

Building teacher knowledge for quality mathematics education in Ireland

Summary of the impact:

Improving mathematics proficiency among Irish school children has long been a topic of national debate.¹²³ The research team at EPI*STEM, the national centre for STEM Education based at the University of Limerick (UL), play a key role in highlighting the subject's challenges and providing solutions. EPI*STEM's research uncovered a fundamental barrier to mathematical attainment. Their 2009 study (Ref 3), reported that almost half (48%) of those teaching mathematics at post-primary level were not adequately qualified to do so: in other words, they were teaching out-of-field (OOF). These results led to EPI*STEM launching a dedicated upskilling programme, the Professional Diploma in Mathematics Teaching (PDMT), in 2012. The programme is government funded, recognised by the Teaching Council, and delivered through a national network of 14 teacher education partners. To date, 1100 teachers have graduated the programme.

Through their focus on STEM research and education, EPI*STEM have: impacted mathematical proficiency among post-primary students; addressed the imbalance in the numbers and age-profile of qualified mathematics teachers within

the education system; and contributed to improving the knowledge, confidence, and classroom practice of mathematics teachers throughout Ireland. A 2018 study by EPI*STEM (Ref 9) found the rate of OOF teaching has since reduced to 25%.

Countries where the impact occurred: Ireland.

Beneficiaries: Post-primary schools, post-primary school teachers teaching mathematics, students learning mathematics), Ireland's educational system – including its international reputation, Department of Education and Skills, Teaching Council, Irish industry.

Details of the impact

Improving the quality of STEM education is a key strategic priority for advanced nations. Ireland's Department of Education and Skills (DES) recognises this.¹ The publication of the 2009 EPI*STEM report on OOF mathematics teachers showed that Ireland needed to improve its post-primary mathematics programme, making it competitive internationally. However, according to Clive Byrne, Director of the National Association for Principals and Deputy Principals in Ireland, qualified mathematics teachers "were 'scarce and very difficult to get' and it was 'an issue of concern' (Source 7).



EPI*STEM's research uncovered a fundamental barrier to mathematical attainment.



This precipitated a national response. The education minister at the time “announced plans for major reforms, starting with putting more emphasis on teaching teachers how to teach, as well as devoting more time to basic ... numeracy in schools.” (Source 6). DES sought to address the issue, and improve Ireland’s international standing, by funding an upskilling programme for post-primary mathematics teachers, especially OOF teachers. Building on their research, the EPI*STEM team developed the curricula for this programme.

In 2012, the Professional Diploma in Mathematics for Teaching (PDMT) / Dioplóma Gairmiúil sa Mhatamaitic don Mhúinteoireacht was launched. The programme is led by EPI*STEM, accredited by UL and NUI Galway, and recognised by the Teaching Council of Ireland. It is delivered through a national consortium of 14 academic institutions and involves teacher education centres; Google is also an industry partner.

To qualify for the course, candidates had to: currently teach mathematics in a post-primary Irish school; be qualified as a post-primary teacher in a non-mathematical discipline; be registered with the Teaching Council as a post-primary teacher. The roll-out of the new programme coincided with the introduction of “Project Maths”, a new post-primary mathematics syllabus. The Dioplóma Gairmiúil sa Mhatamaitic don Mhúinteoireacht was also offered through the medium of Irish for OOF mathematics teachers in Irish-medium and Gaeltacht schools.

The PDMT was delivered in a blended learning format through local nodes in associate partner institutions, in face-to-face, and online modalities. In terms of student success, the PDMT graduation rate was high (above 90%, see Source 1). Supports were in place to ensure students progressed through the demanding programme.

The government’s funding commitment to the programme was substantial,

totalling around €7 million. The national media described it as a “historic step in terms of supporting maths teaching in post-primary schools” (Source 1), with DES covering the fees for students from 2012-2020. To date, some 1100 teachers in Irish post-primary schools have upskilled through the programme.

The DES established a Monitoring Group for the PDMT to evaluate and report on the programme. The Monitoring Group continuously engaged with teachers in their schools. They report that mathematics teaching in schools has been very positively affected, especially in the Junior Cycle (Source 2). In their view, teachers are more confident about delivering the new curriculum (and are delivering it), a culture of collaboration is developing in schools in the shape of communities of practice, and these teachers are well respected by their peers - often serving as the ‘go to person’ for the new curriculum.

EPI*STEM initiated an expanded research programme to further understand the PDMT’s impact. In 2018, the 2009 survey was repeated with further analysis still in development. The results to date show a substantial decline (to 25%) in the OOF rate and a broadening of the age-profile of qualified mathematics teachers (Ref 9). In addition, survey responses highlighted lower levels of self-efficacy among OOF teachers, many of whom perceived themselves to be less effective in teaching mathematics than their qualified counterparts. An additional survey of PDMT graduates found that they reported a substantial change in their mathematics teaching practices towards the problem-solving orientation promoted by the second level mathematics curriculum in Ireland (Ref 10).

In the broader context, the introduction of mathematics bonus points has contributed to higher numbers of students taking higher level mathematics at leaving certificate level. The number



increased from 8,510 in 2008 to 18,153 in 2019; (Source 3). The 2015 Programme for International Student Assessment (PISA) report found a marginal improvement: Irish students ranked 13 out of the 30 OECD countries, 9 in the EU, and 18 of all countries for mathematical attainment among 15-year olds (Source 4). In early December 2019, preliminary [PISA 2018 results](#) were released which showed Irish teenagers performing above average in science (22 overall) and mathematics (22 overall).

