

RELIEVING OUT OF FIELD TEACHING
IN AUSTRALIAN SECONDARY MATHEMATICS

Analysis of out-of-field secondary mathematics teacher upskilling initiatives in Australia

By Michelle Barker, Merrilyn Goos and Mary Coupland
JANUARY 2024

[AMSI.ORG.AU/RELIEVING-OUT-OF-FIELD-TEACHING](https://amsi.org.au/relieving-out-of-field-teaching)



TABLE OF CONTENTS

1. INTRODUCTION	2
2. DEFINING “TEACHING OUT-OF-FIELD”	2
3. ACCREDITATION REQUIREMENTS	3
4. UPSKILLING INITIATIVES	5
4.1 INITIATIVES FOR QUALIFIED TEACHERS	6
4.2 INITIATIVES FOR UNIVERSITY GRADUATES WHO ARE NOT QUALIFIED TEACHERS	10
4.3. STATE AND TERRITORY GOVERNMENT SUPPORT FOR TRAINING INITIATIVES	10
4.4 PROGRAM EVALUATIONS	11
5. INTERNATIONAL COMPARISONS	12
5.1 IRELAND	12
5.2 UNITED KINGDOM	13
6. IMPLICATIONS FOR TEACHER DEVELOPMENT	14
ABOUT THE AUTHORS	15
REFERENCES	15
APPENDIX	18

ABBREVIATIONS USED IN THIS DOCUMENT

AAMT	Australian Association of Mathematics Teachers
AITSL	Australian Institute for Teaching and School Leadership
AMSI	Australian Mathematical Sciences Institute
Aust MS	Australian Mathematical Society
CQU	Central Queensland University
CSP	Commonwealth-supported place
CSU	Charles Sturt University
ECTS	European Credit Transfer System
EFTSL	Equivalent Full-Time Student Load
FFP	Full fee paying
FT	Full-time
ITE	Initial Teacher Education
ITT	Initial Teacher Training
MANSW	Mathematical Association of NSW
MDPT	Mathematics Development Program for Teachers
MERGA	Mathematics Education Research Group of Australasia
NCETM	National Centre of Excellence in the Teaching of Mathematics
NCTL	National College for Teaching and Leadership
NESA	NSW Education Standards Authority
OOF	Out-of-field (Out-of-field teaching is defined on page 3.)
PDMT	Professional Diploma in Mathematics for Teaching
PT	Part-time
QTS	Qualified Teacher Status
SiAS	Staff in Australian Schools
SKE	Subject Knowledge Enhancement
SSA	Statistical Society of Australia
STEM	Science, Technology, Engineering, and Mathematics
TSST	Teacher subject specialism training
UTS	University of Technology Sydney
UNE	University of New England
UND	University of Notre Dame

Analysis of out-of-field secondary mathematics teacher upskilling initiatives in Australia

By Michelle Barker, Merrilyn Goos and Mary Coupland

January 2024

1. Introduction

This study identifies and describes the key features of out-of-field (OOF) secondary mathematics teacher upskilling initiatives throughout Australia, as well as selected international cases, to assist in understanding how to address findings that 40% of those teaching secondary school mathematics in Australia are out-of-field (Australian Institute for Teaching and School Leadership [AITSL], 2021).

The study discusses the difficulties in defining “teaching out-of-field” and provides a review of national and state/territory accreditation requirements for initial teacher education (ITE) programs in Australia, with a particular focus on comparing the minimum standards set by AITSL and the higher requirements of the NSW Education Standards Authority (NESA). Detailed analysis is then undertaken of upskilling courses available for OOF secondary mathematics teachers, profiling the different features of the wide array of courses available, to provide information on how many courses mirror ITE requirements. It is highlighted that some state and territory governments provide funding for programs in these areas. This analysis of the Australian situation is then compared with case studies of Ireland and the UK, which utilise national programs. Evaluations of these upskilling programs are also considered where available.

This study was sponsored by a consortium of the Australian Mathematical Sciences Institute (AMSI), the Australian Mathematical Society (Aust MS), the Statistical Society of Australia (SSA), and the Mathematics Education Research Group of Australasia (MERGA).

2. Defining “teaching out-of-field”

Out-of-field teaching is an international phenomenon that involves teachers being assigned to teach subjects, specialisms, or year levels that do not match their qualifications or background (Hobbs et al., 2022a; Ingersoll, 2002). Different jurisdictions within Australia and around the world have varying regulatory requirements for qualifications deemed suitable for in-field teaching, which affects how OOF teaching is defined. These definitions can also be used for different purposes, such as managing supply and demand in teacher workforce planning, distributing the teacher workforce within a jurisdiction or school sector, assessing the need for upskilling programs to build teacher capacity, or allocating funding to cover current subject offerings (Hobbs et al., 2022a).

Approaches to defining OOF teaching in secondary schools mostly focus on subject qualifications. In Australia, however, there have been different ways of specifying what is required for a subject specialisation. For example, Weldon’s (2016) analysis of the Staff in Australian Schools (SiAS) 2013 report used three definitions of “in-field” when reporting findings. The first was the agreed usage in all SiAS reports: (1) that a teacher had *either* studied the subject at second-year tertiary level or above, *or* trained in teaching methodology for that subject at tertiary level. To provide a comparative analysis, Weldon considered two additional definitions, if a teacher: (2) had studied the subject (for at least one semester) at second-year tertiary level, but *may or may not* have studied teaching methodology in that subject; (3) had studied both one semester at second-year tertiary level *and* teaching methodology in that subject. **All of these definitions set a lower threshold for in-field teaching than the current ITE requirements accredited by AITSL (2022).**

3. Accreditation requirements

This section details accreditation requirements to illustrate how this can affect teacher education options for OOF teachers seeking to build pedagogical and content-related expertise. In Australia ITE programs are accredited nationally against standards published by AITSL. The actual work of accreditation panels is done via state and territory-based authorities.

Minimum requirements are set nationally and described in the *Accreditation of initial teacher education programs in Australia: Standards and Procedures* (AITSL, 2022). States and territories can add other requirements, but only NESA does so with regard to secondary school mathematics (NESA, 2018, 2021). Table 1 provides a comparison of AITSL and NESA requirements for undergraduate programs, with the major difference being that **NSW has prescribed topics, with particular emphasis on algebra and calculus for content studies.**

However, this specific requirement should not detract from the importance of other topics in the school mathematics curriculum, especially statistics.

