Girls Thriving in Geek Courses

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Abstract: *This paper reports findings from a national study of first year STEM students at Australian universities. It focuses on the expectations and experiences of 1547 females and males enrolled in male-dominated courses (physics/astronomy, engineering, IT). The study found no significant sex differences in students' ratings on a wide range of items including interest in the course, social fit, teaching quality, and intention to complete the course, among others. The paper concludes that high school girls considering enrolment in male-dominated STEM courses should find encouragement in the findings that, on balance, many of their university experiences are likely to be no more negative than those of males enrolled in the same courses.*

Keywords: STEM education, Girls in STEM, course experience, engineering education

1. Introduction

This paper reports results from a comparison of the experiences of female and male undergraduate students enrolled in male-dominated STEM courses (physics/astronomy, engineering and information technology) in Australian universities. These results are drawn from a national survey undertaken as part of the Australian contribution to the international Interests and Recruitment in Science (IRIS) project led by the University of Oslo (see Henrikson, Dillon, & Ryder, 2015).

2. Literature review

Since at least the early 1980s (Raat, 1981), concerns have been expressed in many countries including Australia about the low representation of females in particular STEM school subjects, university courses and fields of employment. Figure 1 illustrates the percentages of tertiary qualifications awarded to women in these fields in a range of countries in 2009 (OECD, 2011).

Despite the attention and resources directed towards this issue, female participation rates in physics/astronomy, engineering and IT courses have not increased to any marked extent, and in countries such as Australia, have actually declined over the first decade of this century (see Figure 2). More recent engineering data from Kaspura (2014) indicate that the percentage of females (domestic and international) has only increased from 16% in 2009 to 17% 2012.

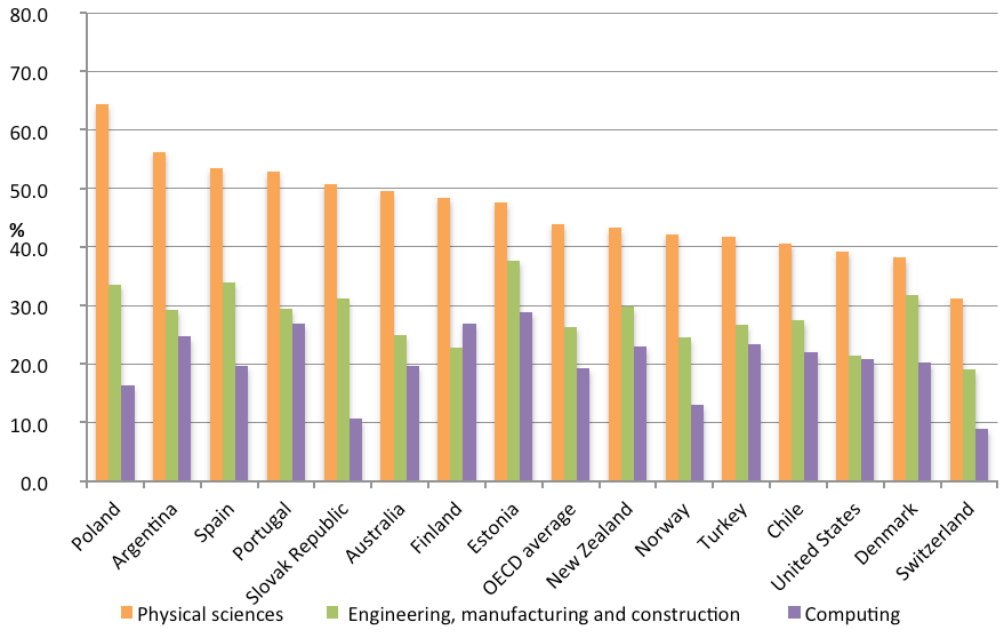

Figure 1: International comparison of percentages of tertiary qualifications awarded to women in tertiary-type A and advanced research programmes, by STEM field of education (2009) (adapted from OECD, 2011). NB: 'Physical science' includes chemistry.

