

Letters to the Editor

THE LEE FIELDS MEDAL
A CIT MATHEMATICS COMPETITION
From J.P. McCarthy

Introduction. Save for a Higher Diploma and a Masters in Data Science & Analytics, the Department of Mathematics at Cork Institute of Technology is primarily in the business of service teaching, with the mathematics taught taking an applied and sometimes even vocational slant. However for a number of years the Department has offered a module — MATH6028 Mathematical Explorations — (conceived by Michael Brennan) that students can take as a free choice elective. As can be seen from the module descriptor:

The objective of this module is to capture the beauty and power of mathematics through various explorations,

this module provides the CIT student with something very different to their programme-aligned mathematics modules. Mathematical Explorations runs in both Semesters I and II, and is always enrolled to capacity. The ongoing popularity of Mathematical Explorations proves that there is an appetite amongst CIT students for more mathematics, mathematics for enjoyment.

The other side of the coin is that there can sometimes be a feeling within our department, and perhaps further afield in the IoT sector in general, that while we (rightfully) expend a lot of our energy on student retention, and on those struggling, that perhaps some of our students that are more interested and more capable in mathematics might be missing out on some attention.

For these reasons, the CIT Department of Mathematics established a mathematics competition, open to all currently registered CIT students. Called the Lee Fields Medal, the contest consists of a paper of ten questions, based on mathematics no more advanced than Ordinary Level Leaving Certificate Mathematics.

A Call-to-Arms. Are you lecturing mathematics in an Irish IoT? Do you feel some of your students would appreciate a similar outlet? Perhaps, and you don't necessarily need a local competition to do this, you would be interested in setting up an inter-IoT mathematics competition? If yes, please get in touch with J.P. McCarthy, jeremiah.mccarthy@cit.ie

Year One. The inaugural competition was held in October 2018, where 18 intrepid students sat the paper. An evening Software Development student, Damien Murphy, prevailed with a fine score of 83%. The toughest question on the paper was the Birthday Problem. Paschal Mullins, a first year student of Mechanical Engineering (Hons) was the only student to get full marks in that question, and went on to win the best first year prize with a score of 74%. The paper also contained questions designed to try and get students to think a little harder. Consider the following question:

A piece of wire 10 m long is cut into two pieces. One piece is bent into a square and the other is bent into an equilateral triangle. How should the wire be cut so that the total area enclosed is maximised?

Quite a number of students proffered what might be called a Pavlovian solution, immediately cutting the wire into lengths of x and $10 - x$, finding an expression for the total area as a function of x , setting the derivative equal to zero, and declaring that the maximum...

Given that the students would attend a Results & Solutions Night afterwards, we were also in a position to, e.g., explain (and correct) the logical error of answering:

Professor Oldie does not believe in calculators. You have to prove it to him on paper, using mathematical considerations, that

$$\sqrt{10} > \sqrt{2} + \sqrt{3}.$$

You may not use approximations nor your calculator,

by assuming the proposition and deriving a true statement.

Year Two. In October 2019 the competition returned, and 25 students took the paper. The winner of Best First Year in 2018, Paschal Mullins, returned and with 83% took down the title. On this occasion the toughest and second toughest questions were the geometry questions, and Shane Allen, a third year Level 7 Mechanical Engineering student was the only entrant to get full marks on both questions. To encourage more Level 7 students to enter, we added a Best Level 7 prize, and Shane won this award to go with the honour of cracking the two geometry problems. A first year computer science student, Yi Ming Tan, came second overall with a mark of 79%, and so the Best First Year student went to the next highest ranked first year, Sofia Dolera Perez, an Electronic Engineering (Hons) student with a score of 70%.

There was some controversy when a student took issue with an (unintentionally) ambiguous Monty Hall Problem:

In a game show you have to choose one of three doors. One conceals a new car and the other two contain angry lions who will attack you. You choose but your chosen door is not opened immediately. Instead the presenter tells you that another door (which you have not picked), contains a lion. You then have the opportunity to change your mind. Is there any benefit to doing so? Justify your answer.

Once again we saw evidence of students trained to ‘react’ to questions rather than think, with very few writing down the one line solution to:

Suppose that m and c are constants. What is the equation of the tangent to the graph $y = mx + c$ at $x = 1$?

We also saw some inventiveness. The following question was answered very easily by those with Higher Level Mathematics (and with a bit of work by those without):

If you expand

$$(1 + x)^{2019} = a_0 + a_1x + a_2x^2 + a_3x^3 + \dots + a_{2019}x^{2019},$$

what is the coefficient of x^2 , a_2 ?

One student gave a lovely solution, differentiating both polynomials twice, and evaluating at $x = 0$.

See https://mathematics.cit.ie/let_s-do-maths for the 2018 and 2019 papers.

Organisation. The competition is organised in a collaborative manner by an organising committee (OC). A bank of questions in ten categories has been developed, and there is an annual call to departmental colleagues to submit further questions. The competition is held relatively early in Semester I, with students invited via an “all-students” email.

The paper is chosen democratically, with two rounds of voting. First the OC each pick three questions from each category, and then the two top-voted questions are ran off against each other in a second vote. On the night the students receive a pack containing instructional cover sheet, question paper, ten answer sheets, and formula booklet. We also use the opportunity to advertise elective modules run by the department with a brochure.

Key to the process are the answer sheets: only one question per sheet, and this makes the process of divvying up the corrections very straightforward. Members of the OC each mark two or three questions, and submit marks to an online spreadsheet. Two weeks after the students sit the paper, we have a Results & Solutions night where the prizes are presented. Furthermore, on the night of CIT Faculty of Engineering and Science Awards, the winner is presented with a rather fetching gold medal, suitably inscribed with Euler's Identity.