Table 1: Comparison of AITSL and NESAs requirements for undergraduate programs.

Knowledge type	<u>AITSL 2022</u>	<u>NSW 2021 – Subject eligibility guidelines – abridged version (in addition to AITSL requirements)</u>	<u>NSW 2018 – Subject content knowledge requirements – summary of detailed version (in addition to AITSL requirements)</u>
Discipline content	<p>a. A major of 6 semester-long courses¹ in the first teaching area, with no more than two at first-year level and no fewer than two units at third level.</p> <p>b. A minor of 4 semester-long courses² in the second teaching area, with no more than two at first-year level.</p>	<p>a. A major in pure or applied mathematics that must include algebra and calculus. One unit only of statistics may be counted. Engineering units may be considered.</p> <p>b. A minor in pure or applied mathematics that must include algebra and calculus. One unit only of statistics may be counted. Engineering units may be considered.</p>	<ul style="list-style-type: none"> ● Broad and critical knowledge and understanding of the mathematics academic discipline. ● Nature of various forms of mathematical proof. ● Study of calculus (analysis). ● History of the development of mathematical ideas. ● Simple counting principles and basic combinatorics as well as some discrete mathematics. ● Measurement and data representation. ● Algebraic structures. ● Appreciate different geometries. ● Problem solutions using appropriate statistical processes. ● Working Mathematically to construct arguments to prove or justify results and use data to support conclusions.
Content specific pedagogy	<p>a. 2 semester-long courses in the first teaching area.</p> <p>b. 2 semester-long courses in the second teaching area.</p>		<ul style="list-style-type: none"> ● Models of pedagogy, and range of strategies, for teaching and assessing. ● Methods and strategies of differentiating instruction to meet special education and diverse needs, and supporting students with disabilities. ● Embedding Aboriginal and Torres Strait Islander histories and cultures in Mathematics. ● Central ideas & common misconceptions. ● Role and value of mathematics in the broader school curriculum. ● Knowledge and understanding of the use of digital resources and tools. ● NESAs assessment requirements and comprehensive syllabus understanding.

When teachers graduate from their ITE programs in Australia they are registered with the relevant state or territory authority. In almost all Australian states and territories this accreditation does not include designation of particular subjects; the exception being NSW where teachers are certified to teach particular subjects. Consequently, OOF secondary mathematics teachers wishing to upskill to be able to teach secondary mathematics in NSW need formal accreditation, whereas this is not the case in other states and territories. Table 2 compares Australian ITE requirements with the requirements in NSW for secondary teachers to add accreditation to teach secondary mathematics

¹ Or equivalent to three-quarters of a year Equivalent Full-Time Student Load (EFTSL).

² Or equivalent to half a year EFTSL.

after their ITE³ (NSW Government, n.d.). The table shows both NSW requirements for secondary teachers with no previous undergraduate studies in mathematics, and those with underpinning mathematics content studies. This illustrates that **OOF secondary mathematics teachers who become accredited are required to have less mathematics content expertise than through ITE**. The content specific pedagogy and practicum requirements are similar, where practicum refers to time spent observing and teaching in a school as part of teacher training.

Table 2: Comparison of AITSL ITE requirements with NSW retraining requirements.

	<u>AITSL - ITE</u>	<u>NSW - no previous mathematics</u>	<u>NSW - underpinning mathematics</u>
Discipline content	a. A major of 6 semester-long courses in the first teaching area, with no more than two at first-year level and no fewer than two units at third-year level. b. A minor of 4 semester-long courses in the second teaching area, with no more than two at first-year level.	Complete 4 subjects in pure or applied mathematics with at least 2 subjects at second-year level and above (must include algebra and calculus).	n/a
Content specific pedagogy	a. 2 semester-long courses in the first teaching area. b. 2 semester-long courses in the second teaching area.	Complete 1 or 2 subjects (depending on focus) of mathematics method and curriculum studies for years 7-12 .	Complete 1 or 2 subjects (depending on focus) of mathematics method and curriculum studies for years 7-12 .
Practicum	a. Include no fewer than 80 days . b. Consist of supervised and assessed teaching practice undertaken over a substantial and sustained period. c. Are as diverse as practicable. d. Provide opportunities for pre-service teachers to observe and participate purposefully in a school/site.	Complete 1 or 2 subjects of practicum in a secondary mathematics setting.	Complete 1 or 2 subjects of practicum in a secondary mathematics setting.

NSW also details requirements for primary teachers to add accreditation to teach secondary mathematics after their ITE. The requirements for primary teachers without underpinning mathematics content studies is the same as for secondary teachers with no previous mathematics. Primary teachers with underpinning mathematics content equating to a major must complete the same studies as secondary teachers with the same content background (NSW Government, n.d.).

4. Upskilling initiatives

OOF secondary mathematics teachers who wish to upskill can access a range of courses without transitioning to formal accreditation as an in-field secondary mathematics teacher, either because this is not required in their state or territory, or because their desire to upskill is a result of intrinsic motivations rather than formal requirements. These courses range from graduate courses with a

³ These are indicative only. The actual program is dependent on each individual's qualifications.

focus such as secondary mathematics; university short course offerings such as those from the [University of New South Wales School of Mathematics and Statistics professional development courses](#) aimed at high school educators; to more informal professional development options from organisations such as the [Queensland Association of Mathematics Teachers](#).

We reviewed university courses to consider how these compare to ITE and/or NSW accreditation requirements, to understand the range of views on what it takes to be a qualified teacher of mathematics once already registered as a teacher. The courses were segmented by their entry requirements to ensure that we focussed only on courses provided to those with teaching qualifications.

4.1 Initiatives for qualified teachers

University qualifications that enable participants **already holding teaching qualifications** to upskill to teach secondary mathematics include those shown in Table 3. The “Outcome” column uses the descriptions provided by each course.

