SEX DIFFERENCES IN THE PERCEIVED VALUE OF OUTREACH AND MUSEUMS/SCIENCE CENTRES IN STUDENTS’ DECISIONS TO ENROL IN UNIVERSITY SCIENCE, TECHNOLOGY AND ENGINEERING COURSES

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**Abstract:** This paper reports a number of findings from the Interests and Recruitment in Science (IRIS) study carried out in Australia in 2011. The findings concern the perceptions of first year university students in science, technology and engineering courses about the influence of museums/science centres and outreach activities on their choice of course. The study found that STE students in general tended to rate museums/science centres as more important in their decisions than outreach activities. However, a closer examination showed that females in engineering courses were significantly more inclined to rate outreach activities as important than were males in engineering courses or females in other courses. The implications of this finding for strategies to encourage more young women into engineering are discussed.

**Keywords:** IRIS study; women in science, university engineering enrolments, museums, science outreach.

**INTRODUCTION**

There is a considerable body of research on the influence of museums, science centres and outreach programs on students’ attitudes towards and achievement in science. There is however far less evidence concerning the degree to which these types of extracurricular activities influence young people’s career paths. Dabney et al. (2012) note that most research in this area concerns small-scale evaluations of specific programs or centres, which vary considerably in format and focus. Consequently, there is no consensus about the general value of such programs or centres, or whether they have a differential impact on decisions by males and females to enrol in science, technology and engineering (STE) courses (Szelenyi & Inkelas, 2011).

The Interests and Recruitment in Science (IRIS) project was developed in Europe in 2010 to investigate first year university students’ perceptions of the importance of factors from various spheres of influence; family, school, society, etc. on their decisions to take a STEM course (Henriksen, Dillon & Ryder, in press). One focus of the project was the importance attributed by students to museums/science centres and outreach programs. This focus was chosen as the subject of this paper due to the current lack of empirical research about the influence of these informal science experiences despite their promotion by various organisations, including the European...
Commission, as a means of increasing young people’s participation in science. IRIS data have so far been collected from the UK, Norway, Italy, Slovenia, Denmark, Sweden, Austria, Germany and Australia. This paper presents the views of Australian students on the role of these out-of-school experiences in their decisions.

**LITERATURE REVIEW**

The last two decades have seen increasing concerns about declines in the participation of young people in STE. An allied concern has been the persistent low representation of women in some STE fields, particularly physics, engineering and information technology (IT). An OECD survey of 32 countries reported that overall, 58% of tertiary Type A qualifications were awarded to women in 2009. However, only 19% of IT degrees, 43% of physical science degrees and 26% of engineering, manufacturing and construction degrees were awarded to women (OECD, 2011). The situation in Australian reflects this international pattern, although the percentage is even lower for engineering. Figure 1 summarises the percentages of female enrolments in STEM fields in Australia 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](image-url)  
*Figure 1: Percentages of female enrolments in Australian university STEM courses - all levels, domestic and overseas students (adapted from Dobson, 2012).*

There are indications such disparities are likely to continue. According to the results of the 2006 Program of International Student Assessment (PISA), the mean
percentage of 15 year-old boys planning to enter engineering and IT/computing careers in OECD countries was 0.18%. The mean percentage of 15 year-old girls with similar intentions is only a quarter of this at 0.047% (OECD, 2006). In Australia the mean percentage for girls was nearly six times lower than for boys.

In response to such statistics organisations around the world including the European Commission have invested substantially in strategies to encourage more women into these STE fields. In particular, the Commission aims to support informal science education via science centres and museums through the “Young People and Science” component of its 7th Framework Program. However, the issue of the contribution of museums/science centres and outreach activities towards students’ decisions is complex (Bray and Cridge, 2012). While there is some evidence that males and females engage differently with science museums and outreach activities (e.g. Greenfield, 1995), the literature is particularly thin with respect to whether these experiences have a differential influence on the university choices of males and females. Salmi (2002) suggested that experiences of informal science education in Finland had a greater effect on females than males, though it is unclear whether this related to intentions to enrol or actual enrolments. A review of the efficacy of science centres in England concluded that “there is a disappointingly low amount of evaluative evidence for both science centres and … programmes” due primarily to a lack of reliable information on their long-term impacts (Frontier Economics, 2009). The report also found a similar dearth of international evidence.

RESEARCH QUESTIONS AND METHODOLOGY

The IRIS study represented an opportunity to gather such international evidence. The questionnaire was developed by the European IRIS partners and provided to researchers in other countries. The Australian data were collected in late 2011 by a team of researchers from seven universities, and a report – Starting Out in STEM (Lyons, Quinn, Rizk, Anderson, Hubber, Kenny, Sparrow, West & Wilson, 2012) was released in 2012. The results presented here relate to responses by 2497 Australian students from 29 universities enrolled in physics/astronomy, chemical science, biological science, earth science, ‘other natural and physical science’, engineering and IT courses. Table 1 provides a breakdown of these respondents by course and sex.

