Initial Teacher Education and Out-of-Field Teaching: Problem or Solution?

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Out-of-field teaching remains a persistent challenge in mathematics education. Initial Teacher Education (ITE) is often positioned as part of this problem because of perceived gaps in disciplinary preparation, yet it is also a key site for developing teacher capability. Using policy analysis and interview data, this paper explores how ITE is positioned with respect to accreditation constraints on program design and the limited differentiation between preparation for junior and senior secondary mathematics teaching. The analysis suggests that ITE operates simultaneously as both a constraint and an opportunity within the broader system shaping mathematics teacher supply and preparation.

Teacher shortages across many education systems have contributed to a growing reliance on out-of-field (OOF) teaching, where teachers are assigned to teach subjects for which they lack formal qualifications or disciplinary preparation (Hobbs, 2013; Ingersoll, 2002). In mathematics education, the implications of this practice are especially significant. Effective mathematics teaching requires specialised disciplinary knowledge alongside pedagogical content knowledge that supports students' conceptual understanding and teachers' capacity to interpret student thinking (Ball et al., 2008). When teachers are required to teach mathematics outside their area of expertise, this can affect their professional confidence, identity, and instructional decision-making (Du Plessis et al., 2015).

Recent work has increasingly moved beyond framing OOF teaching solely as a deficit in teacher preparation. Instead, it is understood as a systemic issue shaped by teacher supply, workforce distribution, school staffing practices, policy environments, and available pathways for professional learning and re-specialisation (Hobbs & Porsch, 2021; Ross & Hobbs, 2024). Within this broader landscape, ITE occupies a complex position. Universities are expected to prepare graduates with strong disciplinary expertise and pedagogical capability, yet teacher education programs operate within accreditation frameworks and institutional constraints that shape what can be included in that preparation. ITE is therefore often discussed in two contrasting ways. On the one hand, it may be viewed as part of the problem when graduates

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are perceived as insufficiently prepared to teach mathematics (Campbell et al., 2019) or when teacher shortages persist despite the provision of teacher education (Dawborn-Gundlach, 2025). On the other hand, ITE remains one of the most important formal sites for developing the knowledge, identity, and professional capability required for effective mathematics teaching. This dual positioning raises an important question: *To what extent is ITE part of the mathematics out-of-field teaching problem, part of the solution, or both?*

This paper addresses that question, focusing on two interrelated issues identified in the analysis. Drawing on literature and illustrative interview data from mathematics-connected teacher educators (ITE providers), the paper examines how these issues shape ITE's capacity to respond to the realities of mathematics teacher supply and preparation.

Literature Review

Out-of-Field Teaching in Mathematics Education

Out-of-field teaching has been widely documented as a persistent feature of education systems in many countries, particularly in shortage areas such as mathematics and science (Goos et al., 2023; Ingersoll, 2002; Weldon, 2016). In Australia, workforce analyses suggest that a substantial proportion of teachers teaching mathematics – up to 40% – do not hold specialist qualifications in the subject (AITSL, 2021). The scale of the issue has become more visible in recent years as teacher shortages have intensified and schools have increasingly relied on pragmatic staffing responses (Ross & Hobbs, 2024).

Hobbs (2013) conceptualises OOF teaching as a boundary-crossing event in which teachers move beyond their disciplinary expertise and must renegotiate their professional identities. Teachers assigned to teach outside their field frequently report increased workload, reduced confidence, and challenges in developing subject-specific pedagogical strategies (Du Plessis et al., 2015). These challenges can be particularly pronounced in mathematics, where effective teaching requires specialised disciplinary knowledge and pedagogical content knowledge that supports students' conceptual understanding (Ball et al., 2008).

At the same time, OOF teaching should not be interpreted solely as a deficit in teacher capability. Rather, it reflects broader structural conditions within education systems, including teacher shortages, workforce distribution, and school organisational practices (Hobbs, 2020; Weldon, 2016). Recent project work has reinforced this wider view by examining how OOF mathematics teaching is shaped through workplace practices, policies, and professional education cultures (Ross et al., 2024). This broader framing is important because it shifts attention away from the simplistic assumption that ITE alone can solve the problem. For example, modelling undertaken by Prince and O'Connor (2018) estimated that to achieve the goal of reducing OOF teaching of mathematics to 10% in the next ten years, it would be necessary to recruit new graduates at 120% of the teacher retirement rate per year. It seems unfeasible for ITE to provide such a "solution".