Further analysis of the courses listed in Table 3 is shown in Table 4, to demonstrate the **wide differences in a range of categories**: length of time to complete the course and whether full-time (FT) or part-time (PT); cost for a Commonwealth-supported place (CSP) and full fee paying (FFP); the number of subjects containing discipline content, and whether these are university or school level mathematics; whether discipline content includes algebra and calculus; whether content specific pedagogy is included; and what practicum is required. Further details on the last four columns are provided in the Appendix. The course costs should be taken as indicative only, as costs can vary depending on the commencement year of the course and the subjects taken. It should also be noted that it is not necessarily the case that these courses are being offered at present and/or in the future.

Table 3: Summary of courses for teachers to upskill to teach secondary mathematics.

No.	Course	University	State	Outcome
1	Graduate Diploma of Mathematics	Charles Sturt University (CSU)	NSW	Add mathematics as a second teaching area or to move from primary to secondary mathematics teaching.
2	Master of Mathematics for Secondary Education	University of Technology Sydney (UTS) ⁴	NSW	Designed to retrain approved primary and secondary school teachers in teaching secondary mathematics.
3	Grad Dip in Mathematics for Secondary Education	UTS	NSW	Designed to retrain secondary school teachers, and primary school teachers with sufficient undergraduate mathematics studies .
4	Bachelor of Education (In-Service Conversion) (area of mathematics)	University of New England (UNE)	NSW	Satisfies the seven elements prescribed by AITSL in a discipline and/or sector different from that for which you are already qualified.
5	Master of Education (specialisation in mathematics)	University of Newcastle	NSW	Intended for teachers who wish to retrain in an additional teaching area or gain further professional learning.
6	Master of Mathematics Education	University of Notre Dame (UND)	NSW ⁵	Designed to retrain accredited teachers from other disciplines in mathematics as a teaching area.
7	Graduate Diploma of Mathematics Education	UND	NSW	Upskills teachers with mathematics skills and teaching methods.
8	Diploma of Secondary School Teaching (major in mathematics)	Central Queensland University (CQU)	Qld	For secondary school teachers who want to improve their content knowledge within an existing teaching area or gain discipline content knowledge to add a new area.
9	Graduate Certificate of Secondary Mathematics	Deakin University	Vic	Supports graduates to move into new areas of teaching beyond those recognised through their ITE degree.

⁴ UTS Masters and Grad Dip courses will suspend intake from Autumn session 2023.

⁵ Whilst UND has campuses in Western Australia as well, this course and the Graduate Diploma of Mathematics Education are listed as being taught from the Sydney campus.

Table 3 (cont.): Summary of courses for teachers to upskill to teach secondary mathematics.

No	Course	University	State	Outcome
Years 7-10 focus				
10	Graduate Certificate in Education (major in secondary mathematics for years 7-10)	Murdoch University	WA	Enables qualification as an educator for high school mathematics for Years 7-10.
11	Master of Specialist Teaching (specialisation in numeracy)	Federation University	Vic	For teachers looking to specialise in numeracy or those teaching OOF. Develop understanding needed to teach years 7-10, catering for diversity and inclusion, and linking mathematics with other STEM areas.
12	Graduate Certificate in Specialist Teaching (Mathematics Education)	Federation University	Vic	For teachers looking to specialise in numeracy or those teaching OOF. Develop understanding of the content and pedagogical knowledge to teach years 7-10.

Table 4: Further details of the courses in Table 3, assuming 2024 start.

No	Course	Uni	Length (yrs)		Total cost \$ (unless indicated)		Number of Maths content courses (subjects)	Uni or school level maths	Algebra and calculus	Pedagogy	Practicum (days)	
			FT	PT	CSP	FFP						
1	Graduate Diploma of Mathematics	CSU	1	Equiv ⁶	4,432	30,688	6	Uni	✓	✓	Up to 60	
2	Master of Mathematics for Secondary Education	UTS	-	3	6,668	37,348	6+ ⁷	Uni	✓	✓	15	
3	Grad Dip in Mathematics for Secondary Education	UTS	-	2	4,445	33,868	6	Uni	✓	✓	15	
4	Bachelor of Education (In-Service Conversion)	UNE	1.5	Up to 6	5,924 yr 1	27,234	6	Uni	✓	✓	20	
5	Master of Education	Newcastle	1	Up to 4	4,445	22,465	6	Uni (5 ⁸) & school	✓	✓	15	
6	Master of Mathematics Education	UND	-	3	4,445	23,443	6	Uni	✓	✓	-	
7	Grad Dip of Mathematics Education	UND	-	2	2,963	15, 629	5	Uni	✓	✓	-	
8	Diploma of Secondary School Teaching	CQU	-	2.5	10,382 yr 1	18,456	4	Uni	Algebra, calculus as optional	✓	-	
9	Grad Cert of Secondary Mathematics	Deakin	-	2	Not offered ⁹	11,900	4 ¹⁰	School	Algebra	✓	-	
10	Years 7-10 focus	Graduate Certificate in Education	Murdoch	0.5	Equiv	2,221 ¹¹	8,280	2	School	Algebra	✓	-
11		Master of Specialist Teaching	Federation	-	3	6,660	24,700 ¹²	2	School	-	✓	-
12		Grad Cert in Specialist Teaching	Federation	-	1	2,220	12,350	2	School	-	✓	-

⁶ Equivalent denotes that the course information advises that a part-time equivalent is available, without specifying timeframes.

⁷ Students can choose two electives from a range of subjects that cover both disciplinary content and content specific pedagogy.

⁸ Contains the equivalent of no more than 5 university-level mathematics courses across a range of courses. Blended with other content.

⁹ Funded places are provided by the Victorian Government's [Secondary Science and Mathematics Initiative](#).

¹⁰ Courses combine mathematics content and mathematics pedagogy

¹¹ This program is also provided as fully funded through the [LEAP program](#).

¹² Federation FFP course costs are based on the costs of a Master of Education and Graduate Certificate of Education (Tertiary Education).

Analysis of Table 4 provides the following information on how many courses mirror ITE requirements:

- 5 of the 12 courses (rows 1-4, 6) require at least the same amount of discipline content (6 subjects) of university level mathematics for a major in mathematics within an ITE qualification.
- 8 of the 12 courses (rows 1-8) require at least the same amount of discipline content (4 subjects) of university level mathematics for a minor in mathematics within an ITE qualification, which is also the requirement in NSW for secondary teachers to add accreditation to teach secondary mathematics after their ITE.
- 5 of the 12 courses include a practicum of 15-30 days, noting that those enrolling in these courses are already qualified teachers who have completed a prior ITE practicum of 80 days.

