Mathematics Education in Ireland

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Introduction

Ireland is a small country on the western edge of Europe, independent since 1922 (while Northern Ireland remained part of the United Kingdom). It has been a member of the European Union (EU/EEC) since 1973.

Although pre-schooling is not compulsory in Ireland, each child is now entitled to two years of education at this level. Primary education normally begins when children are about four or five years old and continues for eight years, while post-primary education follows this for five or six years. Public higher education has two main sectors, namely the seven universities and 14 institutes of technology. Post-primary education is divided into two cycles: the three-year Junior Cycle, and the two- or three-year Senior Cycle, the duration of which depends on whether an optional Transition Year is taken at the beginning of this cycle. High-stakes examinations (the Junior and Leaving Certificates) are offered at the end of the Junior and Senior Cycles. In 2016, 92.7% of all Leaving Certificate students took mathematics at one of three available levels, higher, ordinary or foundation. Accommodation is made for schooling through the medium of Irish (Gaeilge), catering for about 6% of students.

There are two models of initial teacher education (ITE), concurrent and consecutive. The concurrent model requires a student to take a Bachelor of Education degree, while the consecutive model involves a primary degree followed by a Professional Master of Education. Since 2006, the Teaching Council has regulated the teaching profession. The seven universities (either directly or through colleges of education) and one private college deliver ITE. Primary teachers are qualified to teach all curriculum areas, while post-primary teachers qualify (typically) in two subjects. In addition, for mathematics, the University of Limerick delivers a

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Professional Diploma in Mathematics for Teaching (PMDT) to address the historical problem of 'out-of-field' teachers in the subject.

Transition issues between education sectors have been receiving significant attention in recent years, and in relation to mathematics, in particular. The key transitions have been identified from pre-school to primary, from primary to Junior Cycle in post-primary school, from Junior to Senior Cycle, and from post-primary to higher education. There are active policy innovations and research on all of these transitions, and indeed on identifying the barriers to progression from further education and training to higher education.

Outside the formal education sector, many initiatives support the learning of mathematics and mathematical endeavour generally. Among these is Maths Week Ireland which has been held every year since 2006. This celebration of mathematics involves young and old alike, participants ranging from primary school children to Fields medallists. In 2016 there were over 300,000 participants, making it the largest such event in the world. Mathematics professionals are supported by academic and professional organisations, especially the Royal Irish Academy (RIA, founded in 1785), the Irish Mathematics Teachers' Association (IMTA, 1964), the Irish Mathematical Society (IMS, 1976) and the Irish Applied Mathematics Teachers' Association (IAMTA, 2006).

Policy

There are several key players involved in the development and implementation of policy in mathematics education:

- The Department of Education and Skills (DES, www.education.ie) including its Inspectorate
- Agencies of the DES:
  - The National Council for Curriculum and Assessment (NCCA, www.ncca.ie)
  - The State Examinations Commission (SEC, www.examinations.ie)
  - The Educational Research Centre (ERC, www.erc.ie)
- Stakeholders (teacher unions, subject associations, such as IMTA and IAMTA)
- Support and advocacy agencies:
  - The Professional Development Service for Teachers (PDST, www.pdst.ie)
  - National Adult Literacy Agency (NALA, www.nala.ie).

In the years 2003–2015, the overall performance of Ireland (with OECD average in parentheses) in PISA mathematics was 503 (500), 502 (498), 487 (499), 502 (496) and 504 (490), with performance significantly above the OECD average in 2012 and 2015. A particular area of weakness for students in Ireland in PISA is the Space and Shape content area, where performance has been below OECD average levels.