Initial Teacher Education and Teacher Preparation

Initial Teacher Education (ITE) plays a central role in preparing teachers for professional practice. Traditionally, ITE programs aim to develop disciplinary knowledge, pedagogical knowledge, and practical teaching capability through university coursework and school-based experiences (Campbell et al., 2019; Hobbs & Porsch, 2021). In mathematics education, strong disciplinary preparation has been widely recognised as essential for effective teaching, particularly in supporting conceptual understanding, anticipating misconceptions, and making informed pedagogical decisions (Ball et al., 2008). In Australia, accreditation of ITE programs is governed by the Program Standards of the Australian Institute for Teaching and School Leadership (AITSL, 2025). The program standards set out mandatory content requirements for discipline studies (providing content knowledge, CK) and discipline-specific curriculum and pedagogical studies (providing pedagogical content knowledge, PCK). For undergraduate programs, discipline studies must comprise *“at least a major study in one teaching area and preferably a second teaching area, which must comprise at least a minor study”* (AITSL, 2025, p.23). Graduate entry ITE programs require entrants to have completed equivalent discipline studies in a prior degree. Undergraduate and graduate entry programs require the same amount of discipline-specific curriculum and pedagogical studies, although slight variations exist between first/second teaching areas and undergraduate/graduate entry programs. However, the AITSL Program Standards do not differentiate the preparation required for teaching junior versus senior secondary mathematics, which adds to the complexity of the relationship between ITE and OOF teaching.

Campbell et al. (2019) argue that teacher education programs must prepare teachers not only for teaching within their disciplinary specialisation but also for the possibility of teaching outside it. This perspective reflects the reality that teachers’ professional trajectories do not always align neatly with the subject boundaries established during initial preparation. Hobbs and Porsch (2021) similarly note that OOF teaching presents specific challenges for teacher education, requiring more explicit attention to how teacher preparation connects with later professional contexts.

These studies collectively suggest that expectations placed on ITE programs may exceed what they can realistically achieve. Teacher education programs operate within accreditation requirements, program duration limits, and curriculum coverage demands across multiple learning areas. Moreover, subject allocation decisions are typically made within schools rather than universities. As a result, even graduates with strong disciplinary preparation may find themselves teaching outside their area of expertise because of workforce pressures or school staffing needs. These tensions highlight the importance of understanding ITE not as an isolated solution, but as one element within a broader network of policy, institutional practice, and professional learning (Prince & O’Connor, 2018; Weldon, 2016).

An Ecological Perspective on Teacher Preparation

To understand how ITE relates to OOF teaching, it is useful to consider teacher preparation within a broader system of influences. Bronfenbrenner’s ecological systems theory (1994) provides a framework for examining how individuals’ experiences are shaped by interactions among immediate environments (the microsystem), institutional relationships (the mesosystem), policy structures and other external settings that indirectly affect the individual (the exosystem), and broader cultural values (the macrosystem) (Bronfenbrenner, 1994). Within such a framework, teachers operate in interconnected systems that influence both their professional development and the conditions under which they work. This perspective is useful for OOF teaching because it helps explain why teacher preparation cannot be separated from the broader structures that shape teacher assignment and development. University programs, accreditation frameworks, school staffing practices, and professional learning opportunities all play a role in shaping who enters mathematics teaching, how they are prepared, and what kinds of support remain available when they encounter OOF contexts. Understanding the positioning of ITE within this wider system is therefore essential for developing more coherent responses to the challenges associated with OOF teaching.

Methodology

This paper forms part of a broader investigation into the system of professional education surrounding OOF teaching. The analysis in this paper focuses on mathematics and draws on two sources of data: a review of policy documents and literature on OOF teaching and mathematics teacher preparation, and illustrative interview data from participants connected with mathematics teacher education.

Policy Review and Analysis

Phase 1 of our project involved a policy review and analysis. To this end, the whole research team collected documents from teacher professional associations, teacher registration bodies, government departments and agencies, unions, and other learned societies (110 documents in total). The mathematics teacher educators in the research team (i.e., the underlined authors of this paper) analysed all documents related to mathematics education. The documents were read iteratively and examined for statements that directly or indirectly referred to OOF teachers or teaching, to identify recurring themes.

Following individual analyses, the mathematics group met to discuss emerging themes and compare interpretations. We checked the reliability of our analysis and drew on our professional capital (Hargreaves & Fullan, 2012; Oates et al., 2021) to discern the meaning and implications of the findings (see Ross et al., 2025). Emerging themes were examined through the lens of ecological systems theory to assess their degree of influence on the broader ecosystem of support for OOF teachers. In positioning the themes, two issues emerged as particularly significant for mathematics teacher preparation: accreditation constraints affecting program design and the differentiation of preparation for different levels of secondary mathematics teaching.

Interview Data

Phase 2 of the broader project involved interviews with 37 stakeholders, including teacher educators, professional association representatives, and policy actors. In this paper, however, the interview data are not treated as a standalone dataset for analysis. Instead, anonymised statements are selected which address the two key issues identified in the documentary analysis. Because of our focus on ITE, these excerpts are drawn from three mathematics teacher educators and used illustratively, woven through the findings. Their words bring to life and exemplify the themes derived from the documentary analysis, highlighting how they are experienced, interpreted, and negotiated by participants, and illuminating the opportunities, tensions, and challenges embedded in ITE for mathematics. As such, the interview material is presented to illustrate broader patterns rather than as independent evidence for claims.

