Financial considerations such as earning a high income and making money as soon as possible were regarded as less important, with the latter being rated as unimportant or of little importance by 16% of respondents. On the other hand, getting a secure job was considered important by 88% of respondents.

5.6.1 Sex differences in priorities for the future

Figure 29 presents the mean importance ratings of these items by male and female respondents.



Figure 29: Mean ratings of male and females on items relating to the question: “Regarding your priorities for the future; how important are the following factors to you?”

The figure suggests that while males and females tended to rate the three personal priority items in a similar manner, their opinions differed regarding the importance of the societal benefits. Chi-squared tests identified significant associations between these three items and sex of respondent. First, significantly more females than expected rated “helping other people “as very important⁷², with significantly fewer than expected rating it as of little importance (ASR=3.3). Significantly more females than expected rated “working with something important for society” as very important⁷³, with significantly fewer than expected rating it as not important (ASR=3.4). Finally, significantly more females than expected rated “contributing to sustainable development and protection of the environment” as very important⁷⁴, with significantly fewer than expected rating it as not important (ASR=5.5). Each of the significant sex differences had a small Effect Size.

5.6.2 Future priorities of females in male-dominated STEM fields

Contingency table comparisons between males and females in male-dominated courses produced similar rating patterns to those reported above, with more females

⁷² $\chi^2(4) = 82.27$; $p < 0.001$; Cramer’s $V = 0.157$, ASR = 8.3

⁷³ $\chi^2(4) = 78.52$; $p < 0.001$; Cramer’s $V = 0.153$, ASR = 6.4

⁷⁴ $\chi^2(4) = 92.16$; $p < 0.001$; Cramer’s $V = 0.166$, ASR = 7.8

than expected rating ‘helping other people’, ‘working with something important for society’ and ‘contributing to sustainable development/protecting the environment’ as very important. However, among Physics/Astronomy and IT students these associations were strongly suggestive rather than significant ($p < .003$). Among Engineering students however, the association between sex and this third item (sustainable development/environment) was significant. The association was due to significantly more engineering females than expected rating this item as very important, and more engineering males rating it as not important⁷⁵. The Effect Size of this difference was small.

Comparisons between females in male- and female-dominated STEM courses revealed significant associations between type of STEM course and two of these items: helping other people⁷⁶ and working with something important for society⁷⁷. For both items the associations were due to more females than expected in female-dominated courses rating the item as very important. The Effect Sizes were small.

5.6.3 Field of Education differences in priorities for the future

Figure 30 illustrates the mean ratings by students in different fields of education on nine items concerning their priorities for the future. Chi-squared tests of responses to these items found no significant associations between field of education and the three personal priority items. However, significant associations were found with the three items relating to societal considerations, and are likely to relate to the sex differences identified in section 5.6.1.

First, fewer IT students than expected rated “working with something important for society” as very important⁷⁸. In contrast, significantly more Health students than expected rated this as very important⁷⁹. There was a small Effect Size.

