Conceptualisation of an Undergraduate Primary Mathematics Specialisation

Heather McMaster
The University of Sydney

Jennifer Way
The University of Sydney

Janette Bobis
The University of Sydney

Received: December 2022 II Accepted: January 2024

Over the past decade, there has been unprecedented regulation of initial teacher education (ITE). The objective of this study was to generate an in-depth understanding of the structural challenges faced by tertiary educators as they responded to a federal policy and a related state government policy in teacher education. The policies imposed on ITE reach through tertiary education providers and into school classrooms. To capture the three spaces of (1) policy makers, (2) tertiary education providers and (3) teacher education graduates, this study adopts a *socio-spatial approach* as both a conceptual organiser and an analytical stance. One specific case is detailed, namely one metropolitan university's establishment of a pathway enabling pre-service primary teachers to specialise in mathematics teaching. The study then follows two graduates into their first two years of teaching. The findings generated are potentially transferable to other contexts. We conclude that to reap the benefits of ITE policies, tertiary education providers and all employers of teachers need common expectations for their role in implementing these policies. Also, support for graduates needs to be sustained through liaising between tertiary education providers and employers.

Keywords · mathematics teacher education · primary mathematics specialisation · government policy · socio-spatial approach · teacher employers

Introduction

Australian federal and state governments endeavouring to raise the achievement levels of school students, have focused strongly on improving the quality of teachers. Hence there has been scrutiny of initial teacher education (ITE). Despite numerous government inquiries into teacher education, Louden (2008) claimed at the time of his writing that these inquiries had little impact on regulation of Australian teacher education as they produced no "compelling evidence of differential effects of well- or poorly-organised programmes" (p. 357). More recently, such inquiries have resulted in policies containing regulatory requirements, for example, the recent national and state policies referred to in this article.

The purpose of this article is to illustrate the need for national and state policymakers to consider the alignment of their policies with each other and prepare for their implementation through extensive consultation with both ITE providers and teacher employers. This article provides an example of how a national ITE policy and a related ITE policy of the state of New South Wales (NSW) were responded to by one ITE provider. It details the challenges faced by this provider in re-structuring their ITE program and describes the expectations and experiences of two of their initial graduates. The example of ITE policy detailed in this paper, is the conceptualisation of a new form of graduate qualification: a generalist primary teaching degree with a specialisation in primary mathematics.

Background

The Meaning of a Primary School Specialisation in Australia

In this article, we define a teacher "with a primary mathematics specialisation" to be a teacher who has graduated from an ITE program, having elected to take a Mathematics Specialisation Pathway (MSP) with additional units in mathematics or mathematics pedagogy during the 4th-year of study, as shown in Figure 1 (see later in the Methodology and Findings section, p. 12). There is, however, a lack of underlying research supporting this conception, and consequently a proliferation of definitions of a primary mathematics specialist has emerged. In this section, our definition is compared with a range of previous and current definitions of specialisation roles in Australia and overseas.

Education in Australia is regulated by state and territory governments. The Australian Institute for Teaching and School Leadership (AITSL) assists states and territories to develop accreditation according to nationally agreed standards referred to as the Accreditation Standards and Procedures (AITSL, 2022), which were first published in 2011. In response to "the declining engagement and participation of students in mathematics and science, as well as the lack of confidence that teachers have in these areas" (AITSL 2017, p. 1), AITSL specified that by 2019, all ITE programs for primary school teachers must provide their graduates with a subject specialisation. AITSL's latest Accreditation Standards and Procedures identify mathematics, science and languages as focus areas for specialisation but recommend that the states and territories consider employer demand. Because of this level of flexibility, the ITE providers in different states and territories, implemented the specialisations differently (Main et al., 2023). In 2021, the most popular specialisation offered by the 33 Australian universities with ITE programs for primary school teachers, were Mathematics and English, each being offered by 22 universities (Main et al., 2023). The ITE specialisations across the states and territories, also required different numbers of units for students to graduate as specialists, some units being within their School of Education and some being outside of it.

Mills et al. (2020) use "disciplinary experts" as an umbrella term under which they classify specialists in primary schools as "specialist teachers" (those responsible for planning and delivering lessons in only one discipline), "instructional coaches" (those who work with teachers to improve their teaching practice) or "generalist teachers with a specialisation"; however, some overlap is acknowledged. Traditionally, primary school teachers in Australia have been generalist classroom teachers. When Ardzejewska et al. (2010) surveyed over 400 primary school principals in NSW in 2010, they found that although 73% of them explicitly endorsed the use of subject specialists and most had employed a subject specialist, none had employed a mathematics specialist. This was because they held the belief that "primary schooling should provide the foundation for English and Mathematics" (p. 209). At this time in NSW there was no conception of a generalist primary school teacher with a specialisation in Mathematics.

In the category of generalist teacher with a specialisation, Mills et al. (2020) include classroom teachers who may or may not have a formal role, and who may or may not have time away from teaching to fulfil that role. Two generalist teachers for example, may co-plan, co-teach and co-assess and decide between them to give the greater responsibility for a particular subject area to the teacher whom they believe has greater expertise in that area. Generalist teachers with a specialisation may have obtained their specialisation as an elective taken during their ITE program or as an in-service teacher having received professional learning in an area of specialisation.

A recent initiative of Victorian Government Schools involved in-service primary teacher training for a category of teacher they call a "learning specialist" (Victoria State Government, 2017). Using Mills et al.'s (2020) classification, a learning specialist in Victoria would be a generalist teacher with a specialisation. These teachers have a post-graduate qualification and occupy a somewhat different role within a school to that of a leading teacher. Unlike a leading teacher, a learning specialist continues to spend most of the time in the classroom (Victoria State Government, 2017). The primary role of a learning specialist is to "model excellence in teaching and learning through demonstration lessons, and

mentoring and coaching teachers in improving the skill, knowledge and effectiveness of the teaching workforce" (Victoria State Government, 2017, p. 50).

In their research, Downton et al. (2022) use the term "school mathematics leaders" to mean leaders within schools with "specific skills and expertise who work directly with teachers with a focus on student learning" (p. 196). Grootenboer et al. (2020, p. 1) and Roche et al. (2022, p. 741) refer to these teachers as "middle leaders". In addition, mathematics leaders who are also classroom teachers, have been called numeracy coordinators, primary mathematics specialist teachers (Driscoll, 2017), numeracy leaders and school mathematics leaders (Vale et al., 2023).

Our conception of a teacher with a primary mathematics specialisation, fits within Mills et al.'s (2020) category of generalist teachers with a specialisation. The New South Wales Educational Standards Authority (NESA) distinguishes primary graduate teachers with a mathematics specialisation (or a science and technology specialisation) from other graduates who have an AITSL specialisation by requiring them to have completed additional units of study in mathematics content knowledge and/or pedagogy in their ITE program (NESA, 2016). The NSW Department of Education (2023) recently listed as one of its initiatives, to "recruit specialist mathematics primary teachers to enhance mathematics teaching expertise in NSW" (p. 6). This initiative aims for teachers of mathematics to have "improved access to and participate in quality professional learning opportunities for teaching mathematics" (p. 6). In its 2016 policy framework, NESA specified the structure of ITE programs necessary for students to graduate with a recognised primary teaching specialisation. More recently, teachers in NSW have been being recognised as primary mathematics specialists through completion of an in-service professional learning program, such as that described by Lomas (2022).

