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Abstract

Research on the achievement and retention of female students in science and mathematics is located within a context of falling levels of participation in physical science and mathematics courses in Australian schools, and underrepresentation of females in some science, technology, engineering and mathematics (STEM) courses. The Interests and Recruitment in Science (IRIS) project is an international project that aims to contribute to understanding and improving recruitment, retention and gender equity in STEM higher education.

Nearly 3500 first year students in 30 Australian universities responded to the IRIS survey of 5-point Likert items and open responses. This paper explores gender differences in first year university students’ responses to three questions about important influences on their course choice.

The IRIS study found good teachers were rated highly by both males and females as influential in choosing STEM courses, and significantly higher numbers of females rated personal encouragement from senior high school science teacher as very important. In suggestions for addressing sex disparities in male-dominated STEM courses, more females indicated the importance of good teaching/encouragement and more females said (unspecified) encouragement. This study relates to the influence of school science teachers and results are discussed in relation to implications for science education.
THE INFLUENCE OF SCHOOL SCIENCE TEACHERS - THE DIFFERENTIAL IMPORTANCE ATTRIBUTED BY MALES AND FEMALES TO ENCOURAGEMENT FROM SCIENCE TEACHERS.

Objectives
This paper aims to briefly review the relevant Australian literature pertaining to the issues of declining STEM enrolments, and the underrepresentation of female students in some STEM courses. It then explores the views of first year students enrolled in STEM courses, in relation to impacts on their choice of course, by examining the responses of a sample of Australian first year STEM students at Australian universities to three questions related to the influences of school experiences and significant persons on their choice of course.

The influence of teachers on students’ choice of university STEM courses was an important focus of the study. The following research question is explored in this paper: How importantly does a sample of female Australian first year STEM students at Australian universities rate teachers as an influence in choosing their course, and how does this compare to males?

Significance
Low post-compulsory science and mathematics enrolments are a concern in many countries in the Western world. Student retention is of concern to universities worldwide, in part because it is a performance indicator of quality assurance (Crosling, Heagney & Thomas, 2009). This research is located within a context of falling levels of participation in physical science and mathematics courses in Australian schools (Goodrum, Druham, & Abbs, 2011; Lyons & Quinn, 2010) and relative declines in STEM participation by females and underrepresentation in some STEM courses (Lyons et al., 2012, p. 4). These falling levels are reflected in higher education, as is persistent inequitable participation in some STEM by female students. Dobson (2012) reported that in the period 2002-2010, as overall university enrolments increased in Australia, relative enrolments in Agriculture, Information Technology, and Natural and Physical Sciences declined.

Many of the issues faced by students in their schools are likely to have implications on their university enrolments in science, technology, engineering and mathematics (STEM) courses. International studies such as the Programme of International Student Assessment (PISA), have reported lower levels of mathematical literacy in female Australian students although there were no significant gender difference in scientific literacy (Thomson et al, 2011). The Universities Australia report (2012) examined first year university students’ attitudes towards science, technology, engineering and mathematics, and compared the responses of 701 STEM and 851 non-STEM students. They reported the importance of the influence of teachers in high school, and awareness of career pathways. Research has traced influences on degree completion back to high school, not only experiences during the degree itself. Secondary school studies had an impact. “What you study, how much of it, how deeply, and how intensely has a great deal to do with degree completion. Secondary schools must
provide maximum opportunity-to-learn” (Adelman, 2006, p. 108). In investigating factors that impact on STEM degree completion, Maltese and Tai (2011) found that interest during high school is an important factor. Research by Hulleman and Harackiewicz, (2009), showed that one reason that students demonstrated low levels of engagement in STEM courses in high school was that links were not made between their lives and what they were learning. When students were encouraged to make links to real-life relevance, their interest increased. Positive attitudes to and interests in science strongly influence students’ STEM choices (Lyons & Quinn, 2010).