⁷⁵ $\chi^2(4) = 25.18$; $p < 0.001$; Cramer’s $V = 0.146$, ASR = 4.0

⁷⁶ $\chi^2(4) = 24.65$; $p < 0.001$; Cramer’s $V = 0.143$, ASR = 4.4

⁷⁷ $\chi^2(4) = 24.81$; $p < 0.001$; Cramer’s $V = 0.143$, ASR = 4.0

⁷⁸ $\chi^2(36) = 188.18$; $p < 0.001$; Cramer’s $V = 0.118$, ASR = 4.9

⁷⁹ $\chi^2(36) = 188.18$; $p < 0.001$; Cramer’s $V = 0.118$, ASR = 4.8

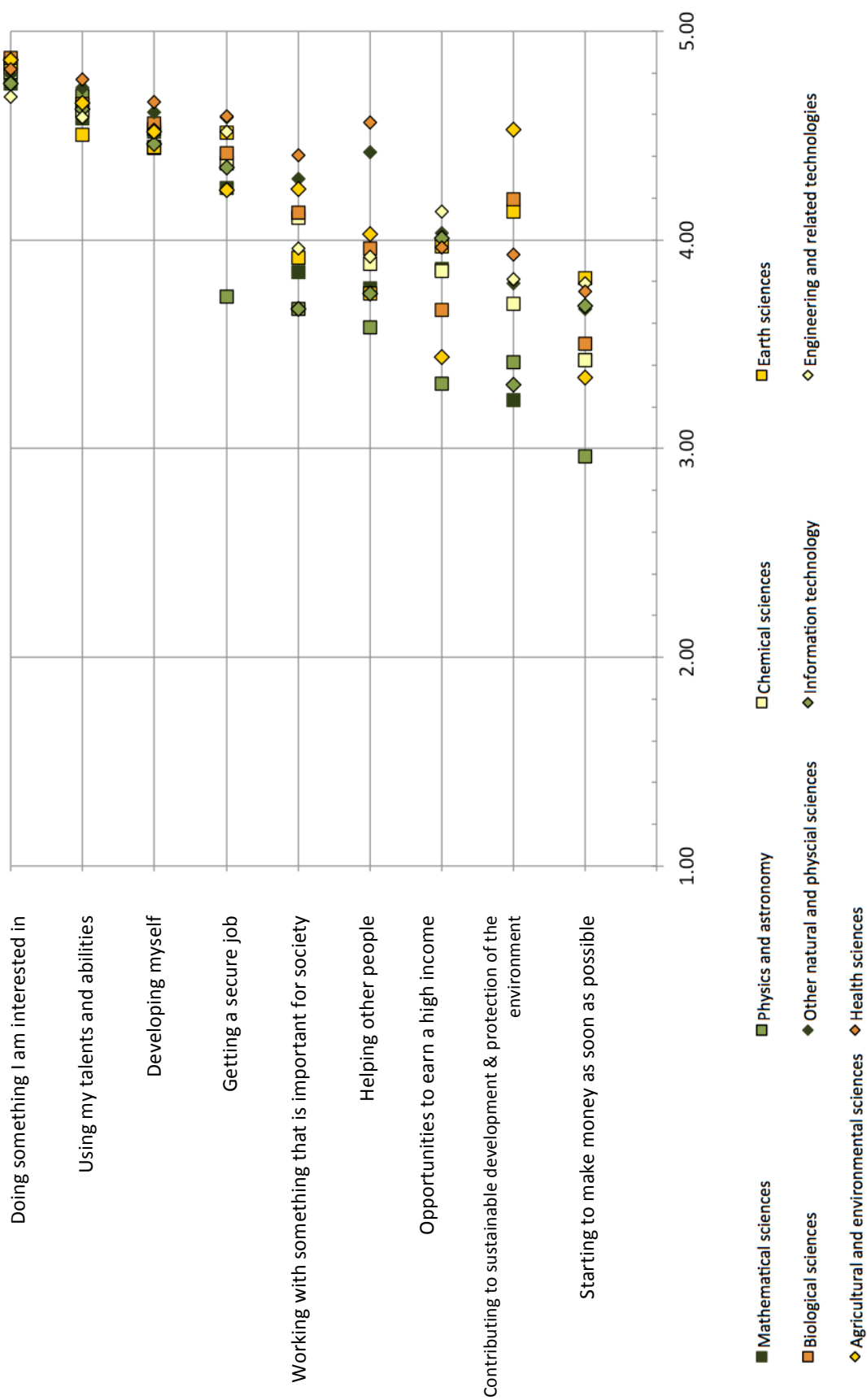


Figure 30: Mean ratings of respondents in different Fields of Education on items relating to the question: “Regarding your priorities for the future; how important are the following factors to you?”

Second, fewer than expected IT students than expected rated ‘helping other people’ as very important⁸⁰. In contrast, more Health⁸¹ students and Other Natural or Physical science students⁸² rated this item as very important. These results were significant, with Effect Size just below the medium range.

The strongest associations with Field of Education were found in ratings of the importance of contributing to sustainable development and protection of the environment. As might be expected, significantly more Agriculture/Environmental studies students⁸³ and Biological sciences⁸⁴ rated this item as very important than would be expected if the variables were not associated. However, significantly more Mathematics students⁸⁵ and IT students⁸⁶ than expected rated this item as not important. The Effect Size was medium.

Chi-squared contingency table tests also found significant associations between field of education and ratings on items financial considerations and job security. First, significantly more Physics/astronomy students rated ‘getting a secure job’ as not important⁸⁷ than might be expected if there was no association, and significantly fewer rated it as very important (ASR 6.5). The Effect Size was small.

Second, significantly more Engineering students than expected rated ‘opportunities to earn a high income’ as very important⁸⁸ and significantly fewer than expected rated it as not important (ASR 4.9). In contrast, significantly fewer Physics/astronomy students⁸⁹, Biological science students⁹⁰ and Agriculture/Environmental science students⁹¹ rated this priority as very important. The Effect Size was small.

⁸⁰ $\chi^2(36) = 264.54$; $p < 0.001$; Cramer’s $V = 0.140$, ASR = 3.6

⁸¹ $\chi^2(36) = 264.54$; $p < 0.001$; Cramer’s $V = 0.140$, ASR = 8.2

⁸² $\chi^2(36) = 264.54$; $p < 0.001$; Cramer’s $V = 0.140$, ASR = 9.1

⁸³ $\chi^2(36) = 355.87$; $p < 0.001$; Cramer’s $V = 0.162$, ASR = 9.4

⁸⁴ $\chi^2(36) = 355.87$; $p < 0.001$; Cramer’s $V = 0.162$, ASR = 8.7

⁸⁵ $\chi^2(36) = 355.87$; $p < 0.001$; Cramer’s $V = 0.162$, ASR = 6.4

⁸⁶ $\chi^2(36) = 355.87$; $p < 0.001$; Cramer’s $V = 0.162$, ASR = 5.4

⁸⁷ $\chi^2(36) = 84.86$; $p < 0.001$; Cramer’s $V = 0.117$, ASR = 5.2

⁸⁸ $\chi^2(36) = 209.18$; $p < 0.001$; Cramer’s $V = 0.125$, ASR = 5.1

⁸⁹ $\chi^2(36) = 209.18$; $p < 0.001$; Cramer’s $V = 0.125$, ASR = 4.1

⁹⁰ $\chi^2(36) = 209.18$; $p < 0.001$; Cramer’s $V = 0.125$, ASR = 5.5

⁹¹ $\chi^2(36) = 209.18$; $p < 0.001$; Cramer’s $V = 0.125$, ASR = 4.4

Finally, there as a significant association between Field of Education and earning money quickly, with significantly more Engineering students than expected rating “starting to make money as soon as possible” as very important⁹², and significantly fewer than expected rating it as not important (ASR=4.8). In contrast, significantly fewer than expected Physics/astronomy students rated this priority as very important⁹³, and significantly more than expected rated it as not important (ASR=6.1).

5.7 Q 12. What recommendations would students make to those considering enrolling in STEM courses?

Students were invited to respond to the following question via an open-ended response: “If someone you know was thinking about enrolling in your course and asked you about it, what would you say to her or him?”

Coding of the 3013 responses to this question yielded 7804 individual explanatory units. These focused on a range of quite diverse themes, from study advice, recommendations on whether or not to take the course, how it might relate to career considerations, and some of the course positives and negatives.

5.7.1 Advice about the course

Responses relating to the range of different advice given about the course are shown in Figure 31. Only categories containing 50 responses or more are reported here to aid interpretation of the main findings of the data.