Influencing Other Teachers

One outcome that NESA expects to achieve through recruiting primary mathematics specialist teachers, is primary teachers who feel more confident in teaching mathematics (NESA, 2020). This expectation assumes that primary mathematics specialist teachers will influence other teachers. There are various ways in which teachers influence other teachers, both formal and informal. Grootenboer at al. (2020) highlighted the middle leaders' role as working with their colleagues to generate a shared vision for mathematics teaching and learning, this being achieved through developing trusting relationships. Similarly, a survey by Sexton and Downton (2014) of primary mathematics leaders in Victoria, identified their role as developing shared understandings of mathematics teaching and planning practices. Also important was their influencing of teacher affect towards mathematics and facilitating teacher professional learning. This learning may come through having access to other teacher's classrooms, team teaching and mentoring or coaching.

In Victoria, Roche et al. (2022) surveyed 149 primary mathematics middle leaders who they viewed as being in a position to negotiate between the school leadership and the teachers. They found that while around 15% of these teachers focused on their capacity to lead, nearly half were more focussed upon their own teaching aspirations at the classroom level. It should be noted however, that 77% of participants had three or fewer years as a mathematics middle leader, over half of them had four or fewer hours per week allocated to their role, and many did not have a formal mathematics leadership role. Similarly, Sexton and Downton (2014), Driscoll (2017) and Downton et al. (2022) found the extent of mathematics leaders' work in a school was often restricted by the time they were allocated for their role. Another important factor was the level of support given by the school principal.

The first primary teacher graduates in NSW with a NESA accredited specialisation in Mathematics, completed their degree in 2017. Earlier that year, McMaster et al. (2018) interviewed six primary school principals across a range of school systems, school sizes and locations, concerning their views about employing primary teachers with a specialisation in mathematics. These principals had volunteered to be interviewed because of their interest in strengthening mathematics leadership at their school. When stating their expectations of the role a new graduate with a specialisation in mathematics might fulfil in their schools, it was apparent that they had "little or no knowledge of the requirements placed on ITE providers by the NSW Education Standards Authority regarding the preparation required by ITE

programs for the mathematics specialisation" (McMaster et al., 2018, p. 553). It was not until 2021 that the NSW Department of Education gathered information about primary mathematics specialists across the state's ITE providers, informed principals concerning recruitment of these graduates, and brought them together in a professional learning community (NSW Department of Education, 2021).

With support and a vision for their school's improvement, Roche et al. (2022) believed that primary mathematics specialists can become mediators and influencers beyond their school. In Canada, Robinson et al. (2021) stated that graduates of their 2-year postgraduate certificate in Elementary Mathematics Pedagogy (Grades K–8) articulated their growing capacity to teach mathematics, the roles they took on, and the contributions they were making as teacher leaders. The authors concluded that in future, these teachers would not only influence the teaching of mathematics in their own schools and regions, but also "influence more policy development and changes in curriculum and instruction" (p. 870).

The Impact of Primary School Specialisation on Student Learning

It has been argued that the strength of employing generalist primary teachers with responsibility across all learning areas, is that they develop the child's social and emotional needs alongside their academic needs (Bourke et al., 2020). Another argument is that generalist teachers are better able to integrate across subject areas (Pezaro, 2017) and have fewer classroom management difficulties (Liu, 2011). Opposing this, is the argument that many teachers lack the content knowledge and confidence to teach all subject areas, notably mathematics and science. Specialist teachers can better meet students' academic needs and seek targeted professional learning (Brobst & Markworth, 2019; Markworth et al., 2016). Given the importance governments are placing on STEM education (Department of Education, Skills and Employment [DESE], 2021), there is growing support for greater content knowledge and expertise in the teaching of science and mathematics in primary schools. However, the impact of mathematics specialists on student learning is a difficult area to research because of the many factors that influence it.

In their review of research in this area, Mills et al. (2020) found few articles providing evidence of a positive impact on student learning. The existing evidence was complex and somewhat contradictory. It mainly concerned the work of specialist teachers (those only responsible for teaching their specialist discipline) and instructional coaches. When comparing two large 3-year programs in the US state of Minnesota, one involving mathematics specialists and one involving instructional coaches, Curry (2017) found that the specialist program resulted in significantly higher mathematics test scores for fourth grade students. Campbell and Malkus (2013) provided evidence of growth in student learning when mathematics experts (both specialist teachers and instructional coaches) were placed in 15 US schools and students' results compared with results from similar schools. A significant difference in student achievement only happened when specialists were placed in a school for more than a year. They concluded that time is needed for mathematics specialists to gain the respect of other teachers and be seen as a supportive resource rather than someone placed in their school to "fix struggling teachers" (p. 203).

In summary, there is an absence of research evidence concerning the long-term impact on student learning when schools employ generalist primary school teachers with a specialisation in mathematics. As well as being a complex area of research owing to the many variables influencing student learning, an extended timeframe is needed to show an impact. The concept of a generalist primary teacher with a specialisation in mathematics is relatively new.

Supporting New Teachers

For specialist teachers, balancing the responsibilities of classroom teaching and subject expertise can be difficult, especially for early career teachers (Driscoll, 2017; Jorgensen, 2016). In their NSW policy framework for primary teaching specialisations, NESA (2016) mentions that the provision of specialisations *could be supported* by mentors, targeted professional experience placements, professional teacher associations, or other professional learning providers and educational researchers.

More recently, the Australian Government's report of their Quality Initial Teacher Education Review (Australian Government, 2022) listed as one of three key areas, that teachers be more supported as they move into the classroom. They recommended "developing an agreed set of national standards to set the bar for mentoring early career teachers" (Recommendation 16).

There is considerable research evidence of the importance of supporting first-year-out teachers and their continuing professional learning. For example, a study by Hudson (2012) investigating the needs of ten beginning teachers showed that, synonymous with similar studies internationally, beginning teachers required more support in the induction process. In addition, Hudson (2012) reported the need for greater consideration of beginning teachers' developing teaching practices. He recommended they be assigned mentors who can model the teaching practices they aspire to emulate and provide them with feedback as they endeavour to enact these practices in their own classroom.

According to Ambrosetti et al. (2013), the relational components of teaching are best addressed by a mentoring relationship, particularly if an extended period is available for this relationship to develop. In a graduate program focussing on mathematics teaching in primary schools, Myers et al. (2020) illustrated the value of sustained mentoring by a more knowledgeable other in a community of practice. Mentoring could begin with the professional experience placements of pre-service teachers as they complete a specialisation. Such experiences maximise a student's potential to transform mathematics teaching and learning in primary schools (Cavanagh & McMaster, 2017). Main et al. (2023), reporting on the perceptions of Western Australian graduates with specialisations, recommended that pre-service teachers receive more experience in the classroom, teaching in their area of specialisation. These placements would need to be structured in ways that involve mentors, fit within the course structure of the ITE program (Main et al., 2023) and ideally, provide mentoring to pre-service specialist teachers into their beginning year of teaching. Three years after the graduation of the first primary school teachers with a specialisation in mathematics, the NSW Department of Education began to offer primary mathematics specialist teachers additional professional learning opportunities in mathematics education and opportunities to network with each other and with their NSW Mathematics Strategy Professional Learning team (NSW Department of Education, 2020).

Conceptual Framework

A socio-spatial approach has been adopted in this study as both a conceptual organiser and an analytical stance (Cobb & McClain, 2006). The term "spatial" refers to "spaces" as social structures rather than physical or geographical spaces and suggests the existence of bounded, distinct contexts populated by different groups of people. Yet these social spaces influence and interact with each other with the implication that to understand what is happening in one space, consideration must be given to the other inter-related spaces. When applied to the field of teacher education, the *socio-spatial* approach captures the spaces of policy makers, tertiary educators and teacher education students, making is a logical framework to apply our investigation of the introduction of the Primary Mathematics Specialisation in ITE (Rowan et al., 2015). In an era of unprecedented regulation of teacher education and the imposition of policy driven reforms that reach through tertiary education and into school classrooms, it has become increasingly important for research to capture the complexity of teacher education and build an evidence base which feeds back to policy creation (Mayer, 2016; Sleeter, 2014). Drawing on the work of Rowan et. al. (2015) we have conceptualised three spaces—the *Conceived Space* of policy makers, the *Perceived Space* of teacher educators, and the *Lived Space* of pre-service teachers/graduates.