Finally, the success of the PDMT and the research findings from EPI*STEM impacted the development of other education programmes. They fed into the development of the Professional Diploma in School Leadership (PDSL), a DES investment resulting from the Action Plan for Education 2017. Building on the PDMT success, UL was involved in the design and delivery of this diploma. A blended learning model pioneered through PDMT was applied to the PDSL, while the model for collaboration in the original consortium provided a blueprint for engagement between the HEI partners. In addition, the PDMT fostered an approach to collaboration by HEIs: delivering teacher professional development that address national educational priorities. The PDSL is delivered in partnership with UCD, NUI Galway, and WIT.

Since its establishment, EPI*STEM expanded its team and attracted international research talent to the University. It is now a world-leader in STEM education, in particular OOF research. A recent visit by a peer (Source 5) to EPI*STEM stated "I was so impressed with [how John O'Donoghue and Merrilyn Goos] engage with many role-players in the STEM education space in Ireland – at the level of policy, research and practice. The PDMT is just one of the outputs of this kind of sustained engagement."

Sources to corroborate the impact

1. Irish Independent (2016) Teachers add maths to their skillset: [https://](https://www.independent.ie/irish-news/education/teachers-add-maths-to-their-skillset-34682429.html)

2. PDMT Monitoring Group, Department of Education and Skills
3. State Examinations Commission (2019) Leaving Certificate 2019 Provisional National Statistics <https://www.examinations.ie/misc-doc/EN-ST-71736616.pdf>
4. Programme for International Student Assessment (2015) Results in focus <https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf>
5. Director, Marang Centre for Science and Mathematics Education, University of Witwatersrand, South Africa
6. Katherine Donnelly, "Reading, maths skills of Irish students show alarming fall" (news article, Independent newspaper, December 8th, 2010): <https://www.independent.ie/life/family/learning/reading-maths-skills-of-irish-students-show-alarming-fall-26604509.html>
7. Irish Times (2010), 48% of maths teachers at second level unqualified <https://www.irishtimes.com/news/48-of-maths-teachers-at-second-level-unqualified-1.622705>

Underpinning research

In 2006, the OECD's PISA ranked Ireland's performance in post-primary mathematics assessment at 16 out of 30 participating OECD countries. Underperformance of post-primary students in mathematics was a national concern.³ The Government highlighted mathematics as a "fundamental requirement for the growth of the knowledge economy and the development of a world-class research and innovation system in Ireland" (EGFSN, 2008, page 12).

At the time, there was little research into understanding the root cause of the decline in mathematics proficiency or the effectiveness of interventions to address the problem (Ref 3). It was clear that mathematics proficiency at post-primary

was an important indicator of economic growth (EGFSN, 2008). However, it was not clear why Ireland was not competing at a global level in this area.

In 2008, UL was awarded €1.87 million in funding by the Higher Education Authority (HEA), SIF II, to tackle this issue through a programme of research, teacher education, and engagement. This programme was led by the then National Centre for Excellence in Mathematics and Science Teaching and Learning, later renamed EPI*STEM, which was established at UL under the aegis of the Shannon Consortium.

EPI*STEM's research team rapidly focused on the core challenge in STEM education – post-primary mathematics teaching. Their 2009 publication by Ní Riordáin and Hannigan (Ref 3) involved a national study of mathematics teachers in Irish post-primary schools. The study found that 48% of teachers were unqualified to teach mathematics; they were what is termed 'out-of-field' (OOF) teachers. The findings also highlighted a worrying trend in the age-profile of qualified mathematics teachers: only 40% of teachers under 35 years had a teaching qualification; the majority of those qualified teachers (65%) were over 35. Ireland risked losing its qualified mathematics teachers through retirement. Furthermore, at this time, only 16% of Leaving Certificate students sat higher level mathematics; this was 50% of the national target. Ireland lacked suitably qualified mathematics teachers and had few students studying higher level mathematics.

Through their focus on STEM research and education, EPI*STEM have: impacted mathematical proficiency among post-primary students; addressed the imbalance in the numbers and age-profile of qualified mathematics teachers within the education system; and contributed to improving the knowledge, confidence, and classroom practice of mathematics teachers throughout Ireland. A follow up study by EPI*STEM in 2018 (Source 9) found the rate of OOF teaching has

2 Expert Group on Future Skills Needs (EGFSN) (2008). Statement on raising national mathematical achievement. Dublin: EGFSN.
3 Task Force on the Physical Sciences (2002). Report and recommendations of the task force on the physical sciences. <http://www.irlgov.ie/educ/pub.htm> or <http://www.sciencetaskforce.ie/report>.
4 National Council for Curriculum and Assessment [NCCA] (2005). Review of mathematics in post-primary education – a discussion paper. Dublin: NCCA.

since reduced to 25%. In addition to the substantial decline in the OOF rate, the results show a broadening of the age-profile of qualified mathematics teachers. Survey responses highlighted lower levels of self-efficacy among OOF teachers, many of whom perceived themselves to be less effective in teaching mathematics than their qualified counterparts. Additional research (Ref 11) of PDMT graduates found that they reported a substantial change in their mathematics teaching practices towards the problem-solving orientation promoted by the second level mathematics curriculum in Ireland.

By January 2020, the PDMT has upskilled more than 1100 OOF mathematics teachers. This represents 17% of the total estimated post-primary mathematics teaching force in Ireland, at a total cost of €7million. The PDMT has been a game-changer for teacher continuing professional development (CPD). It introduces over 1000 teachers to university postgraduate study and the practice of action research conducted in their own classrooms.

This work is unique internationally, in its scale, longevity, and education policy alignment, with significant potential for transfer of learnings to other countries and disciplines.

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Underpinning research linked to UN Sustainable Development Goals: • Goal 4 Quality Education

• Goal 8 Decent Work and Economic Growth