As shown in Figure 31, by far the most commonly offered piece of advice to intending students was to make sure they were interested in the general area. Over 900 students made this point. In the words of one student:

If they are passionate about this subject then it is worth doing. There is no point studying something that you are not interested in. - Biological Sciences

The next most frequent piece of advice was to put in the effort and work hard:

Do it! But don't expect it to be easy. You will need to put in substantial effort to complete it. You get out what you put in! - Biological Sciences

⁹² $\chi^2(36) = 155.02$; $p < 0.001$; Cramer's $V = 0.107$, ASR = 3.3

⁹³ $\chi^2(36) = 155.02$; $p < 0.001$; Cramer's $V = 0.107$, ASR = 6.1

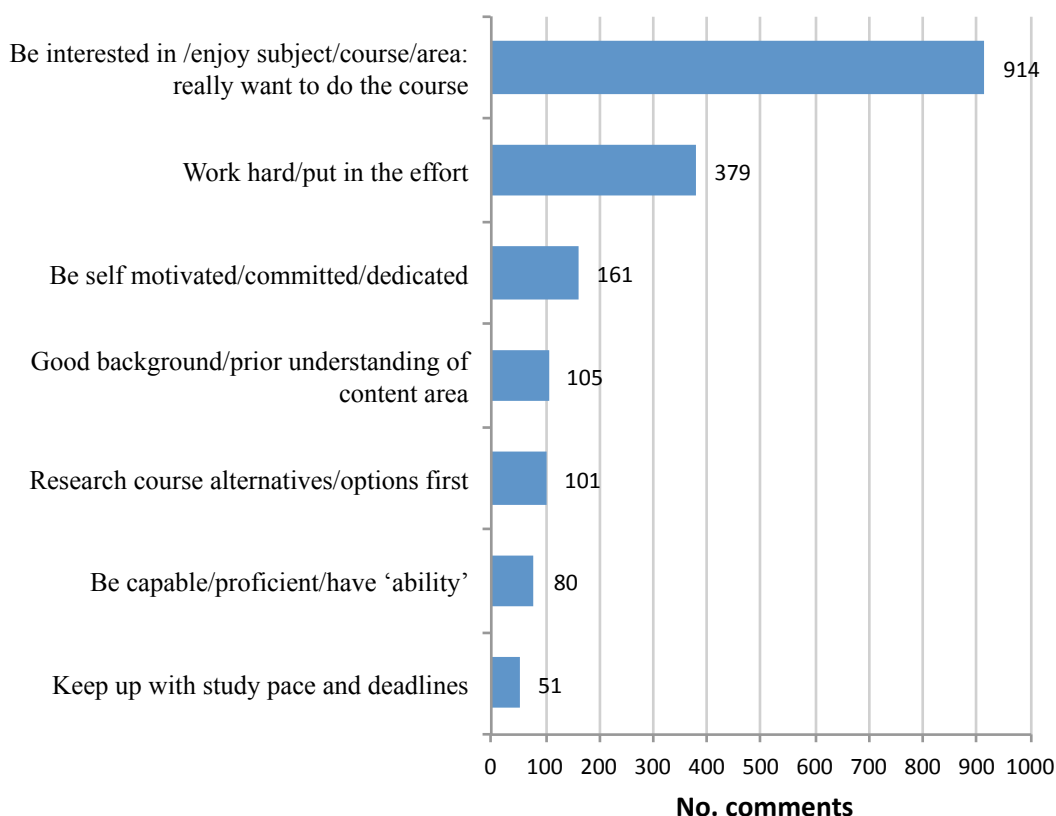


Figure 31: Frequency of student “Advice about the course”, in response to the question “If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him? (N= 7804 explanatory units from 3013 responses).

A more colourful response describes the potential consequences of disinterest or not working hard as follows:

Do you really want to study Science? Or are you just doing it because: a) your parents want you to be someone? b) You don't know what else to do? c) You feel like wasting \$2000.00 a semester because you're a [noun deleted] who comes to 5% of your classes only to play Farmville? And then you get depressed because you failed, so instead of studying harder you start clubbing more and coming to school half drunk? Doesn't that seem like faulty logic? Have fun washing my dishes... - Process and Resources Engineering

A related issue raised by many students was the need to be dedicated and committed to manage the study challenges of the course:

Only study this course if you have total commitment. - Physics and Astronomy

I would tell them to only enrol if they are motivated and have understood what the course entails. It is definitely very challenging (in regards to the work load, concepts in lectures, labs..) - Chemical Sciences

The need for prior knowledge was also highlighted by over a hundred students in comments such as the following:

Make sure you do Chem and Bio in High school, because they just expect you to know stuff you didn't need to get in the course with, even though you have no clue what's going on. – Other Natural and Physical Sciences

'introductory' chemistry and physics courses are a myth, there is no such thing as 'no prerequisites' no matter what the guide says. You cannot do really well without some background. The pace is far too fast to absorb all you need to know. It is really disappointing and can leave you feeling really lost and hopeless, as though you don't belong. - Biological Sciences

About a hundred students also recommended the value of researching options carefully beforehand, as in the following comment:

Go and have a look at your second and third study options, you may like them more than your first when you go and see what is happening with those jobs in the world now. Also try to talk to current students and recently graduated students about your study plans. - Mechanical and Industrial Engineering and Technology

5.7.2 Relationship of course to career prospects.

The different categories of response relating to career prospects are shown in Figure 32. Only categories containing 20 responses or more are reported here to aid interpretation of the main findings of the data.