The Conceived Space of national and state policymakers is the domain of political and economic agendas that drive policies largely directed at the perceived need to increase standards and accountability in teacher education, which hereafter we refer to as Policy Space. The Perceived Space of tertiary educators in ITE institutions (mostly universities) involves the interpretation of policies and the development of curriculum and teaching practices, which we hereafter refer to as ITE Space.

> In both their teaching and research, teacher educators seek to reconcile established theories and contemporary research in the mathematics education field with the directives, constraints (and

> opportunities) imposed by the policies from the Conceived Space, while also attempting to address the needs of their cohorts of pre-service teachers. (Way et. al., 2020, p. 96)

The third space is the Lived Space of the students themselves, as both pre-service teachers experiencing the courses designed by the teacher educators and as new graduates moving into employment in schools. For the purposes of this paper, we refer to it as the Graduate Space.

The socio-tri-spatial approach has informed the research design for the study and shaped the research questions that focus our inquiry and analysis. As found by Rowan et al. (2015) in their studies of teacher education, such an approach was ideal because it helped rationalise why it was necessary to address all three spaces in one study. Namely, to provide a more comprehensive picture of how both institutional and regulatory body constrains could be met while presenting at least one possible way of developing a specialisation in primary mathematics course at the preservice level that could effectively achieve the goals envisioned by its mathematics educator creators. Further, there seems to be a research gap in that even though there is a government policy for mathematics specialists, and there is some literature about that role as enacted through in-service work, the responses from universities who are required to prepare those mathematics specialists for that work at the in-service and pre-service levels is yet to be fully theorised.

The research questions we sought to answer were:

- *What policy expectations guided the introduction of a primary mathematics specialisation for graduates in NSW?*
- *What challenges did an ITE provider face in meeting the requirements for accreditation of generalist primary teachers with a specialisation in mathematics, and how did they meet these challenges?*
- *How did recent graduates perceive and experience the role of a teacher with mathematics specialisation?*

Methodology and Findings

Our study is exploratory, with qualitative data having been collected from multiple sources as appropriate to each space—Policy, ITE, or Graduate. Due to the distinct context of each space, we present the investigation of each space with its own methods and findings before reflecting on the connections between the three.

Policy Space: Conceived Space of National and State Policy Makers

Each research question relates to a different space. The first question concerns the expectations guiding the national and state policies.

Policy Space: Methods

Data to address this research question were obtained through document analysis processes, with the purpose of establishing a knowledge base (Bowen, 2009) for the policy context underlying the other two research questions in this study. The process began with selecting policy documents pertaining to initial teacher education from the period 2013 to 2017, which covers the period in which the notion of a primary mathematics specialisation emerged (see Table 1). Reflecting the joint national/state responsibility of tertiary qualifications for teaching in Australia, all the selected documents in Table 1 originated from either the federal government or the state government, with the state of New South Wales (NSW) featured because of the location of the participants in the other components of this study.

Table 1
Policy Documents Selected for Analysis

Title	Source and level	Release date
Great Teaching, Inspired Learning: A Blueprint for Action	NSW Government	March 2013
Action Now: Classroom Ready Teachers.	Teacher Education Ministerial Advisory Group (TEMAG)	December 2014
Action Now: Classroom Ready Teachers: Australian Government Response	Australian Government	February 2015
Transforming STEM Education in Australian Primary Schools: Everybody's Business	Prinsley and Johnston, Office of the Chief Scientist	December 2015
National STEM School Education Strategy 2016–2026	Education Council Australian Government, Education Minister's Meeting	December 2015
Subject Content Knowledge Requirements for Primary Teaching Specialisation Policy	NSW Education Standards Authority (NESA)	2016
Learning to Teach Primary Mathematics	Board of Studies Teaching and Education Standards (now NSW Education Standards Authority [NESA])	2016
Accreditation of Initial Teacher Education Programs in Australia Guideline: Primary Specialisation	Australian Institute for Teaching and School Leadership (AITSL)	June 2017

Note: Documents of the NSW state government are shaded.

An hybrid approach (Fereday & Muir-Cochrane, 2006) of deductive, then inductive analysis, was utilised to first identify document segments judged to be relevant to the study, then to reveal themes that emerged from the extracts. The selection of extracts was focused by a search for statements expressing, a) policy intent, b) the nature of *primary specialisation* (particularly in mathematics) and the role of graduates with a specialisation in schools, and c) requirements for ITE providers. In the search for emerging themes, attention was given to the chronological order of document publication, and to commonalities and differences in the policy expectations across the documents. One researcher conducted the initial analysis and a second researcher cross-checked to confirm or question the selection of extracts and identification of commonalities and discrepancies.

Policy Space: Findings

The overarching context of education policy in the second decade of the 2000s is the governmental perception of the need to raise the achievement levels of school students by improving the quality of teachers, primarily through the improvement of undergraduate teacher education. The Teacher Education Ministerial Advisory Group called for reform of initial teacher education and made 38 recommendations, the majority of which called for greater regulation of ITE providers (TEMAG, 2014). For example, "Recommendation 3: The Australian Institute for Teaching and School Leadership be reconstituted to undertake a stronger role to ensure high standards of initial teacher education in Australia" (TEMAG, 2014, p. xiv).

The focus on the STEM subjects in education was partly driven by the national STEM agenda (Prinsley & Johnston, 2015) and reinforced by the National STEM School Education Strategy 2016-2026 (DESE, 2015). Whenever primary teachers are mentioned, policy documents consistently present a deficit view of their content knowledge and confidence in mathematics and science teaching. This view gives rise to the suggestion of recognised specialisation in undergraduate qualifications.

> The Advisory Group heard of the challenges primary teachers face in confidently delivering instruction across the diverse range of subject areas in the primary curriculum and noted strong support from

> stakeholders for primary teachers to have a specialisation, particularly in science, mathematics or languages. (TEMAG, 2014, p. 21)

The underlying assumption that new graduates with their "specialisation" will then "… complement the teachers they work with by sharing their expertise and skills" (Australian Government, 2015) is prevalent throughout the documents, though no supporting research evidence is cited. The actual meaning of such a specialisation was ill-defined and problematic throughout the development of policy.

The nature of primary specialisation. The novelty of a primary graduate with a recognised specialisation should be emphasised to highlight the significance of its introduction through new policy. Historically, ITE programs have had the option to offer students electives to expand their preparation in specific curriculum areas, but there had never been the opportunity to have a specialisation recognised as an employment qualification, nor had it ever been mandated in ITE course design. All primary teachers have been employed as generalist teachers, so there was no pre-existing understanding of what a primary specialisation means.

In 2013 the NSW Government forecast the possibility of recognising a specialist primary graduate that could teach mathematics or science in either primary or secondary schools through ITE providers developing "… primary teacher education course patterns that allow specialist elective strands …" (New South Wales Government, 2013, p. 8). Such a statement suggests a generalist qualification but potential for the graduate to be employed as a specialist teacher, potentially teaching only in that curriculum area.

The NSW vision appeared to be echoed in 2014, with the rationale given by the national Teacher Education Ministerial Advisory Group.

> The role of a primary teacher has traditionally been viewed as a generalist teaching role. Increasing curriculum demands and the capacity of teachers to develop strong content knowledge has led to suggestions that there is a need for specialist teachers in the primary setting. (TEMAG, 2014, p. 20).