The five courses that come closest to including the same requirements as an ITE qualification (i.e., numbers 1-5 in Table 4 as these all include a practicum) are all offered by NSW-based universities, and all meet the requirements in NSW for secondary teachers to add accreditation to teach secondary mathematics after their ITE. These five courses also range from graduate diplomas to masters, and thus there does not seem to be a particular pattern in the requirements of courses at different levels. Consequently, it may be **challenging for OOF secondary mathematics teachers to identify courses** that meet their needs.

Table 4 also indicates other differences in courses:

- The length of time of the courses varies widely.
- Some courses are supported by government funding initiatives (see section 4.3).
- The mathematics content may be at either university level (as is the case for accredited ITE programs) or school level (which is valuable for giving teachers deeper insights into the content of the school mathematics curriculum).

These differences may also make it difficult for teachers wishing to upskill to identify their ideal enrolment choice, and there could be benefits in using different types of badging to highlight key differences such as if the course content is university or school level mathematics.

It should be emphasised that whilst the other courses listed in Table 4 have less of the requirements of an ITE qualification to teach secondary mathematics, they enable a variety of other outcomes. For example, the Federation University [Master of Specialist Teaching](#) (specialisation in numeracy, developing the mathematical content knowledge and pedagogical knowledge to teach students in years 7-10) also has features on catering for diversity and inclusion in mathematics as well as linking mathematics with other STEM discipline areas.

There are also courses for qualified teachers that are not listed here that have a broader focus, such as science, technology, engineering, and mathematics (STEM) education, including the [Graduate Certificate in Secondary STEM Education](#) from Western Sydney University that equips secondary teachers with the skills and knowledge to design and implement integrated STEM programs; [the Master of Education - STEM in Education Specialisation](#) from Queensland University of Technology for educators who want to engage in professional learning to develop their STEM pedagogical content knowledge and skills; and the [Master of Education](#) from Australian Catholic University that affords teachers and educators the opportunity to learn about innovative approaches to SETM education that align with the Australian Curriculum and respective state and territory syllabi.

4.2 Initiatives for university graduates who are not qualified teachers

OOF secondary mathematics teachers can also upskill through a range of courses designed for participants who do not need to hold teaching qualifications, where **only a bachelor's degree (in any**

subject) is required for entry. A number of these highlight their ability to provide upskilling in secondary school mathematics teaching, including those shown in Table 5.

Table 5: Courses only requiring a Bachelor's degree for entry.

Course	University	Outcome
Graduate Certificate in Mathematics	University of Notre Dame	Ideal for accredited teachers from other disciplines who want to improve their employment prospects by gaining the content knowledge to teach mathematics.
Graduate Certificate in Mathematics	Open Universities Australia	Designed as the first in a set of programs to enable existing teachers to retrain to teach mathematics.

4.3. State and territory government support for training initiatives

Some Australian state and territory governments have introduced initiatives to fund upskilling of OOF secondary mathematics teachers. Current programs include:

- NSW Government: [Mathematics Teacher Retraining Program](#) covers course fees for master's degree, graduate diploma or graduate certificate for current teachers to retrain as a mathematics teacher. The program pilot commenced in early 2023 with an initial cohort of approximately 40 teachers. There is a scholarship process in place for teachers in the Department of Education. The [Teach and Learn Scholarship](#) (High Demand Subject Areas) includes Mathematics as a target teaching area. Incentives include \$20,000 per year of full-time study and a permanent position in a NSW Public School upon completion of studies.
- Victorian Government: [Secondary Science and Mathematics Initiative](#) for OOF science and mathematics teachers who want to upskill with a university graduate certificate to become in-field specialists. Each school will receive 0.2 full-time equivalent time release for each teacher taking part in the graduate certificate. In 2022 places were limited to 75 participants in mathematics (Victoria State Government, 2021).
- Western Australia: [Leap Program](#) gives both new and existing teachers opportunities to gain further qualifications to teach in additional specialist areas or move into a new area of teaching (including mathematics). This course is an accredited postgraduate university qualification. In 2020–21, Leap trained 447 teachers in secondary mathematics, design and technology, English, science, humanities and social sciences, and primary languages (Department of Education Western Australia, 2021).

4.4 Program evaluations

It is **difficult to find publicly available evaluations for any of the programs** listed in Tables 4 and 5 to assist in understanding the effectiveness of their varying approaches. And even when analysis does exist, there are a wide variety of metrics utilised, such as changes in teacher beliefs, knowledge and practices; and number of OOF teachers. There are evaluations of programs to improve ITE, such as [evaluation](#) of the Australian Government's Enhancing the Training of Mathematics and Science Teachers Program, which identified two approaches as critical to gaining major improvement in the quality of mathematics and science teachers: "collaboration between faculties, schools or departments of science, mathematics and education, which will produce teachers who have a contemporary and dynamic view of science that can inspire students; and curriculum arrangements

that give pre-service teachers of science and mathematics a new vision of how mathematical and scientific content, thinking and pedagogy can work together” (Maconachie et al., 2018, p. v).

One of the few available studies of Australian OOF secondary mathematics teaching support initiatives is an [evaluation of methodological issues](#) in the analysis of a professional learning program for OOF teachers of mathematics and science in Tasmanian government schools. The evaluation considered issues related to both structural features (form, duration, collective participation) and core features (content, active learning, coherence). The major finding was that for “any retraining program to be successful there needs to [be] attention not just to building teachers’ capacity to teach the out-of-field area. But there also needs to be attention to the school culture within which the teacher operates” (Kenny & Hobbs, 2015, p. 12). Another evaluation reports on an unnamed government-funded program designed to support teachers teaching ‘out-of-field’ in science and mathematics. The initial design of the program drew on existing literature, concluding that “growth in teachers’ confidence and relational understandings of content, pedagogy and curriculum was evident” (Kenny et al., 2020, p. 500). This evaluation also highlighted the importance of government funding and recommended further research to “give greater insight into the issues around planning effective professional development for out-of-field teachers in different contexts, and under different funding regimes” (Kenny et al., 2020, p. 512).

5. International comparisons

Analysis of Australian requirements in comparison with other countries can also provide different perspectives, and case studies are provided here for Ireland and the UK.