As indicated in Figure 32, 189 students considered that their course would give them good career prospects, for example:

The job opportunities are good although slightly lower paying but the potential jobs are so broad, lab, field, production, food safety, crop physiology, horticultural, soil, management and so on, that if you dislike one component of the industry there are many others that are so different. - Agriculture

This was by far the most well represented category with more than double the number of responses as the next most frequent, which relates to the need for a career goal or reason for doing the course, for example:

I will ask why he or she wants to enrol and if it is the best course for this purpose. – Process and Resources Engineering

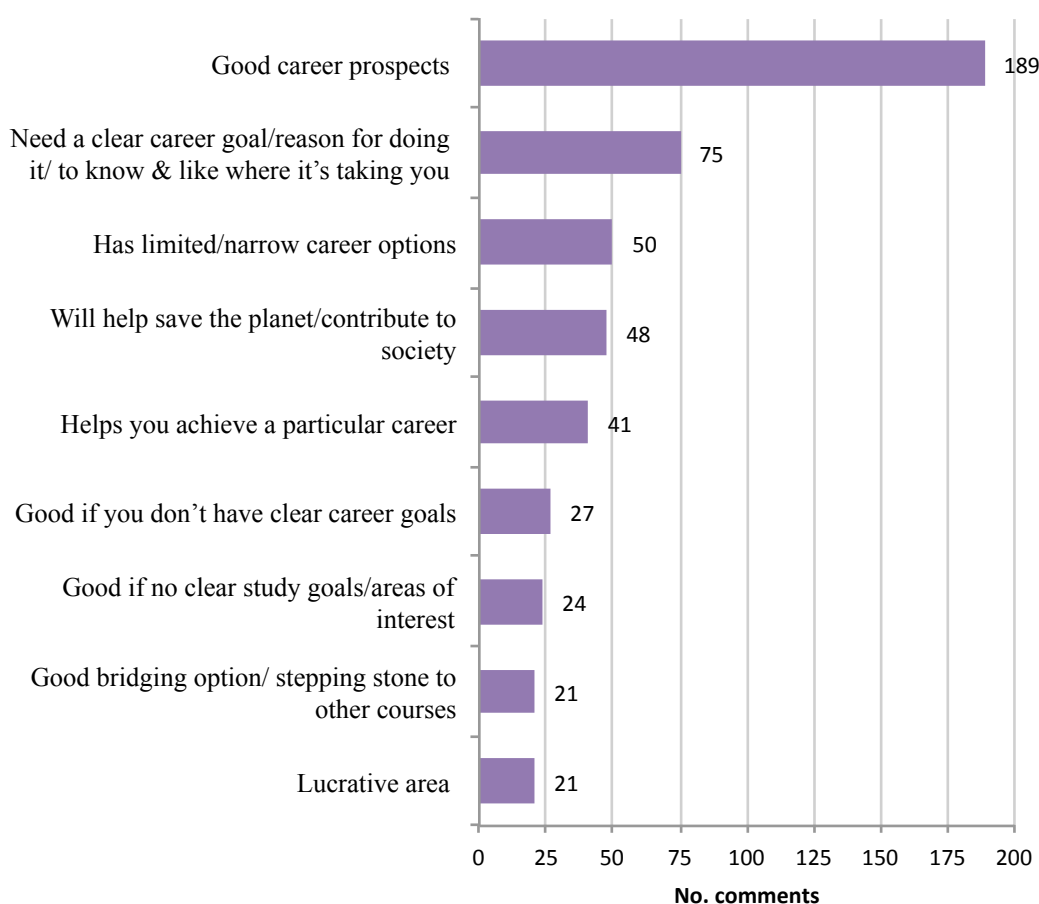


Figure 32: Frequency of student comments relating to careers, in response to the question “If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him? (N= 7804 explanatory units from 3013 responses).

There were 50 students who stated that their course had limited career prospects

Go for other specific courses that may give you a better chance at finding the right job. - Other Natural and Physical Sciences

I would say don't bother, it is very hard and doesn't improve your job prospects. There really isn't any job prospects unless you are a genius. – Civil Engineering

Slightly fewer students highlighted the potential of the course to contribute to society, for example:

In my case, aquaculture and the sustainable use of our resources, is what has really caught my interest. The course is a real eye opener as to how many changes need to be made to ensure a bright and biodiverse future. The more you learn, the more you feel obligated to teach others about sustainable development. - Agriculture, Environmental and related studies (unspecified)

5.7.3 Positive and negative aspects of the course

Many students responded to the question by describing aspects of the course, both positive and negative. These comments are summarised in Figure 33, with categories comprising fewer than 50 responses suppressed. The figure indicates that positive comments considerably outweigh the negatives in both range and total frequencies, although this result has to be interpreted keeping in mind that the survey cohort is the first year survivors: the voices of those that may have fallen by the wayside prior to the survey are not represented in this report.

