

## **Report on: Understanding the influence of gender on academic achievement in physics.**

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In this application, we proposed to investigate whether gender plays a role in performance and eventual success in undergraduate physics at the University of Edinburgh. Our first submission of the School of Physics and Astronomy to the Institute of Physics for “Practitioner” status under the IoPs ‘Juno’ scheme<sup>1</sup> enabled us to reflect on gender equality within the school and across the undergraduate programme. Our submission highlighted a number of issues, including a lack of clear, basic information about the progression of students from year to year within the programme. We knew that ~40% of the students who commence 1<sup>st</sup> year physics do not complete the BSc programme, and we did not know where students exit the degree (or transfer to another subject) and why. We also had no data on whether women are more, less or equally likely to exit the programme than men and if their reasons for doing so are similar or different.

We had three primary aims of this project:

- 1) To identify the ultimate destinations of students entering but not completing the undergraduate physics programme, and to determine those factors that cause students to change their degree intention. Are female students more likely to change their destination than male students, and can this be correlated with aspects of our teaching programme?
- 2) To establish whether there are consistent, year-on-year differences between the attitudes of male and female undergraduate students to physics, and whether these change as a function of degree programme year.
- 3) To determine whether there is a gender gap in terms of performance in assessed work, and whether there is a difference in performance on examinations versus coursework.

Outcomes:

- 1) We performed qualitative interviews with undergraduate students who had left the physics degree programme, but who had stayed in the University to study elsewhere. We found that the biggest driver for leaving physics was interest in an “outside” subject, i.e. the non-physics subjects that students take in years 1 and 2. The decision to leave the physics programme did not correlate with performance, nor did it correlate with mathematics ability. Male students were just as likely to change degree programme as female students. Since the University of Edinburgh degree programmes are designed to be flexible for just this reason, we were satisfied that it was not something intrinsic to our teaching of physics.
- 2) We used the CLASS (“Colorado Learning Attitudes about Science Survey”) instrument to measure whether there are year-on-year differences between the attitudes of male and female undergraduate students to physics. The survey ranks the agreement of the participant with the expected response of an “expert” in the discipline. Contrary to our previous results, with a larger sample size we found no significant gender difference in attitudes to learning, with males and females proving equally “expert-like” (72-74% on entry into the course). The survey was then extended to members of the Institute of Physics throughout the UK. Practicing UK academics did show significant gender differences: female members of academic staff scored consistently more “expert-like” than their male colleagues in all categories. This surprising result was conveyed to the Institute of Physics and to the survey participants and is in the process of being written up, in combination with data acquired from Australian academics and university students.
- 3) We used the Force Concept Inventory (FCI) instrument to examine gender differences in conceptual understanding of physics. This work has been written up and published<sup>2</sup> and shows that there is a persistent gender gap over the course of the semester. Males outperform female students by 10.6% at the point of entry to the under-graduate programme as measured by the conceptual understanding test administered in week 1 of Physics 1A. This statistically significant gender difference persisted after one semester, although the gender gap reduced to 7.7%. This gap is also seen at the Universities of Manchester and Hull – with their very different student populations – suggesting that this is not an Edinburgh phenomenon. In looking at different assessment types, we found that female students consistently outperformed male students in coursework in each year between 2006 and 2010, on

average by 7%,. This is a statistically significant result ( $p < 0.01$ ). In examination scores there is far more variation year-on-year.

#### Benefits to the School/ College/ University

Our findings have reassured us that there is no specific aspect of our teaching programme that is putting women (or indeed men) off studying physics, and provided much-needed data on the apparent loss of ~40% of our cohort from year 1-4. Furthermore, our extension of the CLASS survey to a wider cohort demonstrated that there is no significant difference in the attitudes of our male and female students to the study of physics, and thus no intervention is needed here either. The results of the FCI survey have highlighted that there is a consistent and persistent gender difference in the conceptual understanding of fundamental physics concepts, and although we have satisfied ourselves that this is not an “Edinburgh” or even “Scottish” problem, we are yet to identify where the difference(s) lie. Our finding has underpinned some of our changes in the way we teach first year physics, but we have seen no improvement as yet. We have additionally investigated the self-reported study skills of our students by administering the “Study Process Questionnaire” but observed no difference between male and female students or correlation with performance on the FCI. Our efforts to address this imbalance are ongoing.

The data from this project fed into the School of Physics and Astronomy submission to the Institute of Physics for the renewal of our Juno Practitioner status and, more recently, our award of Juno “Champion” status (equivalent to Athena SWAN Silver status). We are one of 9 Physics Departments in the UK to hold this award, and the panel particularly commended our evidence-based approach and the strength of our unique Physics Education Research programme.

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<sup>1</sup> “Project Juno”, 2009 <http://www.iop.org/policy/diversity/initiatives/juno/> [accessed 8<sup>th</sup> January 2011]

<sup>2</sup> European Journal of Physics, Vol. 34, No. 2, 03.2013, p. 421-434.

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