This paper addresses the question of how important first year university STE students consider their experiences of museums and science centres to have been in their choice of course. Accordingly, students were invited to respond via a five point Likert-like scale (from very important to not important) to two IRIS items:

- How important were museums/science centres in choosing your course?
- How important were Outreach activities in choosing your course?
Table 1

Breakdown of the Australian IRIS sample for this analysis by sex and STE Field of Education. NB: Small discrepancies between column totals and the overall cohort are due to missing Field of Education data from some respondents.

<table>
<thead>
<tr>
<th>Field of Education</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics/astronomy</td>
<td>32</td>
<td>97</td>
</tr>
<tr>
<td>Chemical sciences</td>
<td>51</td>
<td>82</td>
</tr>
<tr>
<td>Biological sciences</td>
<td>431</td>
<td>166</td>
</tr>
<tr>
<td>Information Technology</td>
<td>53</td>
<td>204</td>
</tr>
<tr>
<td>Engineering</td>
<td>190</td>
<td>732</td>
</tr>
<tr>
<td>Earth Sciences</td>
<td>44</td>
<td>47</td>
</tr>
<tr>
<td>Other Natural and physical sciences</td>
<td>250</td>
<td>107</td>
</tr>
<tr>
<td>Total</td>
<td>1051</td>
<td>1435</td>
</tr>
</tbody>
</table>

Respondents’ ratings of these items were analysed by crosstabulation and chi-squared contingency table tests. This procedure was likewise used to establish whether there were any significant sex or Field of Education differences in responses to each item. A significance level of 0.001 was adopted for tests across the whole cohort. For tests across smaller categories of respondents – for example, males and females within a particular STEM field – results up to the p<.005 level are reported as strongly suggestive of a relationship between the relevant variables. Cramer’s V was used as a measure of effect size to determine whether any significant differences were meaningful. Details of the methodology can be found in our IRIS report (http://simerr.une.edu.au/pages/projects/132iris_report.pdf).

RESULTS AND DISCUSSION

Overall results

Figure 2 shows a breakdown of respondents’ rating of the importance of museums/science centres and outreach activities in their decisions. The figure shows that 30% of students rated museums/science centres as important or very important in their course decisions. By comparison, 25% of students rated outreach activities as important or very important, though 58% considered these to be of little or no importance.
Figure 2. Breakdown of respondents’ ratings of the importance of Museums/science centres and Outreach activities in their decisions to enrol in university STE courses.

Sex differences in ratings

The difference between males and females on these items were investigated via chi-square analysis of contingency tables. This revealed that significantly more females than expected rated museums/science centres as important in their course choice ($\chi^2(4) = 39.80; p<0.001$; Cramer’s $V = 0.127$, ASR = 4.7), while more males than expected rating these as not important (ASR=3.2). The differences had a small effect size. There were no significant differences in the ratings of males and females on the importance of outreach activities in their decisions. Some indication of these results can be gained from the plotting of mean ratings in Figure 3. It should however be recognised that our conclusions are based on the chi-square analyses of rating frequencies rather than the means depicted in this figure, which is included here as a visual cue.

Figure 3. Mean ratings by males and females of the importance of Museums/Science centres and Outreach activities.
Ratings by students in different STE fields

The ratings patterns of respondents in different STE fields were also investigated via chi-square analysis of contingency tables. No significant differences were found in ratings of the importance of outreach activities. By contrast, several significant differences were found in the levels of importance attributed to museums/science centres ($\chi^2 (24) = 117.717; p<0.001; \text{Cramer's } V = 0.134$). First, students enrolled in biological science rated these as having been very important in their decisions significantly more often than expected (ASR=6.9). Second, students enrolled in engineering rated museums/science centres as ‘very important’ significantly less often than expected (ASR=5.7). Finally, IT students rated museums/science centres as ‘not important’ significantly more often than expected (ASR = 6.8).

Ratings by males and females in different STE fields

The results in Figure 1 give the impression that museums/science centres tend to have a greater influence than outreach activities on students' decisions to enrol in STE courses, and in general this is the case. However, further analysis of ratings by males and females in different STE fields revealed that this was not the case for females in engineering, who rated outreach activities as important in their decisions significantly more often than expected ($\chi^2 (4) = 18.68; p<0.001; \text{Cramer's } V = 0.143, \text{ ASR= 4.1}$). The effect size was small. There were no significant differences in ratings by males in different STE courses.

The analysis also revealed that females in engineering were more inclined than females in other STE courses to rate outreach activities as important in their decisions ($\chi^2 (4) = 54.49; p<0.001; \text{Cramer's } V = 0.114, \text{ ASR= 4.0}$). In contrast to the overall cohort, female engineering students also rated outreach activities as more important in their decision than museums/science centres.

Conclusion and implications

These results indicate that while museum/science centres and outreach activities in general might be regarded as of moderate importance in encouraging Australian students’ to take up STE courses, females taking engineering attribute a higher value to outreach opportunities than males taking engineering and females taking other STE courses. Whether such opportunities introduced them to engineering, acted as a catalyst or simply confirmed a decision already made is a question in need of further research. Regardless, this result suggests there is value in supporting outreach opportunities targeting girls in engineering.

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