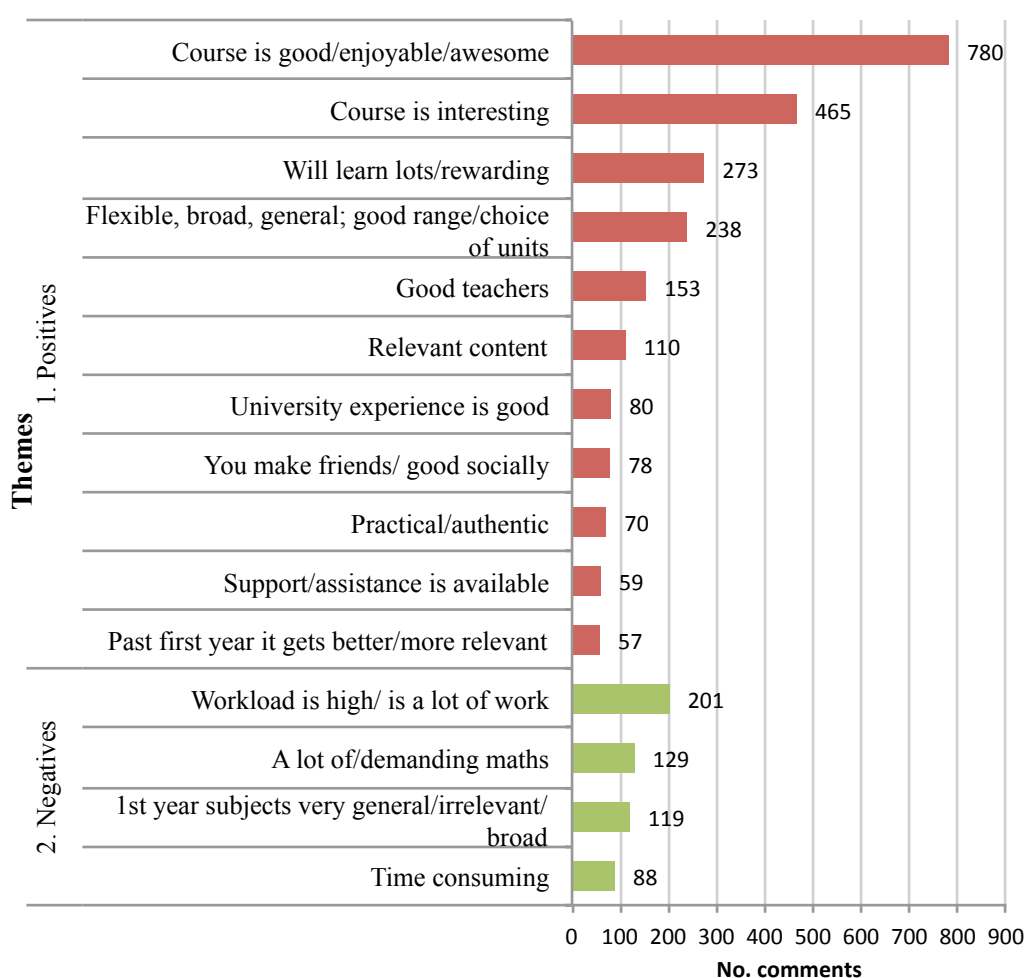


Figure 33: Frequency of student comments relating to positive and negative aspects of the course, in response to the question “If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him? (N= 7804 explanatory units from 3013 responses).

Bearing this caveat in mind, about a quarter of the respondents described their course in positive terms as good and enjoyable, with about the same number of responses stating that it was interesting or rewarding. Some representative comments include:

It's totes interesting and makes for good conversation topics and overall knowledge. - Environmental Studies

Science is an awesome subject to study, simply because it makes you more aware of the world around you and how it works, and science is constantly changing, so technically every new day there's something to learn. Cheesy, but truthful. - Earth Sciences

It is particularly encouraging that comments such as these were so much more frequent than comments relating to the course being boring or unenjoyable; fewer than 50 responses described the course in general terms as boring, uninteresting or irrelevant. Over two hundred students liked the fact that their particular course was flexible and broad, giving them options to explore their interests and specialise throughout the program. For example:

This is a very broad and open course which provides opportunities to experiment in each field of science and is good if you are unsure of what you want to do. - Other Natural and Physical Sciences

There were 153 responses mentioning good teachers, for example:

It is a great course and you get to do heaps of practical work with awesome lecturers who have tonnes of experience. - Agriculture, Environmental and related studies (unspecified)

Although comments relating to good teachers comprised a relatively small proportion of the total responses, there were five times as many references to good than bad teachers. Several other categories relating to perceived positives about the course are shown in Figure 33.

Of the more negative comments about the courses, the most frequent related to high workloads. For example:

... they should not take the decision lightly as the workload is enormous and doesn't allow for much of a social life out of uni during semester. – Biological Sciences

Be prepared for a lot of work. There are constant assignments from all subjects. You will lose a HUGE chunk of personal life due to the workload, but it is rewarding. - Physics and Astronomy

*its not worth it. you have to give up everything for what? a Bachelor of Science. You might as well just suck it up for an extra year and become a surgeon - its the same workload. I panic if i have to go to the toilet that i will fall behind even further. *sigh* - Physics and Astronomy*

Some students compared the workload of science courses unfavourably to the perceived less demanding workload of other courses, for example:

It is a great course, but the amount of work is WAYYY greater than most other courses (From all my friends). - Electrical and Electronic Engineering and Technology

Another issue of concern for over a hundred students was the problem of perceived irrelevance of the broad first year introductory course structure that is common to many science degrees. For example:

The first year is generally pretty boring as it is very non-specific, you spend a lot of time on information that is not relevant to your major. In saying that a lot of information that may be relevant does not appear to be because of the way it must be taught to a variety of students in different degrees/majors. - Biological Sciences

...first year subjects are quite boring as they are the basic fundamentals that you have to know but are completely boring and unmotivating to study, but once you get through first year the subjects get more interesting and engaging. - Other Natural and Physical Sciences

Another recurring theme was the quantity of mathematics in some courses, for example:

I would ask them if they really, really, REALLY like maths, because there sure-as-hell is a lot of it in this degree. If they do, then I would not hesitate to recommend the course. – Computer Science

5.7.4 Perceived difficulty

The perceived difficulty of the course was an aspect touched on by many students, and this aspect of the responses is summarised in Figure 34.

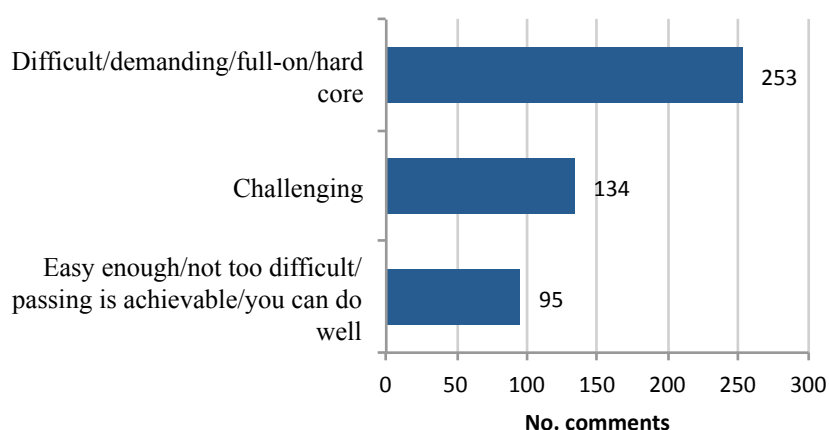


Figure 34: Frequency of student comments relating to difficulty of the course, in response to the question “If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him? (N= 7804 explanatory units from 3013 responses).