FIGURE 1. Paschal Mullins, 2nd Year Mechanical Engineering (Hons), receiving the Lee Fields Medal at the CIT Faculty of Science and Engineering Awards from J.P. McCarthy (left) and HoD David Goulding (right).

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REDUCING THE GENDER GAP IN THE MATHEMATICAL SCIENCES
From Pauline Mellon

Gender gaps are ubiquitous. The gender pay gap in 2017 in Ireland was 14.4%, equivalent to women effectively working from November 9th until year end for free, relative to their male counterparts [1]. A gender pensions gap in Ireland sees the average weekly value of a man's pension more than 54% higher than a woman's [2].

Although it is hardly surprising, therefore, that there is a gender gap in higher education in Ireland, the scale of it may shock. In 2003-2004, across all Irish universities, women comprised 62% of our postgraduate students but only 8% of our professors, with a broadly similar pattern in our Institutes of Technology [3]. The situation surprised the authors of a recent HEA report into gender equality in higher education in Ireland, as its executive summary states "the Expert Group developed recommendations which they themselves would not have believed necessary at the beginning of this process. However, given the current situation and the international evidence which demonstrates that progression towards gender equality is not automatically linear or inevitable, ambitious and radical recommendations for all key stakeholders are essential" [3].

The wide gender gap in higher education only worsens if you move to the STEM areas of Science, Technology, Engineering and Mathematics [4]. My guess is that it may be even worse in mathematics than in STEM generally, at least in Ireland.

Nonetheless, one might hope that those resilient women who persist and succeed in STEM would flourish, after completing degrees and PhDs and postdocs to get full-time employment as scientists in the STEM area. A recent article in Nature suggests otherwise [5]. Its authors state that "STEM work is often culturally less tolerant and supportive of caregiving responsibilities than other occupations, so mothers - and fathers - may feel squeezed out of STEM work and pulled into full-time work in non-STEM fields". It reports, from a US study, that while 23% of men employed as full-time scientists in the STEM area leave STEM after their first child, the figure for women is almost double that. In other words, almost half US female scientists leave full-time science after their first child. STEM, it seems, is significantly less parent friendly overall than other employment sectors.

The culture in academia is no different in Ireland. Lynch [6] argues that there is a long history in higher education generally of a culture of 'carelessness', that is, being free from the work of having to take care of others. She states that the recent new managerialism in higher education has only exacerbated this endemic culture of carelessness, according it almost a moral status and that "given the moral imperative on women to do care work, [7], and on men to be care-less, the carelessness of higher education has highly gendered outcomes".

Let me illustrate this culture of carelessness. At drinks the night before a conference, I joined a group laughing as someone recounted another's tale of how an invited seminar speaker from abroad had the audacity to ask if she could bring her mother and baby with her. I, however, recognized the story as referring (unbeknownst to the raconteur) to myself, my breast-fed newborn and my own lovely mother. My offer to pay my mother's expenses wasn't part of the amusing tale, nor was the fact that the invitation had been withdrawn. While that baby is now an adult, not enough has changed in the culture of academe.

We must do better. A project 'A global approach to the Gender Gap in Mathematical, Computing and Natural Sciences', initiated and led by the International Mathematical Union's (IMU) Committee for Women in Mathematics, and funded largely by the International Science Council, has produced a short and easily implementable list of

recommendations: just four recommendation for ‘instructors and parents’, seven for ‘local educational organisations’ and ten for ‘scientific unions’. Simple recommendations, such as ‘take care of the issues of families attending with children’ and ‘put a budget in place to offer childcare solutions’, might have spared my humiliation in the above encounter had they been in place. Others are surprisingly basic, such as, ‘track who you are engaging in class to ensure that every student has a chance to participate and that girls feel comfortable in speaking up’.

This gender gap in our own mathematical sciences community in Ireland is something we should act quickly to close. There is evidence that it has, surprisingly, already been largely eliminated for students at second level [8]. Let’s work together to reduce the gender gap in mathematics and STEM in Ireland by immediately implementing the IMU recommendations ¹.

- 1:** O’Halloran, M., Irish Times, Nov 8, 2020, ‘Irish women are essentially working for free for rest of year due to pay gap, campaign says’. Also equalpay.ie
- 2:** Nolan, A., Whelan, A., McGuinness, S., Matre, B., ‘Gender, pensions and income in retirement’, ESRI Research Series, September 2019.
- 3:** Report of the Expert Group: HEA National Review of Gender Equality in Irish Higher Education Institutions, 2016, Figure 7 page 32 and Figure 11 page 36.
- 4:** Clancy, P., 2001, ‘College Entry in Focus: A Fourth National Survey of Access to Higher Education’, Dublin: Higher Education Authority.
- 5:** Nature, News, February 2019 ‘Nearly half of US female scientists leave full-time science after first child’.
- 6:** Lynch, K., ‘Carelessness: A hidden doxa of higher education’, Arts and Humanities in Higher Education, 2010, (9), 1, 54-67.
- 7:** O’Brien, M. (2007) ‘Mothers’ emotional care work in education and its moral imperative’, Gender and Education 19(2): 159-77.
- 8:** Lyons, M., Lynch, K., Close, S., Sheerin, E., Boland, P, 2002, ‘Inside Classrooms’. Institute of Public Administration.

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¹Editor: A copy of the document listing these recommendations may be downloaded from the project website <https://gender-gap-in-science.org/>. By kind permission of the IMU, you may also download it from the IMS website at <http://irishmathsoc.org/bull86/resources/IMU.pdf>.