5.1 Ireland

Ireland has a **national approach to upskilling OOF secondary mathematics teachers**. The Ireland Department of Education and Skills funds teachers’ tuition fees (€6,500 per teacher) for the [Professional Diploma in Mathematics for Teaching](#) (PDMT) as a free national program for eligible post-primary teachers, as part of the national strategy to improve standards in mathematics education in post-primary schools by upskilling OOF teachers of mathematics. This is a university postgraduate course, delivered by a national consortium of higher education institutions led by the University of Limerick and designed to meet Ireland’s Teaching Council requirements for registration as a qualified mathematics teacher, which entails:

- A degree level qualification of at least 180 European Credit Transfer System (ECTS) credits, with Mathematics studied up to and including third-year level or higher and comprising at least 60 ECTS;
- Essential areas of study: analysis (including multi variable calculus); algebra (including linear algebra); geometry (including both Euclidean and non-Euclidean geometry); probability; and statistics (including statistical inference);
- Optional areas of study: dynamic systems and chaos; calculus of variations; numerical analysis or computational mathematics; mathematical modelling; discrete mathematics; history or philosophy of mathematics; mathematical logic; set theory and cardinality;
- Subject specific pedagogical content knowledge (Teaching Council, 2020b);
- School placement of 30 weeks (Teaching Council, 2020a).

The two-year part-time PDMT was designed to meet the same requirements as ITE programs in Ireland, so that upskilled graduates are deemed by the Teaching Council to meet post-primary subject curricular requirements for mathematics. The PDMT includes ten mathematics content courses and two mathematics pedagogy courses (which include practical assessment requirements); with each

content course being 6 ECTS credits and the two pedagogy courses being 6 and 9 ECTS credits respectively. The PDMT does not include school placement as all participants must be currently teaching mathematics out-of-field. The first contract to deliver the PDMT funded six cohorts of OOF teachers from 2012-2020, with 1078 graduating as fully qualified teachers of mathematics. A second contract is funding two further cohorts from 2021-2023. The demand for a second offering of the PDMT was such that 650 applications were received for the 115 places in the first cohort. As a result, the Department of Education and Skills increased second cohort places to 200, with more on the waiting list. A number of evaluations have been undertaken of this course, which have demonstrated impacts such as:

- **Reduction in OOF teaching of mathematics** and increased opportunities for PDMT graduates to teach higher level mathematics in the senior post-primary years (Goos et al., 2021).
- Substantial improvements in PDMT graduates' ratings of their confidence for teaching the mathematical content of junior secondary mathematics, and a shift from procedural or teacher-led approaches to more student-centred approaches that focussed on developing understanding (O'Meara & Faulkner, 2022).
- Development of PDMT graduates' self-efficacy beliefs and pedagogical practices that are similar to those of in-field teachers of mathematics (Goos et al., 2021; Goos & Guerin, 2022).

These evaluations lead to conclusions such as that “professional development opportunities, which place a strong emphasis on developing pedagogical content knowledge as well as content knowledge, for out-of-field teachers, such as the Professional Diploma in Mathematics for Teaching, can play a significant role in improving the self-efficacy and effectiveness of teachers of mathematics and can have a positive influence on teachers' ability and willingness to improve their teaching practices” (O'Meara & Faulkner, 2022, pp. 402-403).

5.2 United Kingdom

In the UK, it is a legal requirement to have Qualified Teacher Status (QTS) to teach in many schools and QTS is considered desirable in the majority of schools. Award of QTS usually follows completion of an initial teacher training (ITT) program, but it is not subject-specific. The ITT Core Content Framework (Department for Education, 2019) sets out broad minimum standards for supporting teacher trainee development in behaviour management, pedagogy, curriculum, assessment and professional behaviours. The Framework requires that teachers “Demonstrate good subject and curriculum knowledge”, without specifying the type, level or amount of tertiary level content.

The UK government has invested in several **government-funded courses** to upskill non-specialist secondary mathematics teachers. These include:

- 2021- [Specialist Knowledge for Teaching Mathematics](#) (Secondary Non-Specialist Teachers): The National Centre of Excellence in the Teaching of Mathematics (NCETM) is working through the NCETM-coordinated Maths Hubs Program to deliver a program that is free to participating schools. The [Maths Hubs Program](#) brings together mathematics education professionals in a collaborative national network of 40 hubs, each locally led by an outstanding school or college, to develop and spread excellent practice, for the benefit of all pupils and students. The program is aligned to the NCETM teaching for mastery pedagogy and is based on six key themes: structure of the number system; operating on number; multiplicative reasoning; sequences and graphs; statistics and probability; and geometry. Courses vary from 8 to 28 weeks long, and can also be undertaken by primary school teachers wishing to gain subject expertise (GOV.UK, 2021; NCETM, 2022).
- 2015-20 [Teacher Subject Specialism Training](#): A National College for Teaching and Leadership (NCTL) program to improve subject knowledge for non-specialist and returning-

teachers. The program was coordinated through approximately 100 Lead Schools that successfully bid for funding from the NCTL to provide free teacher subject specialism training (TSST) for teaching mathematics and physics (GOV.UK, 2021; Kidwell, 2015). In March 2022 the UK Prime Minister announced new plans to upskill 15,000 existing non-specialist teachers of mathematics and physics over the next five years.

- 2011-14 Subject Knowledge Enhancement (SKE): A 20-day course, delivered through universities, for serving or returning teachers. This course covered content and pedagogical knowledge in mathematics by including school-based activities and tasks, which included reflections and mentoring (Crisan & Rodd, 2014, 2017). This course replaced the Mathematics Development Program for Teachers described below.
- 2008-11 Mathematics Development Program for Teachers (MDPT): A 40-day course, delivered through universities, of which 30 days were based at the university and 10 days were based in school with specific pedagogical tasks to complete. Eight of these national courses were run by different institutions, which had the freedom to design their own curriculum. For example, in one course decisions about content were informed by evidence from Ofsted about areas of the school mathematics curriculum that were often poorly taught. Little information is available about number of participants, although Crisan and Rodd (2017) report on teaching four cohorts in their institution, each of around 20 teachers, across both the MDPT and SKE courses. MDPT course participants were offered a £5000 bursary and a mathematics specialist certificate on completion of the course (Crisan & Rodd, 2017).