As indicated by Figure 34, 253 students stated that their course was difficult, with a further 134 referring to it as challenging. The strength of the feeling varies among these comments: with some students going as far as suggesting that potential students avoid enrolling because of the difficulties involved:

Don't do it. Its way too difficult. - Mathematical Sciences

*Don't take it, it's a difficult one. And it's kinda hard to find a job outside.
- Process and Resources Engineering*

Others commented on the difficulties in general: for example:

It's heaps hard and intense, a rock is not just a rock!! – Earth Sciences

Other students commenting on the challenging nature of the course expressed this in relatively positive terms:

One of the most challenging but rewarding subjects there is, lots and lots of problems, but when you achieve the end result, it's a sense of real accomplishment. - Other Information Technology

Quite a few students (95) indicated that passing was achievable; for example:

*If you can put in the time and effort then you can easily pass the course. –
Chemical Sciences*

5.7.5 Whether or not to take the course

Many students gave recommendations to prospective students about whether or not to enrol in the course, and these responses are summarised in Figure 35. Nearly ten times as many respondents recommended that prospective students enrol than not do the course. About 500 respondents unequivocally recommended taking the course. For example:

Do it, it is EPIC. - Mechanical and Industrial Engineering and Technology

Do it. sell the house, sell the car, sell the kids. enrol.- Computer Science

Approximately the same number of respondents gave a conditional response.

Sometimes this was expressed positively, for example:

I would say if you love Biology it is the course for you! - Biological Sciences

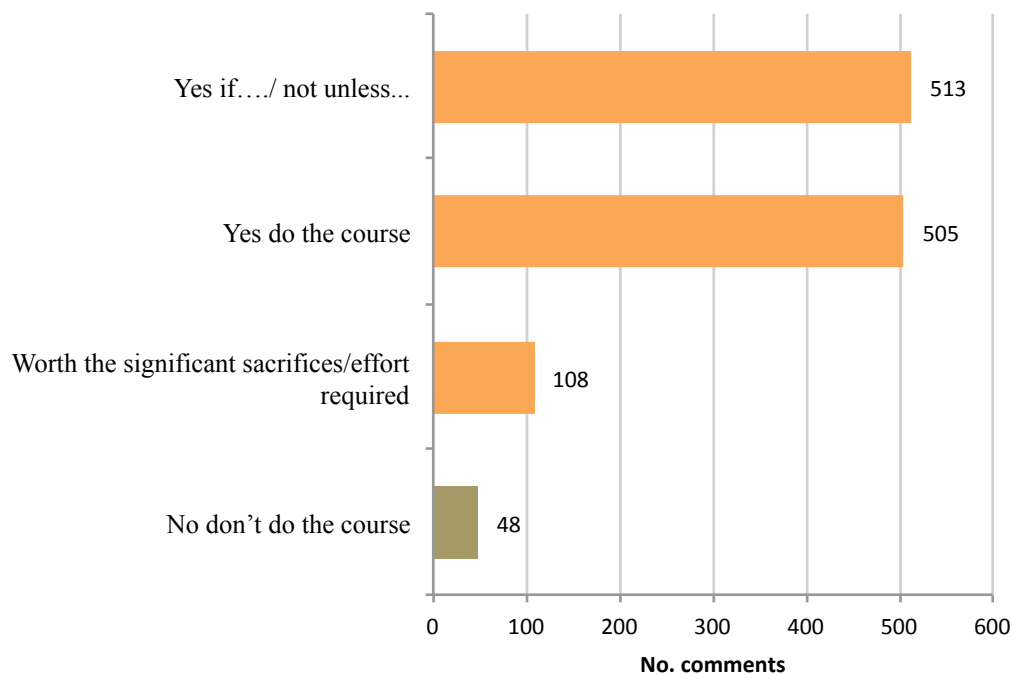


Figure 35: Frequency of student recommendations about taking the course, in response to the question “If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him? (N= 7804 explanatory units from 3013 responses).

Others had a somewhat more negative slant, for example:

Only do it if you have interest in it! and boys are better at it. - Civil Engineering

I'd say that is definitely not for the faint hearted and you should only do it if you're prepared to do the work and if you are genuinely interested. - Civil Engineering

Several respondents pointed out that although the course might entail sacrifices, or be hard work, it would be worth it: for example:

its hard but it will all be worth it in the end and you will feel proud of what you have done and what you are doing. - Civil Engineering

Only 48 students of the total sample size of over 3,000 specifically counselled prospective students against enrolling. Sometimes this was without further comment, for example

don't do it bro - Civil Engineering

Run... - Process and Resources Engineering

Reasons (if given) ranged from better alternatives, perceptions of the course content, career prospects and so forth, for example:

don't do it. Do a trade instead, get paid to learn and earn 120000+ straight out on the mines with generous downtime instead of being saddled with a HECS debt and low pay while you learn enough to be useful to a company - Mechanical and Industrial Engineering and Technology

Don't do it. So far one year in the course seems slow going and overly simple. In place of complex tasks that require in-depth dissection there are simplistic problems repeated non-stop in a manner that does [not] prepare you for more complicated situations. - Manufacturing Engineering and Technology

Go for other specific courses that may give you a better chance at finding the right job. - Physics and Astronomy

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7 APPENDICES

7.1 Appendix 1. IRIS Australia questionnaire

[CLICK >> BELOW TO GO TO SURVEY!](#)

Block 1

This questionnaire is about you and your choice of university course. Your answers are very important to the study! The information you provide to the IRIS research project may help us improve teaching and develop more targeted information for future students. All replies are confidential, and no information will be traceable to you as an individual.
PLEASE NOTE: You can only complete the survey in one attempt - it won't allow you to save and come back to the same question later.

Thank you very much!

Are you...

Female?

☐

Male?

☐

In what year were you born? (YYYY)

At which university are you studying?

State

University

Select your current course(s) from the list below. If you are enrolled in a double degree which includes two courses from the list below, please select both. If your double degree includes one from the list in combination with a non-science or non-engineering course (e.g. BSc/BLaw), please select only the science, IT, engineering or maths course. If you are unsure, enter the name of your course in "Other".