Findings and Discussion

The analysis highlighted two closely related issues shaping the role of ITE in responses to OOF mathematics teaching (see Table 1).

Table 1

Summary of key issues in positioning ITE as a problem and a solution

Issue	Problem	Potential solution
Accreditation constraints and program responsiveness	Rigid accreditation and registration requirements can restrict flexible responses to workforce needs and limit timely program adjustment.	More responsive program design and clearer pathways may strengthen mathematics teacher preparation while maintaining professional standards.
Differentiating preparation for junior and senior mathematics teaching	A single mathematics preparation threshold may obscure different content and pedagogical demands across junior and senior secondary school mathematics.	More differentiated preparation pathways could better align teacher education with the specific demands of junior and senior mathematics teaching contexts.

The first issue concerns how accreditation and program structures can constrain responsiveness in teacher education, while the second relates to the limited differentiation between preparation for junior and senior secondary mathematics teaching. Operating between the meso- and exo- levels of the system, these issues highlight how institutional arrangements and broader policy settings interact to shape practice in ITE. Together, they illustrate how ITE may function as both a problem and a potential solution within the broader system that shapes mathematics teacher preparation.

Accreditation constraints and program responsiveness

Accreditation frameworks play a central role in shaping the structure of ITE programs. These frameworks establish expectations for disciplinary preparation, professional experience, and pedagogical development, thereby contributing to the professional credibility of teacher education. At the same time, accreditation requirements may limit the flexibility of teacher education programs in responding to emerging workforce needs.

Nancy highlighted the force of external registration requirements directly: *"VIT won't register if subject requirements aren't met … NESA won't … QCT won't."* This quote captures the regulatory weight of teacher registration bodies across jurisdictions. It points to a central tension: accreditation and registration standards are designed to ensure professional quality, yet they can also restrict the range of possible pathways into mathematics teaching. This concern was evident across the broader data, where accreditation and registration requirements were repeatedly described as both necessary for maintaining standards and limiting for program responsiveness.

Several interviewees questioned the AITSL program standards requirement that undergraduate ITE programs include third-year level university mathematics. Isobel suggested:

> Maybe what we need is a… profound understanding of secondary level mathematics… do we want them to have studied up to second year level university mathematics… or do we want them to have a really rich, deep connection about what's going on with the secondary level mathematics, with a sense of where it's going?

This comment highlights the problematic boundaries within the discipline of mathematics that are often experienced by both pre-service and practising teachers. In particular, research suggests that secondary school mathematics teachers find it difficult to see connections between the mathematics they learn at university and the mathematics they teach in school (Wasserman et al., 2018). However, ITE programs typically maintain this boundary by separating, rather than integrating, the teaching of these two forms of mathematical knowledge.

These constraints are not limited to external accreditation and registration requirements. Internal university governance can also restrict the capacity for rapid curricular change and the introduction of more responsive pathways. Even where teacher educators recognise a clear need to provide additional preparation for prospective teachers who may be required to teach mathematics, institutional processes may make timely adjustments difficult. In this respect, the issue is not simply whether teacher educators know what should be done, but whether program structures allow it.

Recent work on mathematics OOF upskilling in Australia points to a similar tension. There is growing recognition of the need for clearer, more coherent pathways to support mathematics teacher supply, yet existing arrangements remain fragmented and difficult to scale (Barker et al., 2024; Goos & Marchant, 2025). Although those reports focus mainly on practising teachers, their implications extend to ITE because both domains are shaped by the same wider pressures to maintain standards while responding to the shortage.

Nevertheless, accreditation frameworks also contribute positively to teacher preparation by ensuring that mathematics teachers possess recognised disciplinary and pedagogical preparation. In this sense, accreditation operates simultaneously as a regulatory constraint and as a mechanism that protects the professional standards of mathematics teaching. The challenge lies in balancing these two functions so that teacher education programs can maintain rigorous preparation while remaining responsive to the realities of mathematics teacher supply. One possible response is to develop more flexible program structures and clearer mathematics pathways that retain standards while allowing institutions to respond more effectively to workforce needs.

Differentiating preparation for junior and senior mathematics teaching

A second issue concerns the limited differentiation between preparation for junior and senior secondary mathematics teaching. School mathematics encompasses a wide range of conceptual demands, from foundational number, algebra, and proportional reasoning in lower secondary years to advanced mathematical topics in senior secondary curricula. However, teacher education pathways frequently treat mathematics preparation as a single disciplinary requirement.