However, Recommendation 18 in the same document calls for ITE providers to "… equip all primary pre-service teachers with at least one subject specialisation, prioritising science, mathematics or a language" (p. xv). Saying that generalist teachers do not have sufficient specialised knowledge, yet *all* future generalist primary teachers can be specialists lacks clear logic. The government's response to Recommendation 18 was to transform it into formal policy, "We will instruct AITSL to use course accreditation arrangements to require universities to make sure that every new primary teacher graduates with a subject specialisation" (Australian Government, 2015, p. 8). Accompanying the directive was the explanation of the expectations of the generalist with a specialisation:

> This does not mean primary teachers will teach only in their area of specialisation, but rather that their expertise will be available within the school to assist other teachers with the knowledge and expertise to teach the subject effectively. (Australian Government, 2015, p. 8)

During 2016, the NSW government and its Education Standards Authority (NESA, formerly BOSTES) forged ahead with its agenda to prioritise primary mathematics education standards by releasing *Learning to Teach Primary Mathematics* and the *Content Knowledge Specialisation Policy Framework* which introduced a more targeted strategy in addition to the anticipated national requirements. These documents linked the national STEM agenda to the state's education strategies and emphasised the significant contribution it expected from a more elite group of primary mathematics specialists, saying that:

> Over time and following their induction into teaching and gaining of Proficient Teacher accreditation such teachers will be well placed to become a source of significant support to strong mathematics teaching within their teaching faculties. (NESA, 2016, p. 22)

Interestingly, this statement was the only one located in all the documents analysed that acknowledged the need to support the novice teachers into their specialisation roles once employed.

Requirements for ITE providers. The 2016 NSW documents set out specific requirements for ITE course design that covered advanced development in curriculum knowledge and pedagogy, but also

indicated the importance of attending to the disposition of students and the "… careful selection of candidates prior to and at key points during the specialisation, focussing on both academic and personal attributes including enthusiasm for the learning area" (NESA, 2016, p. 2). As well as mandating the quantity of disciplinary study required by graduates, the state also highlighted the connections ITE providers needed to have with schools and the professional community to support the graduates' development:

> - targeted allocation of schools for professional experience, through formal arrangements between the provider and the school/employing authority, based on the school's prior-arranged supervision and mentoring by supportive, accomplished teachers in the subject areas; and
>
> - providing access to the support of professional teacher associations, other professional learning providers and educational researchers. (NESA, 2016, p. 2)

In 2017, the national authority, AITSL, released a Primary Specialisation Stimulus Paper to provide guidance for ITE providers, followed by the enactment of Program Standard 4.4:

> In addition to study in each of the learning areas of the primary school curriculum sufficient to equip teachers to teach across the years of primary schooling, programs provide all primary graduates with a subject specialisation through … clearly defined pathways into and/or within a program that lead to specialisations, that are in demand, with a focus on subject/curriculum areas. (AITSL, 2017, p. 1)

The policy posed a problem for ITE providers to grapple with: How can ALL graduates leave a course with "1. Expert content knowledge 2. Pedagogical content knowledge 3. Highly effective classroom teaching in their area of specialisation" (AITSL, 2017, p. 3), preferably in mathematics or science? Although the statement, "Standard 4.4 will result in graduates who are generalist primary teachers with a specialisation. It is important that these graduates are identified as distinct from specialist teachers who fulfil specialist roles ..." (AITSL, 2017, p. 2) makes it clear what a specialisation is NOT, it does not clarify what it actually IS and how it can be accomplished in an ITE course. The policy document gave some acknowledgement of the challenge with the statement:

> Primary specialisation represents a significant reform to the way that primary teachers are prepared. If the reform is to be fully realised, change to the structure and/or content of many initial teacher education programs may be required. (AITSL, 2017, p. 3)

NSW ITE providers faced the additional dilemma of how to meet the broad national requirements at the same time as providing the state with a select sub-group of graduates who meet the more exacting specifications for specialisation.

Policy Space: Summary

The concept of a primary teacher graduate who is a generalist teacher with a specialisation is an invention of recent government policy. While the roles of experienced teachers as specialised coaches or instructional leaders has been reasonably well-researched, the primary graduate with a specialisation is a new phenomenon without foundation in education research (Bourke et al., 2020). Further uncertainty arises from the differences in Australian Government policy and NSW Government policy. AITSL Program Standard 4.4 requires that *all* graduates must have a subject specialisation, which clashes with NESA policy that takes a more rigorous and selective approach to identifying a sub-group of specialisation graduates. This situation required NSW ITE providers to design courses within the tight constraints of program accreditation, that could meet both the AITSL and the NESA specifications for specialisation.

ITE Space: Perceived Space of Tertiary Educators

Our second research focus was the perceived space of tertiary educators in the ITE institution who were tasked with the interpretation of policies and the development of curriculum to address them. Data for this space were obtained by the first named author interviewing the third named author (Janette). The second and third named authors had been tasked with establishing a mathematics specialisation pathway (MSP) within the existing BEd (Primary) program at a metropolitan Australian university, in

accordance with the policies of the national and state governments. The interview question: "What challenges did you face in meeting the requirements for accreditation of generalist primary teachers with a specialisation in mathematics, and how did you meet these challenges?" intended to reveal potential challenges that other ITE providers might face and provide potential pathways to mitigate obstacles.

ITE Space: Methods

A decision was made to create a specialisation pathway that culminated in the final year of the BEd program because the educators "wanted an opportunity to identify and attract our most promising candidates from the previous three years of the program." It was felt that the student teachers could make more informed decisions about taking the specialisation by their final year of the programme. It also gave them "an opportunity to see how they performed academically in the core units and during their professional experience." The third named author (Janette) explained that she and her colleagues "didn't want students selecting the specialisation to simply gain an employment edge or to make up for any lack of confidence in mathematics …." Instead, they wanted those who were "already confident and had a passion for teaching and learning mathematics."

Our objective was to generate an in-depth understanding of the challenges faced by one ITE as it responded to this policy initiative and to develop an appreciation of the processes implemented that led to the design elements of a course intended to optimise the learning potential of graduates with a specialisation in mathematics. Case study research is particularly appropriate when there is a need to generate an in-depth understanding of a complex issue or unique phenomenon in its natural context (Yin, 2009). We sought to use this specific case to gain a broader appreciation of the challenges and generate findings that are potentially transferable to other contexts.

Data were collected from semi-structured interviews and documents that included historical briefing papers to state educational authorities and faculty-level committees. Data collected were mostly qualitative, but some documents contained statistical information relating to student teacher biographical data that required some quantitative analysis. Janette, who was a mathematics teacher educator, was instrumental in initiating, developing and delivering a mathematics specialisation pathway (MSP) for primary teachers at the University of Sydney. She was interviewed on two occasions by the first named author who was neither a full-time employee of the University during the MSP conception nor involved in its development. The first interview was conducted at the start of the data collection period and was intended to establish the specific context of this ITE institution within the boundary timeframe. The timeframe of interest commenced in 2013 when the MSP was first conceived and ended with information relating to its graduates as of 2020. Information regarding the ITE's rationale for establishing a MSP, pre-service teacher's backgrounds and the actions taken by the ITE provider to plan, implement and review the program was elicited during the first interview. A follow-up interview took place after initial document analysis to allow clarification and verification of document content. It also provided an opportunity for the interviewer to raise further questions that had emerged from the initial data analysis.

Analysis of documents used the same hybrid approach (Fereday & Muir-Cochrane, 2006) described for the interview. Namely, data were coded using a deductive, then inductive analysis procedure to first identify data segments judged to be relevant to answering the case study research question, then capture unexpected codes as they emerged. During theme identification, attention was given to the chronological order of documents and the events described by the tertiary educator. Therefore, findings from both data sources are presented wholistically and according to the resultant themes: ITE context and rationale, curriculum development and structural challenges, and overcoming other challenges. Most challenges faced by the mathematics educators were structural, such as meeting accreditation requirements, and arose during the actual development of the specialisation pathway. Structural challenges are therefore reported within the theme of curriculum development. Other challenges that related to attracting and retaining quality candidates for the MSP are reported separately.