☐ B. Science

☐ B. Mathematics

☐ B. Engineering

☐ B. Computer Science

☐ B. Biotechnology

☐ B. Information Technology

☐ B. Environmental Science

☐ B. Software Engineering

☐ B. Forensic Science

☐ B. Applied Science

☐ B. Biological Science

☐ Other

From the list below, select the main field (major) you are currently studying or intending to study.

☐ Environmental science and/or Ecology

☐ Software Engineering

☐ Chemical Engineering

☐ Mathematics and/or Statistics

☐ Marine/Maritime/Ocean science

☐ Computer Engineering

☐ Biotechnology

☐ Electrical Engineering and/or Electronics

☐ Aerospace and/or Aviation

☐ Chemistry

☐ Civil Engineering

☐ Exercise and/or Health science

☐ Biology

☐ Mechatronics and/or Robotics

☐ Telecommunications

☐ Physics and/or Astronomy

☐ Mechanical Engineering

☐ Forensics

☐ Geology and/or Earth Science

☐ Mining Engineering

☐ Other

☐ Medical science and/or Radiology

Do you identify as Aboriginal or Torres Strait Islander?

Yes
☐

No
☐

Which best describes the location of the school you attended for all or most of your secondary schooling?

- ☐ In a capital city
- ☐ In a large, non-capital city (population greater than 25000)
- ☐ In a rural city or large town (population between 10000 and 25000)
- ☐ In a small rural or remote town (population less than 10000)

Was this secondary school co-educational or single sex?

Co-educational
☐

Single Sex
☐

Which best describes the type of school?

Government
☐

Catholic system
☐

Independent
☐

Are you an Australian citizen or International student?

Australian
☐

International
☐

Which of the following science and maths subjects did you complete in Year 12?

- | | |
|---|--|
| <input type="checkbox"/> physics | <input type="checkbox"/> advanced or extension mathematics |
| <input type="checkbox"/> chemistry | <input type="checkbox"/> other mathematics |
| <input type="checkbox"/> biology | <input type="checkbox"/> Senior science or multistrand science |
| <input type="checkbox"/> human biology | <input type="checkbox"/> no science subjects |
| <input type="checkbox"/> Earth and/or Environmental science | <input type="checkbox"/> no mathematics subjects |

Block 3

How important was each of the following school experiences in choosing your course?

	Not important					Very important
Your interest in the subject	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your previous attainment in related subjects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Experiments/laboratory work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Field work or excursions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lessons showing the relevance of your subject to society	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lessons showing the practical applications of your subject	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using mathematics in lessons	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Clear feedback on whether you got the right answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your Year 7 & 8 science classes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Not important				Very important
Your Year 9 & 10 science classes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your Year 11 & 12 science classes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Personal encouragement from your senior high school science teacher(s)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 4

How important were the following persons in choosing your course?

	Not important				Very important
Mother (or step-mother)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Father (or step-father)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Good teachers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Friends (including boyfriend/girlfriend)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Siblings or other relatives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Careers advisors in school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other people: (please state their relationship to you - name not required)

How important was each of the following in choosing your course?

	Not important				Very important
Popular science books and magazines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science fiction or fantasy books/films	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Computer games	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Museums/science centres	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Popular science television or radio programmes/channels (e.g. Discovery Channel, Life on Earth, Mythbusters, Dr Karl, Catalyst, Crocodile Hunter etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Films or drama on television (e.g. CSI, Numb3rs, Grey's Anatomy, Stargate, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Outreach activities such as the Science and Engineering Challenge, Siemens Science Experience, National Youth Science Forum, etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 5

Name any science, technology, engineering or mathematics outreach activities you participated in prior to university (e.g. Science and Engineering Challenge, Siemens Science Experience, National Youth Science Forum, summer schools in science, mathematics or computing, etc.). Rate each activity according to how much it encouraged you to choose your current course. Leave this question blank if you did not participate in any outreach activities.

	Not encouraging	Somewhat encouraging	very encouraging	Extremely encouraging
Enter name of outreach activity 1 <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enter name of outreach activity 2 <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enter name of outreach activity 3 <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 7

Describe how you came to choose the course in which you are enrolled.

Block 8

To what extent do you agree with the following statements about your experiences as a university student so far?

	Strongly disagree				Strongly agree
I enjoy the company of the other students on my course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel I fit in socially	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel I can keep up with the pace of the teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get personal feed-back from lecturers and teachers when I need it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel my teachers care about whether students learn or not	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The university offers good working conditions (equipment, library, common areas, cafes, technical support)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can see the relevance of what I learn	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that my course suits the kind of person I am	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have become more interested in the subject since I started	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 9

Have the following aspects of your everyday life as a university student been as expected, better than expected or worse than expected?

	Worse than expected	As expected	Better than expected
The overall experience of being a student in this course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Worse than expected	As expected	Better than expected
Your social relationship with your fellow students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The overall quality of the teaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How interesting you find the content of the course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The effort you have to spend on studying ('worse' means 'greater effort')	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 10

To what extent do you agree with the following statements?

	Strongly disagree				Strongly agree
I will do better than average in this course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I easily learn the subject matter in this course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident that I am good enough at the subjects in this course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am very motivated to study this course	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will probably decide to leave this course before I finish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have seriously considered withdrawing from your course, could you please say why?

Block 11

If someone you know was thinking about enrolling on your course and asked you about it, what would you say to her or him?

Block 12

Regarding your priorities for the future; how important are the following factors to you?

	Not important				Very important
Getting a secure job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Opportunities to earn a high income	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Starting to make money as soon as possible	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working with something that is important for society	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helping other people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Not important				Very important
Contributing to sustainable development and protection of the environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Doing something I am interested in	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using my talents and abilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Developing myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Block 13

Do you attend a course where one gender is over-represented? If so, what is the approximate male:female ratio and why do you think this is the case?

Do you see any reason why the situation described above should be changed - and if so, what do you think could be done to change it?