This issue is also evident in the way teacher education courses are structured. Katrina described the fragmentation that can occur within programs: *"Courses might have one unit that focuses on teaching and another on learning, another on assessment, another on planning … they're kind of more pedagogy first, and then it can be a bit random what content areas they focus on."* This observation suggests that the organisation of coursework may sometimes privilege generic pedagogical categories without ensuring a sufficiently coherent relationship between disciplinary mathematics and mathematics pedagogy. Similar concerns appeared elsewhere in the data, where participants described teacher education structures that separate mathematics-specific content from pedagogical preparation in ways that can weaken the coherence of teacher preparation.

Participants also suggested that a uniform approach to mathematics preparation may restrict potential pathways into teaching, especially for graduate-entry applicants seeking a career change. Prospective teachers with partial mathematics preparation may be able to teach junior secondary mathematics effectively if they are provided with targeted pedagogical and disciplinary support. Yet rigid disciplinary thresholds may prevent such candidates from entering mathematics teaching pathways at all. This has implications for both teacher supply and for the design of ITE programs.

Interview data highlighted the importance of integrating disciplinary knowledge and pedagogical preparation in mathematics teacher education. The relationship between content and pedagogy was made explicit by Isobel, who stated: *"It's very hard to talk seriously about pedagogy without talking about content…pedagogical content knowledge actually needs content knowledge."* This reinforces a core point in mathematics teacher education: content and pedagogy cannot be treated as separate or sequential domains. Preparation for teaching mathematics requires attention to the interplay between what is taught and how it is taught. Across our analysis, this issue was linked to questions about what kind of mathematical preparation is required for different forms of secondary mathematics teaching, rather than assuming that one undifferentiated threshold adequately serves all school levels.

The issue is not whether standards should be lowered, but whether they should be more carefully differentiated. A single undifferentiated specialisation threshold may obscure the distinct demands of junior and senior secondary mathematics teaching. A more nuanced approach could better align teacher preparation with different mathematics teaching contexts while maintaining disciplinary integrity. This is especially important in shortage conditions where schools often need teachers for junior secondary mathematics, but current pathways may be structured around expectations more closely aligned with senior secondary specialisation. A possible way forward is to create preparation pathways that recognise the differing pedagogical and disciplinary demands of junior and senior secondary mathematics teaching.

ITE within the broader system of mathematics teacher preparation

Taken together, these issues illustrate the complex role ITE plays in the wider system that shapes mathematics teacher preparation. Program accreditation and disciplinary expectations influence who enters mathematics teaching pathways and how teacher education programs are structured. At the same time, teacher education institutions remain critical sites for developing the knowledge, professional identity, and pedagogical expertise required for effective mathematics teaching. These dynamics reflect an interplay between the mesosystem (where institutional practices and program structures are enacted) and the exosystem (encompassing policy frameworks and external settings that indirectly shape teacher education).

This suggests that it is unhelpful to attribute ITE as a source of deficiencies in teacher preparation for out-of-field teaching. Rather, it is one component within a broader system that includes policy frameworks, institutional practices, and professional learning opportunities, operating across and between these system levels. The same features that help preserve standards can also restrict flexibility, just as the structures that create barriers to responsiveness may simultaneously provide the formal recognition needed to sustain teacher quality.

Seen in this way, ITE can be both part of the problem and part of the solution. It may contribute to the persistence of OOF teaching when pathways are too rigid, too generic, or insufficiently differentiated. Yet it also remains one of the strongest sites for developing future mathematics teachers' disciplinary confidence, pedagogical capability, and professional identity. Strengthening mathematics teacher preparation, therefore, requires attention not only to teacher education programs, but also to the broader structures that shape their operation.

Conclusion

Out-of-field teaching continues to present challenges for mathematics education systems, particularly in contexts where teacher supply and disciplinary preparation are unevenly distributed. ITE occupies a central position within these dynamics because it represents the primary pathway through which new mathematics teachers enter the profession.

The analysis presented in this paper suggests that ITE should not be viewed simply as either problem or solution. Accreditation frameworks and disciplinary expectations can limit program responsiveness, yet they also maintain professional standards. Similarly, current structures may restrict pathways into mathematics teaching, while teacher education institutions remain essential sites for developing disciplinary and pedagogical expertise.

This analysis is limited to the ITE perspective and does not yet incorporate the lived experiences of teachers teaching mathematics OOF. Even so, it suggests that some of the constraints shaping ITE are located in exosystemic policy and regulatory structures, while some potential responses may emerge through more responsive mesosystem relationships within and across institutions. Understanding ITE as part of a broader system therefore provides a more nuanced perspective on how teacher preparation can respond to the challenges of OOF mathematics teaching. Future research should continue to examine how policy frameworks, institutional structures, professional learning opportunities, and teachers' lived experiences interact to shape the preparation and support of mathematics teachers.

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