None of these courses confers a formal university-accredited qualification. Evaluations of the courses are scant; those available include:

- Findings that “Retraining teachers can clearly be seen to affect teachers’ practices – but the extent and longevity of these developments depend on a multitude of factors, many beyond the control of an individual teacher” (Sani & Burghes, 2021, p. 2457).
- Analysis of how an OOF secondary mathematics teacher identity can be identified, and what constitutes a trajectory towards a mathematics teacher identity (Crisan & Rodd, 2017).

There are a range of other ways that UK teachers can upskill. A 2016 [guide to STEM continuing professional development opportunities for teachers](#) listed some of the professional bodies and subject associations that offer these types of opportunities (NCTL, 2016).

6. Implications for teacher development

This study has shown that there are a wide variety of upskilling options for Australian OOF secondary mathematics teachers, some of which are supported by state and territory funding initiatives. This array of initiatives, combined with differences in requirements between NSW and other states and territories, creates a complicated landscape. It may be difficult for teachers wishing to upskill to identify which courses best meet their needs.

For teacher registration and pathways, the [Australian National Summit on Teaching Out-of-Field](#) report identifies that: “There is a need for a cultural and systemic change in how qualifications are regarded as determining the suitability of teachers to teach a subject or year level” (Hobbs et al, 2022b, p. 34), and makes recommendations including:

- Develop and promote pathways, and associated guidelines, for in-service teachers to become ‘qualified’ in out-of-field subjects through both formal qualifications and concentration of professional development.
- State teacher registration or curriculum authorities develop a culture and process for endorsing postgraduate courses for upgrading teacher qualifications in teaching specialisations (Hobbs et al., 2022b, p. 47).

In comparison, Ireland and the UK provide national programs, although only in Ireland does this upskill OOF teachers to the same level as fully qualified graduates of ITE programs in secondary mathematics teaching. Such a national approach in Australia could enable a more strategic intervention. More consideration also needs to be given to the incentives and disincentives in current upskilling initiatives. For example, course duration, demands of studying tertiary mathematics, cost, and lack of formal certification as a “qualified teacher of mathematics” may discourage teacher participation; conversely, scholarships or government sponsorship together with formal certification may increase motivation to upskill. The promise of career advancement, although not explicitly promoted in current upskilling initiatives, might offer additional encouragement to upskill. (For example, in [NSW](#), a major in mathematics is required for teachers to be eligible for appointment as Head of a school’s Mathematics Department.) However, even the most highly incentivised initiatives in Australian jurisdictions fund relatively small numbers of OOF teachers to upgrade their qualifications. One option could be that ITE “better regulate who becomes a specialist teacher and what disciplinary exposure/education they need to have ... then teacher education providers might use these regulations for mapping pathways for teachers to become in-field in new subject areas” (Hobbs & Porsch, 2021, p. 608). Complementing such an approach, there is a need for a wide range of pathways offering stages towards full upgrading, designed to encourage OOF teachers to engage in some professional development as a first step towards enhancing their knowledge of both mathematics content and mathematics pedagogy.

About the authors

Michelle Barker (barkermd@outlook.com) is an experienced consultant with research and policy expertise in the higher education and vocational education and training sectors. Her clients have included the Australian Academy of Science, the European Commission, and the OECD.

Merrilyn Goos (mgoos@usc.edu.au) is a mathematics educator and Adjunct Professor of Education at the University of the Sunshine Coast. She was previously Professor of STEM Education at the University of Limerick and Course Director for the Professional Diploma in Mathematics for Teaching, Ireland’s national upskilling program for out-of-field teachers of mathematics.

Mary Coupland (mary.coupland@uts.edu.au) is an Associate Professor in the Faculty of Science at the University of Technology Sydney where she teaches first year mathematics. She contributes to mathematics curriculum development for NESA and is a former President of both the Mathematical Association of NSW (MANSW) and the Australian Association of Mathematics Teachers (AAMT) – professional associations for teachers of mathematics.

References

- AITSL. (2021). *Australian Teacher Workforce Data: National Teacher Workforce Characteristics Report*. <https://www.aitsl.edu.au/research/australian-teacher-workforce-data/atwdreports>
- AITSL. (2022). *Accreditation of initial teacher education programs in Australia: Standards and Procedures*. https://www.aitsl.edu.au/docs/default-source/national-policy-framework/accreditation-of-initial-teacher-education-programs-in-australia.pdf?sfvrsn=e87cff3c_48
- Crisan, C., & Rodd, M. (2014). Talking the talk ... But walking the walk? How do non-specialist mathematics teachers come to see themselves as mathematics teachers. In L. Hobbs & G. Törner, *Taking on International Perspective on ‘Out-of-Field’ Teaching: Proceedings and Agenda for Research and Action from the 1st Teaching Across Specialisations (TAS)*