In 2011, the DES published Literacy and Numeracy for Learning and Life (DES, 2011), its national strategy for improvement in these areas for 2011–2020. It presented a broad set of measures designed to enhance the teaching and learning of mathematics, including an increase in instructional time at primary level and Transition Year, and a stated intention to enhance CPD in mathematics (via the Teaching Council). As part of the strategy, a requirement was introduced for primary schools to submit aggregated standardised test results to the DES at specified grade levels annually. Other actions included: (i) participation in TIMSS in 2015 (the first time since 1995 for second year post-primary); (ii) from 2012, for primary level, an extension of the (concurrent) B.Ed. degree programme from three to four years, and the (consecutive) PME from 1.5 to two years, each with a stronger emphasis on mathematics education; (iii) the introduction from 2012 of school self-evaluation and development planning; and (iv) the revision of the primary mathematics curriculum from 2016. In the five years from 2009 to 2014, there were significant increases in average scores in second and sixth classes (primary) in the National Assessment of Mathematics. Consistent with this, students in fourth class (9–10 year olds) in Ireland in TIMSS 2015 achieved a significantly higher mean score than in 2011 and 1995. Some progress has been made in PISA 2015 in achieving targets for PISA mathematics, but the proportions achieving the highest PISA proficiency levels are still relatively low. Nevertheless, the proportion taking the higher level mathematics at Leaving Certificate continues to rise (perhaps because bonus points for entry to higher education are available to most of these students since 2012).

Data from the 2013 PIAAC study showed that Ireland had a mean score that was significantly below the average for participating countries on numeracy, and that one-in-four adults performed at or below Proficiency Level 1 (the lowest level). NALA supports adults with numeracy (and literacy) difficulties, and published a framework for meeting the professional development needs of tutors of adult numeracy in 2015.

A report by the government-appointed STEM Education Review Group (2016) has made a number of recommendations designed to enhance engagement of students in STEM courses including mathematics, and ultimately, in STEM-related careers. The DES will present its own STEM Strategy in 2017.

Curriculum

Curricula and examinations are ultimately the responsibility of the DES, NCCA and SEC as mentioned above. However, when curricula are revised, various stakeholders are involved in negotiations, with the teacher voice in general strongly represented. There is a free market for textbooks, often written by practising teachers, and schools have relative freedom on timetabling and on the time allocated to individual subjects.

The present curricula (www.ncca.ie/en/Curriculum_and_Assessment/) are best understood in historical context. Two frameworks are helpful here. The first distinguishes levels of curriculum, focusing on how they can differ. These levels are: intended (decreed typically by the state), implemented (taught by teachers), and attained (learnt by students). The second refers to types of curriculum, reflecting different views of mathematics and mathematics education. Relevant types here are empiricist (emphasising moving from the perceived world to that of symbols), structuralist (building up structures within mathematics itself) and mechanist (rules without reasons).

At primary level, a curriculum reflecting the work of Piaget and emphasising discovery learning was introduced in 1971; it can be classified as empiricist with some structuralist features. When it was revised in the 1990s, issues addressed included poor attainment of higher-order objectives; the revised version—reflecting world-wide trends—has greater emphasis on problem-solving and applications in real-world contexts. As regards content, algebra and data are 'strands' throughout the curriculum; probability (or rather 'chance') is included in the higher grades; calculators are introduced in fourth class. A redeveloped mathematics curriculum for 3–8 year-olds (from early years to junior primary) is currently being prepared; the underpinning research reports are discussed below.

At post-primary level, major changes in the 1960s involved adoption of curricula much influenced by 'modern' mathematics, hence archetypally structuralist. They were intended to aid understanding and counteract mechanist teaching. However, implementation was challenging for teachers not attuned to the material; also, the content was too abstract for many students, especially with rapidly increasing retention to Leaving Certificate level. Successive partial revisions through to 2000—although deeply considered—were largely pragmatic, gradually removing content that was not well implemented or attained, and adding syllabuses for lower attainers. However, mechanist implementation remained a concern, as did teaching and learning over-focused on excessively predictable state examinations.

Dissatisfaction with students' performance, including the moderate PISA 2000 scores, prompted a root-and-branch revision, preceded by surveys of research and practice internationally (for example, Conway & Sloane, 2005). The initiative is known as 'Project Maths'. Revised curricula, phased in from 2008, are more empiricist and less structuralist; the state examination papers now focus strongly on solving problems set in real-world contexts. As regards content, there is increased emphasis on probability and statistics, but less calculus. To support implementation, enhanced professional development was provided, encompassing constructivist pedagogy and, latterly, mathematical content for 'out-of-field' teachers via the PMDT as mentioned above. The Project Maths initiative—incorporating a somewhat altered model of negotiation with stakeholders, a culture revolution with regard to predictable examining, and initial introduction of changes with little lead-in time before the high-stakes Leaving Certificate examinations—has been controversial; its impact will not be evident for some time.