ITE Space: Findings

ITE context and rationale for the MSP interview and ITE program documents reveal that the primary mathematics educators at the University of Sydney initiated development of a specialisation qualification in mathematics for generalist primary teacher education students in 2013. This was 18 months prior to recommendations made by the Teacher Education Ministerial Advisory Group [TEMAG] (2014). Their aim, expressed in a 2013 briefing paper prepared for the faculty's Teacher Advisory Board, was to enhance the quality of mathematics teaching in primary schools by increasing "the supply of generalist teachers with a specialisation in mathematics" (p. 1). The rationale for the MSP was stated as stemming from research findings, such as those by Claessens and Engel (2013), and policy documents (NSW Government, 2013) advocating the necessity for all students to have access to quality mathematics teaching to "ensure that all students have teachers from their earliest school years who can inspire their interest in mathematics and build their foundational knowledge and skills" (p. 2).

During interview, Janette explained that the University of Sydney was considered ideally placed for a MSP because its BEd. (Primary) program consistently attracted high-achieving candidates for preparation as generalist primary teachers with a relatively high proportion of candidates each year achieving an Australian Tertiary Admission Rank (ATAR) above 90.5% and demonstrating superior levels of competence, confidence and enjoyment in mathematics. Student data collected over successive years confirmed this perspective. For example, between 2014 and 2020 approximately 90% of all first-year candidates studied mathematics to the final two years of high school with 75% of those achieving the top two bands in their higher school certificate with a further 10% undertaking mathematics at post-secondary levels. Additionally, 30% to 55% of candidates each year indicated an interest in undertaking extra mathematics units of study as part of a specialisation track within their BEd program, citing their interest in mathematics education at the primary level for doing so. Due to the relatively strong content knowledge and positive dispositions towards mathematics of the candidates, Janette explained that a decision was made for the MSP to include a goal that focused on developing the mathematics leadership capabilities of these mathematically promising novice teachers.

Curriculum development and structural challenges. Despite having financial and in-principle faculty-level support for a MSP, Janette revealed that she and her colleagues also recognised the need for a more comprehensive strategy involving state accreditation authorities. Importantly, at that time, no national or state accreditation criteria for a MSP existed, and Janette was concerned that a MSP would quickly become redundant if accreditation authorities introduced specific criteria retrospectively that they had not anticipated in their planning. It was also considered that a MSP accredited by authorities would be more attractive for recruitment of potential candidates. To this end, a briefing paper was presented in April 2014 to the Honourable Adrian Piccoli, Minister for Education NSW, outlining a proposal for the development of a MSP. The document also requested that the minister authorise a task force with representation including mathematics educators from the University of Sydney and peak bodies involved in teacher employment and accreditation, to provide advice on how best to develop a MSP that satisfied both national and state-level accreditation requirements. Such a working party was established in early 2015 and was convened by BOSTES (now NESA). Janette was a member of the working party and recalled that:

> Nothing like a MSP for preservice teachers had been accredited by educational authorities in Australia before, so we were breaking new ground here ... We looked at relevant policy documents like TEMAG. We also consulted the major ITE providers and employment bodies to determine what were desirable outcomes but possible for us to achieve in each of our institutional contexts.

When the requirements for primary teaching specialisation were finalised by NESA in late 2015, Janette remembered her initial concern as to how her own institution would manage to embed 36 credit points of mathematics-related content into the existing BEd (Primary) programme. The program structure at the time included core mathematics education units of study totalling only 18 credit points. Fourteen additional credit points were gained with the inclusion of two elective final year units of study. Janette recollected that she and her colleagues had "some tough negotiation with our education colleagues

and had to do some innovative problem-solving" to create a sub-stream for the MSP students with a focus on mathematics education leadership within an existing mentoring unit of study (see Figure 1).

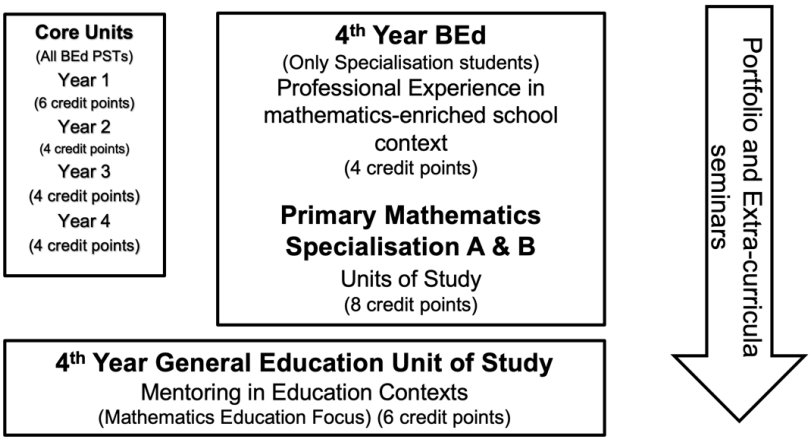

Figure 1. Initial structure of the MSP (36 credit points) accredited by NESA in 2016.

As shown in Figure 1, the final credit points were achieved with confirmation from NESA that mathematics-enriched contexts for professional experience also met criteria for accreditation. Schools for the final year professional experience are "carefully vetted" by the mathematics educators. "We select schools based on our experiences or on advice from colleagues, where we consider our MSP students are most likely to experience quality mathematics teaching and have opportunities to teach it themselves in a supportive context".

Non-structural challenges. Although the 36 credit-point structure of the MSP had been resolved, Janette identified further challenges – some of which had been anticipated during the planning phase and others that emerged as the first cohort of MSP candidates reached the final year of the Bachelor of Education program (BEd). An anticipated challenge was associated with staffing of the new units of study. With no possibility of faculty-level funding for additional staff with mathematics education expertise "we had to ensure that existing staff could cover the workload created by two new units." Coincidentally, a reduction in the number of students allowed into a parallel graduate primary education programme provided "enough slack in each of our workloads to allow us to cover the classes." Janette commented that this arrangement works "as long as we all contribute fairly equally to the teaching—an arrangement we still keep to this day."

Another challenge that was anticipated, was the need to inform preservice teachers as early as possible about the opportunity of undertaking the MSP and to keep this awareness visible even when undertaking semesters with no mathematics units of study. Coupled with this need was the challenge of attracting the most suitable preservice teachers to the MSP, namely, those with higher levels of mathematics content knowledge alongside a passion for teaching and willingness to possibly take on mathematics professional leadership roles in the future. As shown in Figure 1, an extra-curricular seminar series was established with the aim of creating a mathematics education network involving all interested BEd students and prominent researchers/leaders/practitioners from the broader mathematics and mathematics education community. Janette explained that:

> Even though we only meet four times a year, it's enough to build those connections ... We advertise the sessions through Facebook and an email list as well as through student portals. Now that we use zoom for seminars, we have some graduates attending who are living across the globe. It's great for our preservice teachers to hear about the possibilities of a mathematics education focused career. We also hear from prominent researchers—it keeps the motivation for maths bubbling along and keeps the MSP visible.

The most difficult challenges to address, are those that are out of the control-realm of the educators. Although Janette and her colleagues carefully select school sites for field experiences, there are still

many other components of the school sites that cannot be controlled. For instance, schools considered "desirable" in the past, could change drastically with the relocation of teaching staff from one year to the next. To help mitigate negative repercussions of uncontrollable aspects associated with professional experience, Janette and her colleagues act as university mentors to supervise as many MSP candidates as possible and keep in contact via email or zoom with those they do not personally supervise.