- Collective Symposium* (pp. 25–26).
https://www.academia.edu/22317695/TAKING_AN_INTERNATIONAL_PERSPECTIVE_ON_OUT_OF_FIELD_TEACHING Proceedings and Agenda for Research and Action from the 1st Teaching Across Specialisations TAS Collective Symposium
- Crisan, C., & Rodd, M. (2017). Learning mathematics for teaching mathematics: Non-specialist teachers' mathematics teacher identity. *Mathematics Teacher Education and Development*, 19(2), 104–122. <https://files.eric.ed.gov/fulltext/EJ1160851.pdf>
- Department of Education Western Australia. (2021). *Department of Education Annual Report 2020–21*.
<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKewiW07brzeP5AhU11TgGHdhLDCAQFnoECA0QAQ&url=https%3A%2F%2Fwww.education.wa.edu.au%2Fdl%2Fmox8qxx&usg=AOvVaw2pPYVhjEnbYu-SYul8EV20>
- Department for Education, (2019). *ITT core content framework*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/974307/ITT_core_content_framework_.pdf
- Goos, M., & Guerin, A. (2022). Investigating the self-efficacy beliefs and classroom practices of out-of-field, in-field, and upskilled mathematics teachers. In L. Hobbs & R. Porsch (Eds.), *Out-of-field teaching across teaching disciplines and contexts* (pp. 311–332). Springer.
https://doi.org/10.1007/978-981-16-9328-1_15
- Goos, M., Ní Ríordáin, M., Faulkner, F., & Lane, C. (2021). Impact of a national professional development programme for out-of-field teachers of mathematics in Ireland. *Irish Educational Studies*, 42(3), 401–421. <https://doi.org/10.1080/03323315.2021.1964569>
- GOV.UK. (2021). *Teacher subject specialism training (TSST): Programme details*.
<https://www.gov.uk/guidance/teacher-subject-specialism-training-courses>
- Hobbs, L., Campbell, C., Delaney, S., Speldewinde, C., & Lai, J. (2022a). Defining teaching out-of-field: An imperative for research, policy and practice. In L. Hobbs & R. Porsch (Eds.), *Out-of-field teaching across teaching disciplines and contexts* (pp. 23–49). Springer.
https://doi.org/10.1007/978-981-16-9328-1_2
- Hobbs, L., Du Plessis, A., Oates, G., Caldis, S., McKnight, L., Vale, C., O'Connor, M., Rochette, E., Watt, H., Weldon, P., Richardson, P., & Bateup, C. (2022b). *Australian National Summit on Teaching Out-of-field: Synthesis and Recommendations for Policy, Practice and Research—Part A Report*. Deakin University. <https://oofas-collective.squarespace.com/s/TOOF-National-Summit-Report.doc>
- Hobbs, L., & Porsch, R. (2021). Teaching out-of-field: Challenges for teacher education. *European Journal of Teacher Education*, 44(5), 601–610.
<https://doi.org/10.1080/02619768.2021.1985280>
- Ingersoll, R. M. (2002). *Out-of-field teaching, educational inequality and the organization of schools: An exploratory analysis*. University of Washington, Center for the Study of Teaching and Policy.
https://repository.upenn.edu/cgi/viewcontent.cgi?article=1057&context=cpre_researchreports
- Kenny, J., & Hobbs, L. (2015). Researching with in-service teachers teaching “out of field”. *Contemporary Approaches to Research in Mathematics, Science, Health and Environmental Education* 2, 13. https://deakinsteeme.org/wp-content/uploads/2018/01/Kenny-CAR_2015-Tas-TOOF.pdf
- Kenny, J., Hobbs, L., & Whannell, R. (2020). Designing professional development for teachers teaching out-of-field. *Professional Development in Education*, 46(3), 500–515.
<https://doi.org/10.1080/19415257.2019.1613257>
- Kidwell, E. (2015, July 12). Teacher subject specialism training. *IMA*. <https://ima.org.uk/3134/teacher-subject-specialism-training/>
- Maconachie, D., McInnis, C., & Department of Education and Training. (2018). *Enhancing the training of mathematics and science teachers program: Evaluation of the program and projects 2013 to 2017: final report, September 2017*. <http://nla.gov.au/nla.obj-598640257>
- NCETM. (2022). *Specialist Knowledge for Teaching Mathematics (Secondary Non-specialist Teachers) Programme*. <https://www.ncetm.org.uk/maths-hubs-projects/specialist-knowledge-for-teaching-mathematics-secondary-non-specialists/>

- NCTL. (2016). *A guide to STEM continuing professional development (CPD) opportunities for teachers*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/537097/A_guide_to_STEM_CPD_opportunities_for_teachers.pdf
- NESA. (2018). *NSW Supplementary Documentation: Subject Content Knowledge Requirements*.
[https://educationstandards.nsw.edu.au/wps/wcm/connect/1bea4323-19a6-4af6-b657-95ae4cea954b/subject-content-knowledge-requirements-policy.pdf?MOD=AJPERES&CVID=546a77061b2a/subject-eligibility-guidelines.pdf?MOD=AJPERES&CVID=](https://educationstandards.nsw.edu.au/wps/wcm/connect/1bea4323-19a6-4af6-b657-95ae4cea954b/subject-content-knowledge-requirements-policy.pdf?MOD=AJPERES&CVID=546a77061b2a/subject-eligibility-guidelines.pdf?MOD=AJPERES&CVID=546a77061b2a/subject-eligibility-guidelines.pdf?MOD=AJPERES&CVID=)
- NESA. (2021). *Subject Eligibility Guidelines*.
<https://educationstandards.nsw.edu.au/wps/wcm/connect/808f6b61-f9c4-4bed-9dbc-546a77061b2a/subject-eligibility-guidelines.pdf?MOD=AJPERES&CVID=>
- NSW Government. (n.d.). *Subject requirements*. <https://education.nsw.gov.au/teach-nsw/enhance-your-career/teach-and-learn-scholarship-high-demand-subject-areas/subject-requirements#Mathematics0>
- O'Meara, N., & Faulkner, F. (2022). Professional development for out-of-field post-primary teachers of mathematics: An analysis of the impact of mathematics specific pedagogy training. *Irish Educational Studies*, 41(2), 389–408. <https://doi.org/10.1080/03323315.2021.1899026>
- Sani, N., & Burghes, D. (2021). Longitudinal study of 'retraining' non-maths specialist teachers to become capable, confident teachers of mathematics. *International Journal of Mathematical Education in Science and Technology*, 53(9), 2438–2464.
<https://doi.org/10.1080/0020739X.2021.1890248>
- Teaching Council. (2020a). *Céim: Standards for Initial Teacher Education*.
<https://www.teachingcouncil.ie/assets/uploads/2023/08/ceim-standards-for-initial-teacher-education.pdf>
- Teaching Council. (2020b). *Teaching Council Registration: Curricular Subject Requirements (Post-Primary)*. <https://www.teachingcouncil.ie/assets/uploads/2023/11/teaching-council-registration-curricular-subject-requirements-post-january-2023-1.pdf>
- Victoria State Government. (2021). *SMSI*. <https://fuse.education.vic.gov.au/Pages/smsi-2022-intake>
- Weldon, P. (2016). Out-of-field teaching in secondary schools. *Policy Insights*, Issue 6. Australian Council for Educational Research.
<https://research.acer.edu.au/cgi/viewcontent.cgi?article=1005&context=policyinsights>