Research

In recent years, STEM research has become conspicuous at a national level, and international exchanges are vibrant. Foci of research in mathematics education in Ireland encompass a broad spectrum. General themes include teaching and learning (at all levels of education), mathematical knowledge for teaching, and exploration of attitude and identity relating to mathematics and its teaching and learning. There are several 'cohort-focused' areas of interest, including mathematics in early childhood, with adult learners, in bilingual contexts, and with diverse international groups. An increasing number of centres are now active in mathematics education research in Ireland. Some have a focus on STEM teaching and learning (for example, EPI-STEM, in Limerick, and CASTeL and STEM-ERC, both in Dublin) while others have a broader remit but include STEM as an area of interest (for example, CRITE, in Dublin). SCoTENS is an all-Ireland (Republic and Northern Ireland) network that has supported many research initiatives in mathematics education. In a European research context, Irish researchers have participated in the Fibonacci Project (2010–2013) which focused on inquiry-based teaching and learning methods in STEM (primary and post-primary). The ERC (mentioned above) has produced national and international studies relating to mathematics education, including reports on PISA and TIMSS, national assessments of mathematics achievement (primary), and evaluation of mathematics programmes.

Since 2004, two series of conferences on mathematics and science education have been held in Dublin, MEI in odd years (2005–2015) and SMEC in even years (2004–2016). Although these series began as national conferences, they have attracted increasing numbers of international participants in recent years, with SMEC 2014 organised jointly with the SAILS FP7 project and MEI 2015 jointly organised with BSRLM. The Irish Mathematics Learning Support Network (IMLSN) has sustained, since 2006, a series of conferences on learning support in mathematics across higher education. The Project Maths Development Team has held three conferences supporting post-primary curricular reform, and several WIMDI (Women in Mathematics Day Ireland) conferences have showcased the work of women in mathematics and in mathematics education. International conferences held in Ireland have included the International Association for Statistical Education (IASE, 2011) and Adults Learning Mathematics (ALM, 2016), while CERME (2017) is forthcoming.

In 2014, the NCCA published two research reports to support the review and redevelopment of the primary school mathematics curriculum for 3–8 year olds. The first report focuses on theoretical aspects underpinning mathematics education for young children while the second is concerned with pedagogical implications. In common with policy documents on mathematics in many countries, mathematical proficiency (NRC, 2001) is identified as a key aim for mathematics education (Dunphy et al., 2014). Attention is given to goals, processes and content, critical transitions and learning paths, as means of achieving proficiency. New research themes emerging in Irish mathematics education include the interplay between

outcomes of assessment and practice, dialogic pedagogy of argumentation and discussion, identification of critical ideas for development of key concepts, transitions across education settings, design of rich and challenging mathematical tasks, and equity and access.

References

Conway, P. F., & Sloane, F. C. (2005). *International trends in post-primary mathematics education: Perspectives on learning, teaching and assessment* (NCCA Research Report No. 5). Dublin, Ireland: National Council for Curriculum and Assessment.

DES. (2011). *Literacy and numeracy for learning and life: The national strategy to improve literacy and numeracy among children and young people 2011–2020*. Dublin: Author.

Dunphy, E., Dooley, T., & Shiel, G. with Butler, D., Corcoran, D., Ryan, M., Travers, J., & Perry, B. (International Advisor). (2014). *Mathematics in early childhood and primary education (children aged 3–8 years): Definitions, theories, stages of development and progression* (NCCA Research Report No. 17). Dublin, Ireland: National Council for Curriculum and Assessment.

National Research Council (NRC). (2001). Adding it up: Helping children to learn mathematics. J. Kilpatrick, J. Swafford, & B. Findell (Eds.), Mathematics learning study committee, center for education, division of behavioral and social sciences and education. Washington, DC: The National Academies Press.

STEM Education Review Group. (2016). *STEM education in the Irish school system*. Dublin: DES.