Connected with the field experience, are difficulties emerging when principals or supervising teachers working with pre-service teachers on placement are unfamiliar with the MSP and have unrealistic expectations of specialisation students. Disappointment with the fact that "3 to 4 years since mathematics specialisations have been accredited, and principals—let alone the general teaching community—still seem unfamiliar with the MSP," led Janette and her colleagues to issue a letter for principals hosting a MSP student teacher. The letter briefly introduces the MSP and establishes some expectations for these novice teachers. Janette expressed hope that with growing numbers of MSP graduates in the workforce, such a letter will not be needed in the future.

ITE Space: Summary

Importantly, a MSP that satisfied national and state accreditation criteria had not been accomplished before in the Australian education context. As a result, those charged with its development were confronted with multiple challenges, including, the development of a specialisation pathway that could be integrated into existing ITE course structures, satisfying mandatory requirements of state and national government education authorities for ITE (e.g., AITSL, 2017) while also addressing goals reflected in new policy documents (e.g., BOSTES, 2016), attracting sufficient prospective teachers with appropriate backgrounds in mathematics and, critically, retaining these participants within the program. Further challenges came to light when the first cohort of graduates attempted to shift from ITE (the Perceived Space) to the teaching workforce (the Lived Space).

Graduate Space: Lived Space of New Graduates

Our third research focus was to explore the perspectives of two of the first students who chose the MSP. Data were provided by graduates of the case-study university described in the previous section of this paper. The research question, "How do recent graduates perceive the role of a teacher with a mathematics specialisation?" focuses attention on the graduate conceptualisation and experience of what it means to be a specialist mathematics teacher in the infancy of this teaching role. For reporting purposes, pseudonyms are used to maintain participant anonymity.

Graduate Space: Methods

Two participants from the same cohort of students were involved in data collection at two time-points in 2018 and 2019/2020. These students both graduated with the mathematics specialisation and appointed to full-time positions in schools. Data were collected using semi-structured interviews conducted by one of the researchers.

In both interviews the teachers were asked the same set of six questions, which focused on the expectations the school had of them, the professional learning they had been afforded, their satisfaction in their progress as a teacher, enablers and inhibitors they had experienced, and their plans for the future. The analysis was broadly phenomenological in nature, involving reading and noting, listing statements of meaning and developing a structural description of how the phenomenon was experienced by each participant (Creswell, 1998). The resulting "stories" were crossed-checked with the original interview transcripts by a second researcher to confirm interpretations of meaning and the emphasis placed on particular experiences by the interviewee.

Graduate Space: Findings

The stories of the two participants are told separately, and each in two parts (end of first year of teaching, and end of second year of teaching). A brief summary draws together the key messages from each of the graduates.

Andrew's Story

Year 1. The principal and deputy at the primary school were the only staff members that knew Andrew had the specialisation and he felt that, as a new graduate, the other teachers had a low expectation of him. It wasn't until towards the end of the year, when a visiting tertiary educator revealed Andrew's qualification, that he experienced a shift in expectations of him. He felt somewhat dissatisfied with his progress as a teacher, saying:

> I think it's been a humbling year where I've realised that I don't know a lot…I have had to learn the basics, the fundamentals of running a classroom. (G1)
>
> I'm still learning a lot and still trying to figure out how to teach in ways that are, I guess you would say, current best-practice or evidence-based. (G1)

He had been inhibited by the school's focus on literacy and limited access to professional learning in mathematics but could see a shift beginning:

> I think it's really exciting that the school are starting to consider mathematics and teaching numeracy within the school because again, it gives me a platform from which I can share some things that I've learned…(G1)

He had plans for getting the school more engaged with the mathematics teachers' association and aspired to reach an executive position in 10 years.

Year 2. Andrew had not been pressured to be involved in mathematics and numeracy at the school level but had benefited from being a year "wiser" in the classroom, saying, "I've had a lot more headspace I think this year … to be able to focus on improving my practice as a teacher in maths particularly." However, he was still striving to move further away from traditional approaches, speaking of "a dissonance in mathematical philosophies or approaches in my head." He wanted to make greater use of inquiry-based methods but felt he needed someone to model a lesson for him. Andrew explained how seeing a demonstration of "number talks" allowed him to adopt that into his teaching practice. He was now leading the numeracy resources distribution in the school. He had plans for doing some targeted professional learning and moving to "… a larger, better-resourced school with teachers who share a common belief about the direction in which mathematics teaching should head." Andrew could see himself applying for a school executive position within five years because he would like to "lead other teachers."

Summary. In Andrew's story we see a beginning teacher whose confidence in his mathematics specialisation faltered as he grappled with the demands of his first year of teaching in a school environment that did not support his continued professional development in mathematics teaching. Two significant events appeared to reignite his desire to fulfil his goals for mathematics teaching—the staff's discovery of his specialisation and a shift in the school's curriculum focus on mathematics. His leadership aspirations strengthened as he identified strategies for his continued development.

Alice's Story

Year 1. Alice was targeted as a teacher for a new middle school (Years 5–8) which had not yet eventuated. She found herself teaching mathematics at the high school that was going to merge with primary schools to become the middle school. She had taught Years 7 and 8 and had also taught Years 11 and 12 (General Mathematics) at the nearby high school. Only the school executive knew she was primary-trained and that she had taken a mathematics specialisation. She felt she had progressed in her ability to engage children who had little interest in mathematics, and she had been made a "year advisor" for Year 7 students. She had not yet been able to share her pedagogy with teachers of Year 7 classes, saying, "Here with maths, it's more like sit down, textbook work, worksheets, whereas I try to get the kids to stand up, move around, explore and investigate." However, she was being noticed by her mentor teacher and the head-teacher of mathematics. She was supported to attend the annual mathematics conference and to go on a one-week study visit to Singapore with the Australian Association of Mathematics Teachers. Under current rules she cannot aspire to become a head teacher in secondary mathematics because she does not have a mathematics degree, so she was thinking about aiming for a leadership position in primary education.

Year 2. Other teachers were now aware of Alice's primary teaching background and recognised her skills in teaching Years 7 and 8, particularly in relation to inquiry-based learning. She was now expected to show leadership in inquiry-based learning. She had been asked to join committees, contribute to curriculum planning and make a presentation to the staff. Her roles had kept her too busy to allow time for her own professional learning. The new head mathematics teacher told her that she had "… a lot of potential that hasn't been unlocked at this school," and asked her to keep teaching senior classes. Alice had enjoyed the challenges and expected to have further leadership opportunities when they moved into the combined primary and secondary facilities.

Summary. Alice found herself in a "mathematics-rich" teaching and learning environment, and although she also experienced the struggles of the 1st-year-out teacher, her talents were recognised, and her continued development was supported. An important point to note is that Andrew and Alice found themselves in different careers. Alice was not in the role of a generalist primary school teacher with mathematics specialisation, but rather that of a secondary school mathematics teacher. Her strong background in mathematics enabled her to meet the challenges of teaching the secondary mathematics curriculum, while her primary education background began influencing the pedagogy in the lower-secondary classes.

Graduate Space: Summary

When the first cohort of primary teachers in NSW with a specialisation in mathematics entered the workforce, principals were unaware of the accreditation or what it meant (McMaster et al., 2018) and graduates, focussing on more immediate concerns such as classroom management, were loath to reveal their specialisation accreditation to other staff. The expectations placed on graduates, the support they received and the opportunities they were given, varied widely between schools. Three years later, the NSW Department of Education gave principals information about the benefits of recruiting these teachers and offered support for them and their mentors. To reap the benefits of this educational policy, support for graduates needs to be sustained through liaising among ITE providers and all employers of teachers.