Block 14

OK, final question. How important was the cost of study in your choice of course?

Not important ☐ ☐ ☐ ☐ Very important ☐

Please explain your answer

7.2 Appendix 2. STEM related outreach activities as nominated by IRIS respondents (see Q. 4, p. 36)

SCIENCE

1. Adventure World Year 12 Physics Students Day (WA)
2. Ampol Science Competition
3. Annual Science Fair
4. ANU Archimedes Day
5. Australian Informatics Olympiad School of Excellence
6. Australian Schools Science Competition
7. Australian Student Mineral Venture
8. BHP Billiton National Science Awards
9. Biofutures
10. Biology Envirothon
11. Biology Essay Contest
12. Biotech talk
13. Brain Bee Challenge
14. Chemistry Laboratory outreach
15. CSIRO CREST
16. CSIRO Double Helix Program
17. CSIRO Forensics
18. CSIRO Science Project
19. CSIRO Student Research Scheme
20. Edith Cowan University HOT program
21. Envirothon
22. ESKITIS VIP Student day
23. Gifted & Talented Science Program
24. GTAC
25. HSC Kickstart Physics USYD
26. Hunters Hill Science Program
27. International Student Science Fair
28. Junior Landcare Victorian Youth Environmental Conference
29. Junior Physics Olympiad
30. Kids teaching kids
31. London International Youth Science Forum
32. Monash University's Chemistry Challenge
33. MRSM Science Fair
34. National Physics Competition
35. National Science Fair
36. National Science Festival
37. National Science Week
38. National Youth Science Forum
39. NSW Science Competition
40. Odyssey of the Mind
41. Oliphant Science Award
42. PEAC

43. Pedal Prix UniSA
44. PICSE
45. PULSE@Parkes
46. Questacon Schools Training Program
47. RACI Titration Competition
48. RDWA MedSpace
49. RESEARCHER'S NIGHT
50. Rio Tinto Big Science Competition
51. Science and Engineering Challenge
52. Science and Engineering Expo
53. Science Competition (UNSW)
54. Science competition at MACQ
55. Science Congress
56. Science in the Bush
57. Science in the Tropics (JCU)
58. Science Olympiad (generic)
59. Science Olympiad - Chemistry
60. Science Olympiad - Physics
61. Science Talent Search
62. Scienceworks
63. SciTech
64. Siemens Science Experience
65. Spectra ASTA
66. STANSW Young Scientist Competition
67. STAWA
68. Streamwatch
69. Sunsprint Challenge
70. The School for Excellence (TSFX)
71. Tournament of the Minds
72. UNSW Forensic Science 2 Day Seminar
73. UNSW GERRIC Scientia program
74. UNSW Global Science Competition 2010
75. UNSW Science Competition
76. UQ Science Ambassador Program
77. UQ SPARQ-ed
78. UTas science experience
79. Vet for a Day
80. Victor Chang School Science Award Tour
81. Women in Science Seminar
82. Work experience
83. World Scholars Cup
84. Young Scholars' Program
85. Young Scientist Award
86. Youth ANZAAS
87. Youth Chemistry Competition

TECHNOLOGY AND IT

1. Australian Informatics Olympiad School of Excellence
2. CISCO networking challenge
3. Codarra Robotics Challenge
4. ESKITIS VIP Student day
5. F1 in Schools
6. Information Technology Challenge
7. Intel Young Scientist
8. MATE Remotely Operated Vehicle Competition
9. Microsoft Imagine Cup
10. NCSS Computer Programming Challenge
11. Questacon Schools Training Program
12. Robocup
13. Robotic Challenge
14. Robotics Competition
15. SciTech
16. UNSW Programming Competition
17. Women in Mathematics, Science and Technology at the University of Adelaide
18. World Robot Olympiad
19. WorldSkills Australia for Information Technology

ENGINEERING

1. Australian Youth Aerospace Forum
2. Bridge competition by Construction Australia
3. British Army Engineering Challenge
4. Design and Build Challenge
5. Engineer Innovation Day
6. Engineering Link Project
7. ESKITIS VIP Student day
8. Girls in Engineering program
9. Girl's Solving It for Themselves
10. Great Engineering Challenge
11. GTAC
12. MATE Remotely Operated Vehicle Competition
13. Model Solar Vehicle Challenge
14. NASA Space Design Competition
15. National Bridge Competition
16. National engineering competition
17. National Geographic Competition
18. RMIT Engineering Experience Day
19. Science and Engineering Challenge
20. Science and Engineering Expo
21. Singapore Science and Engineering Fair
22. Solar Car Challenge
23. Southern Hemisphere Summer Space Program's Information Sessions
24. Straw Engineering
25. UNSW Engineering Open Day
26. Women in Engineering Seminar

27. Women in Mining conference

MATHEMATICS

1. ANU Mathematics Day
2. Australian (Westpac) Mathematics Competition
3. Commonwealth Bank Mathematics Challenge
4. CSIRO Mathematics student research scheme
5. Mathematics Challenge
6. Mathematics Modeling Challenge
7. Mathematics Enrichment Program
8. Mathematics Olympiad
9. Tournament of the Towns - Mathematics
10. UNSW Mathematics Competition
11. Women in Mathematics, Science and Technology at the University of Adelaide

7.3 Appendix 3. University networks and alliances represented in IRIS

Australian Technology Network	Curtin University of Technology
	Queensland University of Technology
	RMIT
	University of South Australia
	University of Technology Sydney
Group of Eight	Australian National University
	Monash University
	University of Adelaide
	University of New South Wales
	University of Queensland
	University of Sydney
Innovation Research Universities	University of Western Australia
	Griffith University
	James Cook University
	La Trobe University
	Murdoch University
Non-Aligned	University of Newcastle
	Bond University
	Charles Sturt University
	Deakin University
	Edith Cowan University

Macquarie University

Swinburne University of Technology

University of Canberra

University of Tasmania

University of Wollongong

University of Western Sydney

Victoria University

Rural University Network

Central Queensland University

University of New England