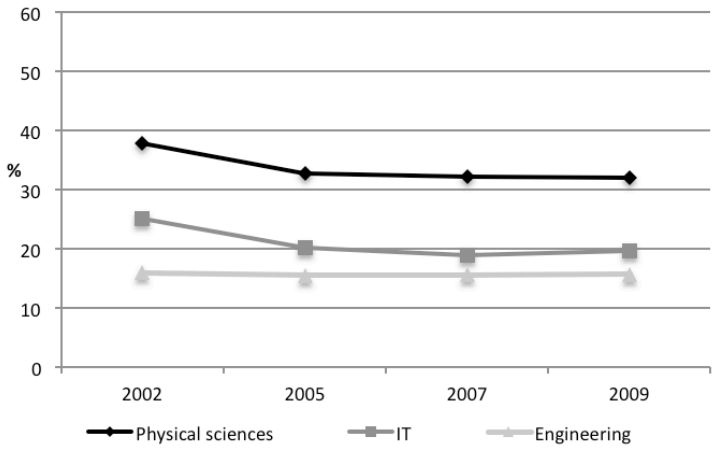

Figure 2: Percentages of female enrolments in bachelors degree courses in physical science, IT and Engineering – domestic and overseas students.

Several researchers suggest that high school girls are disinclined towards study in these fields due to their anticipation of male-dominated cultures within the university courses and careers (e.g. Cheryan, Master & Meltzoff, 2015). Further, Murphy, Steele and Gross (2007) point out that knowledge of female underrepresentation in particular courses can perpetuate this underrepresentation. If this is the case, it is possible a substantial number of girls are turning away from study in these fields because of the reputation for low female participation rates, regardless of the actual experiences of females in

these courses. This self-sustaining 'loop' of perceptions and enrolment decisions can only be broken by a greater understanding by high school girls about the experiences of female students in male-dominated STEM courses.

3. Research questions

The reasons behind the substantial sex differences in commencing enrolments are extremely complex and the subject of much research in Australia and elsewhere. The purpose of this paper, however, is to report on our investigation into whether there are any differences in key undergraduate experiences of males and females who are already enrolled in these courses. This knowledge could provide girls in high school with a more authentic picture of what to expect should they decide to enrol in such courses. In particular, this paper reports results from our investigation into three research questions:

1. Do male and female students enrolled in physics/IT/engineering courses report any differences in their first year university experiences?
2. Are there any differences in the perceptions of male and female students enrolled in first year physics/IT/engineering courses about the degree to which their expectations about the course were met?
3. Are there any sex differences in intentions to complete the course among males and females in physics/IT/engineering courses?

4. Methodology

For the Australian IRIS study (Lyons, Quinn, Rizk, Anderson, Hubber, Kenny, West, & Wilson, 2012), data were collected from 3496 domestic (87 percent) and international (13 percent) students from 30 universities, enrolled in courses in the Natural and Physical Sciences, Information Technology, Engineering and related technologies, Agriculture, Environmental and Related studies and Health. The cohort discussed in this paper consisted on 1547 students enrolled in first year physics/astronomy, engineering, and IT courses (see Table 1). Courses were classified as male-dominated where according to Australian higher education enrolment statistics more than two-thirds (66%) of commencing students in an applicable STEM field of education were male.

Participants responded to an online questionnaire of Likert-type items 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 full list of questionnaire items can be found in Lyons et al., (2012).

Table 1. Breakdown of respondents enrolled in male-dominated STEM courses

Male-dominated STEM courses	**Females**	**Males**	**Total**
Physics/astronomy	36	106	142
Information Technology	62	253	315
Engineering	223	867	1090
TOTAL	321	1226	**1547**

Comparisons between males and females were explored via crosstabulations and chi-square contingency table tests. For this cohort, a significance level of $p<.005$ was adopted as strongly indicative of a relationship between relevant variables. Cramer's V was used as a measure of Effect Size to determine whether any significant differences were meaningful. 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 that individual cell counts are significantly different to those expected if there was no association between the variables.

5. Findings

With respect to the first research question, Figure 3 compares the mean ratings of male and female students on items concerning course experiences during their first year.