Discussion and Conclusion

This article is a focussed study of one ITE provider's experiences in complying with both a national and a state education policy concerning the preparation of primary teachers with a specialisation in mathematics, and the experiences of two of the first graduates with an accredited specialisation in mathematics. Challenges arose due to a lack of alignment between the conceived space of national and state policy makers (the policy space), the perceived space of tertiary education (the ITE space) and the lived space of new graduates (the graduate space).

The national policy on mathematics and science specialisation was conceived to address "the declining engagement and participation of students in mathematics and science, as well as the lack of confidence that teachers have in these areas" (AITSL 2017, p. 1). The expectation of the NSW state policy was that a specialisation would "create groups of primary teachers who are recognised as having stronger discipline and pedagogical knowledge in particular learning areas and who are agents for enriched teaching practices in schools" (NESA, 2016, p. 1). Previously, researchers such as Sexton and Downton (2014), Jorgensen (2016) and Downton et al. (2022) examined the role of teachers working with their colleagues to generate a shared vision for mathematics teaching and learning. However, the role of a new graduate with a generalist primary school teaching degree and a specialisation in mathematics had not been researched prior to introduction of the national and state ITE policies detailed in this article.

In contrast to the national policy (AITSL, 2017), the NSW policy mandated specific subject requirements for ITE providers graduating generalist primary school teachers with a specialisation in mathematics. ITE providers in NSW were also mandated to provide undergraduates with targeted

professional experience in their area of specialisation, supervised by supportive teachers accomplished in teaching the subject (NESA, 2016, p. 2).

Before these policies existed, the tertiary educators at the University of Sydney were already considering offering ITE students a mathematics specialisation pathway. The policies were important to them because they would enable their graduates specialising in mathematics, to gain professional recognition by employers. In particular, the Department of Education would give them priority for permanent employment at graduation, having regard to equity consideration in deployment to schools. However, the tertiary educators at the university did not anticipate the degree of regulation imposed for accreditation of a MSP, and the challenges that would entail.

Accreditation of a MSP required some tough negotiations with colleagues to enable the required number of credit points in mathematics leadership and pedagogy, and the staffing of additional units of study. When NESA's policy was released, another challenge confronting tertiary educators was a lack of awareness of supervising teachers or prospective employers as to what could be expected of students having undertaken the mathematics specialisation pathway (McMaster et al., 2018). This challenge was largely outside their realm of influence, as was the requirement to find suitable supervising teachers for their specialisation students during their final professional experience placement. Pre-service teachers receiving more classroom experience teaching in their area of specialisation as recommended by Main et al. (2023), was challenging because employers of teachers did not inform the ITE provider when someone they knew to be a suitable supervising teacher, changed schools.

Early career teachers can have difficulty developing specialist subject expertise while simultaneously being inducted into teaching and learning to manage their own classroom (Driscoll, 2017; Jorgensen, 2016). Researchers such as Ambrosetti et al. (2013) and Myers et al. (2020) illustrate the value of new graduates having a sustained mentoring relationship. Our interviews with two new graduates within the first cohort, illustrate very different experiences. As a novice teacher, Andrew was not given the mentoring he needed to build his confidence in mathematics teaching while grappling with the demands of his first year of teaching. Alice on the other hand, received mentoring as a novice teacher as well as being recognised and supported as a teacher of mathematics. The delay in the NSW Department of Education offering continued professional learning in mathematics education for all new graduates with the mathematics specialisation, could have been avoided with better communication and consultation between people operating in these two spaces.

This article illustrates that to maximise the benefits that might accrue from a new educational policy (the Conceived Space), there needs to be acknowledgement of its impact and consideration as to how it might be addressed by ITE providers (the Perceived Space) and employers of ITE graduates in schools (the Lived Space). The latest review in ITE, *Next steps: Report of the Quality Initial Teacher* (Australian Government, 2022), takes a broader perspective than the policies described in this article. It includes a consideration of student entry requirements into ITE programs and mentoring requirements for early years teachers in schools. For policies and reviews of ITE programs to be effective, alignment with the other two spaces and interactions among the three spaces, need to be considered.

Ethics Declarations

Ethical approval

Ethical approval for the research was granted by the University of Sydney and informed consent was given by all participants for their data to be published.

Competing interests

The authors declare there are no competing interests.

Corresponding author

Heather McMaster
Education Building
The University of Sydney
Camperdown, NSW
Australia 2050
heather.mcmaster@sydney.edu.au

References

Ambrosetti, A., Knight, B. A., & Dekkers, J. (2013). A new vision of mentoring in teacher education. In E. Lynch & T. Yeigh (Eds.), *Teacher education in Australia: Investigations into programming, practicum and partnership* (pp. 77–93). Oxford Global Press.

Ardzejewska, K., McMaugh, A., & Coutts, P. (2010). Delivering the primary curriculum: The use of subject specialist and generalist teachers in NSW. *Issues in Educational Research, 20*(3), 203–219.

Australian Government. (2015). *Action now: Classroom ready teachers: Australian Government response.* https://www.aitsl.edu.au/tools-resources/resource/action-now-classroom-ready-teachers-australian-government-response

Australian Government. (2022). *Next steps: Report of the quality initial teacher education review.* https://www.education.gov.au/quality-initial-teacher-education-review/resources/next-steps-report-quality-initial-teacher-education-review

Australian Institute for Teaching and School Leadership. (2017). *Accreditation of initial teacher education programs in Australia guideline: Primary specialisation*. https://www.aitsl.edu.au/docs/default-source/default-document-library/guideline-primary-specialisation.pdf?sfvrsn=1ffec3c_0

Australian Institute for Teaching and School Leadership. (2022). *Accreditation of initial teacher education programs in Australia: Standards and Procedures* (First published 2011. Revised 2015, 2018, & 2019). https://www.aitsl.edu.au/tools-resources/resource/accreditation-of-initial-teacher-education-programs-in-australia---standards-and-procedures

Board of Studies Teaching and Education Standards. (2016). *Learning to teach primary mathematics.* https://educationstandards.nsw.edu.au/wps/wcm/connect/6c7653df-1710-4028-bbd9-bc4c967113dc/Learning-Teach%E2%80%93Primary%E2%80%93Mathematics.pdf?MOD=AJPERES&CVID=

Bourke, T., Mills, R., & Siostrom, E. (2020). Origins of primary specialisation in Australian education policy: What's the problem represented to be? *The Australian Educational Researcher*, *47*, 725–740. https://doi.org/10.1007/s13384-019-00370-y

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Brobst, J. A., & Markworth, K. A. (2019). Elementary content specialization: Perspectives on perils and promise. *School Science and Mathematics, 119*(7), 369–381.

Campbell, P., & Malkus, N. (2013). Elementary mathematics specialists: Influencing student achievement. *Teaching Children Mathematics, 20*(3), 198–205.

Cavanagh, M., & McMaster, H. (2017). A specialist professional experience learning community for primary pre-service teachers focused on mathematical problem solving. *Mathematics Teacher Education and Development*, *19*(1), 47–65.

Claessens, A., & Engel, M. (2013). How important is where you start? Early mathematics knowledge and later school success. *Teachers College Record, 115*(6), 1–29. https://doi.org/10.1177/016146811311500603

Cobb, P., & McClain, K. (2006). The collective mediation of a high-stakes accountability program: Communities and networks of practice. *Mind, Culture, and Activity, 13*(2), 80–100.

Creswell, J. (1998). *Qualitative inquiry and research design.* SAGE Publications.

Curry, T. (2017). *A comparative study of elementary mathematics specialists and mathematics coaches on fourth grade students' mathematics achievement.* [Doctoral dissertation, Walden University].

Department of Education, Skills and Employment. (2015). *National STEM school education strategy*. https://www.education.gov.au/education-ministers-meeting/resources/national-stem-school-education-strategy

Department of Education, Skills and Employment. (2021). *STEM education initiatives synthesis report*. https://www.dese.gov.au/education-ministers-meeting/resources/stem-education-initiatives-synthesis-report

Downton, A., Cheeseman, J., & Roche, A. (2022). Goals and challenges of school mathematics leaders. *Mathematics Teacher Education and Development 24*(1), 96–115.