Appendix

No	Course	University	Discipline content	Includes algebra and calculus?	Is maths content uni or high school level?	Content specific pedagogy	Practicum
1	Graduate Diploma of Mathematics	CSU	<p>Teaching Focused Students stream: Computer Aided Mathematics 1 Computer Aided Mathematics 2</p> <p>4 subjects from: MTH400 Introductory Mathematics MTH 403 Multivariable Calculus MTH 404 Ordinary Differential Equations MTH 405 Principles of Operations Research MTH 406 Complex Analysis MTH407 Mathematical Modelling MTH418 Topics in Calculus MTH419 Linear Algebra STA501 Scientific Data Analysis</p>	Algebra Calculus ¹³	University and school University	Curriculum Methods 1: Mathematics EMM442 Curriculum Methods 2: Mathematics could replace one of the two unspecified elective credits for eligible students	Professional Experience 2
2	Master of Mathematics for Secondary Education	UTS	<p>Mathematics for Secondary Education - Statistics Mathematics for Secondary Education - Foundations Algebra Calculus 1 Calculus 2 Calculus 3</p> <p>2 subjects from Electives (Mathematics and Education)</p>	Algebra Calculus	Foundations overlaps with school, others are University	Maths Methods for In-Service Teachers (Year 7-12)	Professional Experience for In-Service Teachers

¹³ The required courses include an introduction to algebra and calculus, and some more advanced algebra. Students can choose to undertake more advanced courses in both as electives.

3	Grad Dip in Mathematics for Secondary Education	UTS	Mathematics for Secondary Education – Statistics Mathematics for Secondary Education – Foundations Algebra Calculus 1 Calculus 2 Calculus 3	Algebra Calculus	University	Maths Methods for In-Service Teachers (Year 7-12).	Professional Experience for In-Service Teachers
4	Bachelor of Education (In-Service Conversion) (teaching area of mathematics)	UNE	Schedule A: 6 subjects from: Probability and Simulation Calculus and Linear Algebra 1 Calculus and Linear Algebra 2 Multivariable Calculus Linear Algebra Introduction to Topology Abstract Algebra Complex Analysis Number Theory Differential Equations Additional subjects (not necessarily mathematics focused)	Algebra Calculus	University	Junior Secondary Mathematics Education 7-10 Senior Secondary Mathematics Education 11-12	Professional Experience 4
5	Master of Education (specialisation in mathematics teaching)	University of Newcastle	Mathematics Teaching curriculum studies 1-6 1. Algebra, functions, continuity and an introduction to calculus 2. Number, arrangements, number distribution and combinatorics 3. Mathematical proof and topology 4. Measurement and trigonometry 5. Statistical methods of data analysis and probability leading to an appreciation of variability etc 6. Calculus and related applications including ODEs, multiple integrals, limits and continuity, analysis	Algebra Calculus	University and school, pedagogical aspects are included: e.g. "will examine current related pedagogical models within the field of secondary mathematics, including assessment policy and structure"	Advanced Studies in Education	Integrated fieldwork studies

6	Master of Mathematics Education	UND	Principles of Mathematics Linear Algebra Statistics Calculus Advanced Calculus Discrete Mathematics Research Methods Research Project Educational Leadership	Algebra Calculus	University (Principles of Mathematics has some school content)	Teaching Methods in Mathematics	Does not appear to be required. ¹⁴
7	Graduate Diploma of Mathematics Education	UND	Principles of Mathematics Calculus Linear Algebra Statistics Discrete Mathematics	Algebra Calculus	University (Principles of Mathematics has some school content)	Teaching Methods in Mathematics	Does not appear to be required. ¹⁵
8	Diploma of Secondary School Teaching (major in mathematics)	CQU	2 x Level 1 and 2 x Advanced Level units from the Mathematics Minor listed in the handbook for Bachelor of Education (Secondary) Level 1 units: Essentials of Applied Mathematics Essential Statistics Level 2 units: Calculus A Calculus B Linear Algebra and Vectors Advanced Applications of Mathematics		University	Middle Years Learning and Teaching Senior Years Learning and Teaching	Does not appear to be required.
9	Graduate Certificate of Secondary Mathematics	Deakin University	Knowledge for Teaching Mathematics 7-10: Number; Knowledge for Teaching Mathematics 7-10: Geometry and Measurement Knowledge for Teaching Mathematics 7-10: Statistics and Probability	Algebra	School	Embedded in discipline content courses	Does not appear to be required.

¹⁴ This information is taken from the [Program Plan](#). It should be noted that the [Program Summary](#) states that the course includes one Practicum Course or Advanced Calculus. However, no information on the Practicum Course is given in the [Program Summary](#) or the much more detailed [Program Plan](#).

¹⁵ This information is taken from the [Program Plan](#). It should be noted that the [Program Summary](#) states that the course includes one Practicum Course or Advanced Calculus. However, no information on the Practicum Course is given in the [Program Summary](#) or the much more detailed [Program Plan](#).

			Knowledge for Teaching Mathematics 7-10: Algebraic Thinking and Function Academic Integrity				
10	Graduate Certificate in Education (major in secondary mathematics for years 7-10)	Murdoch University	Mathematics for Years 7-10 Teachers: Number, Algebra and Geometry ; Mathematics for Years 7-10 Teachers: Number, Algebra and Geometry	Algebra	School	Learning: Multiple Perspectives, Secondary Curriculum	Does not appear to be required.
11	Master of Specialist Teaching (specialisation in numeracy)	Federation University	Sample structure: Science, Technology, Engineering and Mathematics in our World Mathematics Content and Pedagogy 1 Inclusion and Diversity in STEM Mathematics Content and Pedagogy 2 First Nations: Issues in Education Critical Communities of Learning, Inquiry and Leadership Professional Inquiry A Professional Inquiry B Analysis and Inquiry: Reading and Framing the Research Ways of Researching Minor Thesis (Part A) Minor Thesis (Part B)	Does not appear to be required.	School	Included in Mathematics Content and Pedagogy 1 and Mathematics Content and Pedagogy 2	Does not appear to be required.
12	Graduate Certificate in Specialist Teaching (Mathematics Education)	Federation University	Sample structure: Science, Technology, Engineering and Mathematics in our World Mathematics Content and Pedagogy 1 Inclusion and Diversity in STEM Mathematics Content and Pedagogy 2	Does not appear to be required.	School	Included in Mathematics Content and Pedagogy 1 and Mathematics Content and Pedagogy 2	Does not appear to be required.