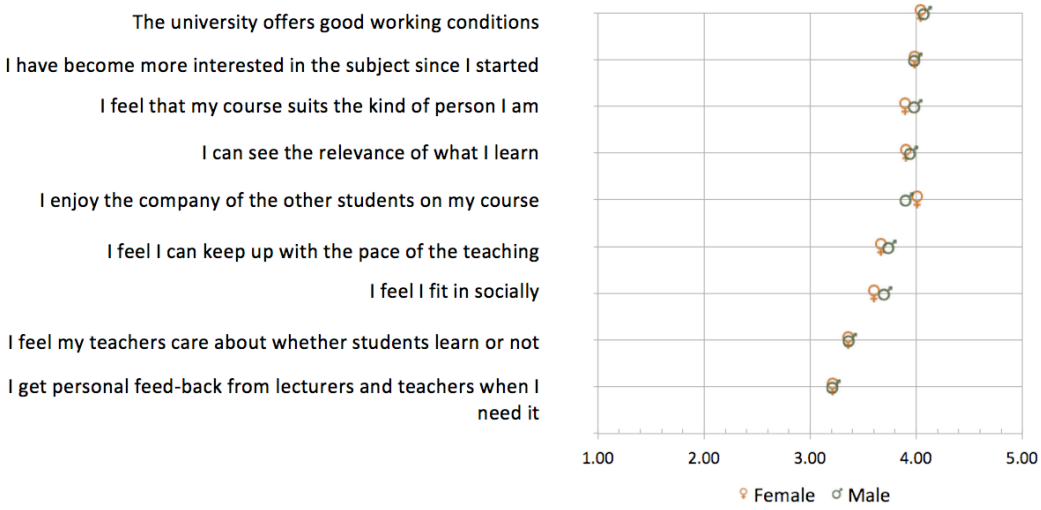

Figure 3. Mean ratings by males and females on course experience items. (Strongly disagree =1, Strongly agree =5)

It is clear from the figure that there is very little variation with sex in the mean ratings on these items. Chi-squared tests revealed no significant sex differences in rating patterns on any items.

With respect to Questions 2 - the degree to which students' experience met their expectations - Figure 4 compares the mean ratings of males and females. The scores on the x axis correspond to the three rating options: 'Worse than expected' (1), 'As expected' (2) and 'Better than expected' (3). Once again, there is little variation, and chi-square contingency table tests revealed no significant sex differences in rating patterns.

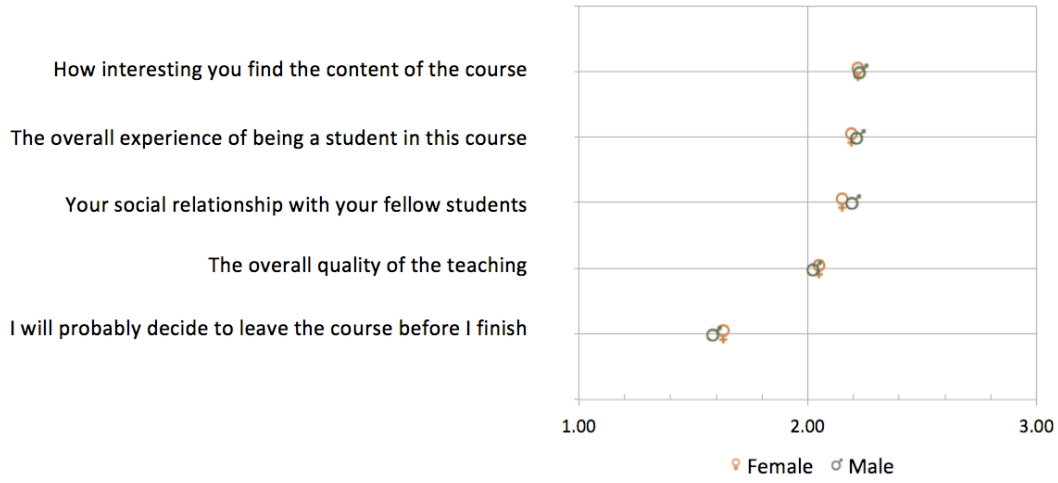

Figure 4: Mean ratings by males and females on their expectations about the course items. (Worse than expected =1, As expected = 2; Better than expected = 3)

6. Discussion and conclusion

The absence of any significant sex differences in means or rating patterns suggests strongly that females enrolled in male-dominated STEM courses have similar perceptions and responses to their course experiences as their male peers. This result has welcome implications for girls in high school who may be contemplating enrolment in physics/astronomy, engineering or IT courses, but are concerned that the predominantly male cohorts, and the attendant male culture, may be regarded negatively by females in these courses. Instead, the evidence indicates that, should they enrol in these types of courses, they would on average be just as likely as males to feel suited to the course, to enjoy the company of other students, to become more interested in the course, and to wish to remain in the course, among others. These results were supported by open-ended comments from females in these courses, which contained nothing to suggest they felt discriminated against by fellow students or faculty.

These results do not indicate that the perceptions of male and female students in physics/astronomy, engineering and IT course were in agreement on every IRIS survey item; there were for example significant differences ratings of self-efficacy, which will be reported elsewhere. However in terms of their perceptions of the teaching, the relevance and interest of the content, and the

social experience of studying these courses, our study found no cause for concern among girls considering enrolment in physics/astronomy, engineering and IT courses.

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