Theory
Self-efficacy and science self-concept influence students’ study and career choices. Bandura’s (1994) studies on self-efficacy show the effect of internalisation of the influences of authority figures on the ability to successfully perform tasks. Self-efficacy impacts aspirations, persistence and motivation (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Britner & Pajares, 2006). Self-efficacy is defined as the confidence in one’s abilities to succeed, while self-concept is more broadly conceptualised as an evaluative judgment of self-worth (Pajares and Schunk, 2001). Both are strongly linked to students’ attitudes and decisions about science. Students are more likely to make science-related secondary, post secondary choices and career choices if they have high science-self concepts and thus high expectations of success in science (Eccles, 2009) and low perceived science ability inhibits students from choosing senior secondary science (Cleaves, 2005).

Much research (reviewed by Simpkins, et al., 2006, and Quinn & Lyons, 2011) has shown that males report higher science self-concepts than females. Quinn & Lyons (2011) found that 15-year old Australian males reported enjoying science more in relation to other subjects than did females, and rated their ability in science more highly than did females. Although science-related self-efficacy and self-concept are reciprocally related to success and performance in science related tasks, they do not necessarily reflect ability or performance. Evidence of the lower self-efficacy and self-concept that is often reported by females persists in spite of parity between males and females in achievement and performance in science (Quinn & Lyons, 2011). Britner and Pajares (2006) suggest encouraging interactions with teachers can enhance female students’ self-efficacy in science.

Design and procedure
This paper comprises a small component of a broader research project - the Interests and Recruitment in Science (IRIS) project. This is a large-scale international study of student recruitment, retention and gender equity in university science, technology, engineering, and mathematics (STEM) courses. The National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia (SiMERR) collected the Australian IRIS data. During second semester, 2011, the Australian IRIS team collected data from 3496 first year University students enrolled in science, technology, engineering and mathematics (STEM) courses in 30 Australian universities (Lyons et al., 2012). IRIS Australia used a questionnaire developed by the consortium partners and previously administered to around 7200 European first year STEM university students. The data collection instrument was a survey with fixed response Likert-type questions and some open response questions. The focus of the survey is on motivations for and influences on students’ course choices, and on their perceptions of their experiences during their first year of studying a STEM related
course at university. The online survey was open to students for ten weeks from September, 2011.

IRIS sought to investigate school experiences that encourage or discourage participation in STEM courses. Data from three specific survey items form the focus of this paper. These are:

1. “How important was each of the following school experiences in choosing your course?” (5-point Likert scale, 1: ‘very important’ to 5: ‘not important’).
2. How important were the following persons in choosing your course?” (5-point Likert scale from 1: ‘very important’ to 5: ‘not important’).
3. What suggestions regarding teachers at high school do students in male-dominated STEM courses have for changing the disparity in the male:female ratio? (open response).

Responses to item 1 and 2 were analysed with a chi-square contingency table test of the frequency data. Item 3 was coded according to the themes emerging from responses over multiple readings and illustrative quotations reported verbatim.

**Findings**

Significantly higher numbers of females rated personal encouragement from senior high school science teacher as very important in choosing course ($\chi^2 (4) = 51.33; p< 0.001$). However, good teachers rated highly my both males and females as the most influential person in choosing STEM course.

In suggestions for addressing sex disparities in male-dominated STEM courses more females said targeted outreach/programs, and good teaching/encouragement, and more females said (unspecified) encouragement (“I think there is far too little encouragement for girls to get into maths and science.” “More programs in schools to encourage females to study engineering based courses. Encourage females to study extension maths”). These results support the conclusions of Britner and Pajares (2006), and Quinn and Lyons (2011) that teaching strategies in secondary classrooms which improve females’ enjoyment of science, and encouraging interactions with teachers can improve female students’ self efficacy and help them overcome some of the barriers that militate against equal participation in STEM courses.

These results highlight the importance of good science teaching in schools, especially senior high school, as this is where subject choices are made that can impact students’ options of future tertiary studies in STEM courses. These results, in the context of falling enrolments in STEM courses at universities, point to the need to identify factors that positively impact on students’ interest and achievement in science and mathematics. It also highlights a need for future research into the issues female students may face in deciding whether or not to do science at the two key transition points of senior school and university/TAFE studies.

**References**


Lyons, T., & Quinn, F. (2010). Choosing Science: Understanding the declines in senior high school science enrolments. National Centre of Science, ICT and mathematics education for rural and regional Australia (SiMERR Australia), University of New England.