Driscoll, K. (2017). Primary school mathematics leaders' views of their mathematics leadership role. In A. Downton, S. Livy, & J. Hall (Eds.), *40 years on: We are still learning!* Proceedings of the 40th Annual Conference of the Mathematics Education Research Group of Australasia, Melbourne (pp. 213–220). MERGA.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods, 5*(1), 80–92.

Grootenboer, P., Edwards-Groves, C., & Rönnerman, K. (2020). *Middle leadership in schools: A practical guide for leading learning*. Routledge.

Hudson, P. (2012). How can schools support beginning teachers? A call for timely induction and mentoring for effective teaching. *Australian Journal of Teacher Education 37*(7), Article 6. https://ro.ecu.edu.au/ajte/vol37/iss7/6

Jorgensen, R. (2016). Middle leadership: A key role in numeracy reform. *Australian Primary Mathematics Classroom, 21*(3), 32–37.

Liu, F. (2011). Pre-service teachers' perceptions of departmentalization of elementary schools. *International Journal of Whole Schooling, 7*(1), 40–52.

Lomas, L. (2022). Preparing job-embedded primary mathematics specialists to lead in Australian schools. In N. Fitzallen, C. Murphy, V. Hatisaru & N. Maher (Eds.), *Mathematical confluences and journeys*. Proceedings of the 44th Annual Conference of the Mathematics Education Research Group of Australasia, Launceston (pp. 346–353). MERGA.

Louden, W. (2008). 101 Damnations: the persistence of criticism and the absence of evidence about teacher education in Australia, *Teachers and Teaching: Theory and Practice, 14*(4), 357–368. https://doi.org/10.1080/13540600802037777

Main, S., Byrne, M., Scott, J., Sullivan, K., Paoline, A., Slater, E., & Boron, J. (2023). Primary specialisations in Australia: Graduate perceptions of outcome and impact. *The Australian Educational Researcher*, *50*, 371–390. https://doi.org/10.1007/s13384-021-00496-y

Markworth, K. A., Brobst, J., Ohana, C., & Parker, R. (2016). Elementary content specialization: Models, affordances, and constraints. *International Journal of STEM Education, 3*(1), 1–19.

Mayer, D. (2016). Policy driven reforms and the role of teacher educators in professionalising teacher education. In B. De Wever, R. Vanderlinde, M. Tuytens, & A. Aelterman (Eds.), *Professional learning in education: Challenges for teacher educators, teachers and student teachers* (pp. 23–37). Academia Press.

McMaster, H., Way, J., Bobis, J. & Beswick, K. (2018). Principals' perceptions and expectations of primary teachers with a specialisation in Mathematics. In J. Hunter, P. Perger & L. Darragh, (Eds.), *Making waves, opening spaces,* Proceedings of the 28th Annual Conference of the Mathematics Education Research Group of Australasia, Auckland (pp. 551–558). MERGA. https://merga.net.au/common/Uploaded%20files/Annual%20Conference%20Proceedings/2018%20Annual%20Conference%20Proceedings/McMaster.pdf

Mills, R., Bourke, T., & Siostrom, E. (2020). Complexity and contradiction: Disciplinary expert teachers in primary science and mathematics education. *Teaching and Teacher Education*, *89*, Article 103010. https://doi.org/10.1016/j.tate.2019.103010

Myers, K., Auslander S., Smith, S., & Smith, M. (2020). prospective elementary mathematics specialists' developing instructional practices: Support and mentorship during an authentic residency. *Journal of Mathematics Teacher Education, 24,* 309–330. https://doi.org/10.1007/s10857-020-09460-6

New South Wales Department of Education. (2021). *Primary mathematics specialisations in initial teacher education.* https://education.nsw.gov.au/about-us/educational-data/cese/publications/cese-evaluations/primary-mathematics-specialisations-in-initial-teacher-education

New South Wales Department of Education. (2023). *NSW mathematics strategy 2025.* March 2023 update. https://education.nsw.gov.au/content/dam/main-education/about-us/strategies-and-reports/nsw-mathematics-strategy/NSW-mathematics-strategy.pdf

New South Wales Education Standards Authority. (2016). *Subject content knowledge requirements for primary teaching specialisation policy.* https://www.educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/resources/policies-procedures/subject-content-knowledge-requirements-for-primary-teaching-specialisations-policy

New South Wales Government. (2013). *Great teaching inspired learning: A blueprint for action*. https://educationstandards.nsw.edu.au/wps/wcm/connect/b3826a4c-7bcf-4ad1-a6c9-d7f24285b5e3/GTIL+A+Blueprint+for+Action.pdf?MOD=AJPERES&CVID=

Pezaro C. (2017, February 13). Specialist science and maths teachers in primary schools are not the solution. *Australian Association for Research in Education Blog.* https://www.aare.edu.au/blog/?p=2012

Prinsley, R., & Johnston, E. (2015). *Transforming STEM education in Australian primary schools: Everybody's business.* Australian Government, Office of the Chief Scientist. https://www.chiefscientist.gov.au/sites/default/files/Transforming-STEM-teaching_FINAL.pdf

Robinson, E., Bordon, L., & Carter, E. (2021). Building teacher capacity and leadership in elementary mathematics classrooms in Nova Scotia: Review of the Certificate in Elementary Mathematics Pedagogy. *Canadian Journal of Science, Mathematics and Technology Education*, *21*, 856–874. https://doi.org/10.1007/s42330-021-00183-1

Roche, A., Russo, J., Kalogeropoulos, P. & Vale, C. (2022). Aspirations for mathematics learning: the voice of primary mathematics middle leaders. *Mathematics Education Research Journal. 34,* (4), 741–765. https://doi.org/10.1007/s13394-020-00360-9

Rowan, L., Mayer, D., Kline, J., Kostogriz, A., & Walker-Gibbs, B. (2015). Investigating the effectiveness of teacher education for early career teachers in diverse settings: The longitudinal research we have to have. *Australian Education Researcher, 42*, 273–298. https://doi.org/10.1007/s13384-014-0163-y

Sexton, M., & Downton, A. (2014). School mathematics leaders' perceptions of successes and challenges of their leadership role within a mathematics improvement project. In J. Anderson, M. Cavanagh & A. Prescott (Eds.), *Curriculum in focus: Research guided practice.* Proceedings of the 37th Annual Conference of the Mathematics Education Research Group of Australasia, Sydney (pp. 581–588). MERGA.

Sleeter, C. (2014). Toward teacher education research that informs policy. *Educational Researcher*, *43*(3), 146–153. https://doi.org/10.3102/0013189X14528752

Teacher Education Ministerial Advisory Group. (2014). *Action now: Classroom ready teachers.* https://www.aitsl.edu.au/tools-resources/resource/action-now-classroom-ready-teachers

Vale, C., Roche, A., Cheeseman, J., Gervasoni, A., Livy, S. & Downton, A. (2023). The practices of middle leaders of mathematics: alignment of their goals and activities. *School Leadership & Management*, *43*(3), 238–260. https://doi.org/10.1080/13632434.2023.2179982

Victoria State Government. (2017). *Victorian Government schools agreement 2017.* https://www.education.vic.gov.au/hrweb/Documents/VGSA-2017.pdf

Way, J., Attard, C., Anderson, J., Bobis, J., McMaster, H., Cartwright, K. (2020). Research in mathematics education in Australasia 2016–2019. Springer. https://doi.org/10.1007/978-981-15-4269-5

Yin, R. (2009). *Case study research: Design and methods*. SAGE Publications.