Understanding Subject Specific Professional Development for Out-of-field Teachers: An Evidence Review

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Introduction

We are in the midst of a teacher recruitment and retention crisis, particularly in shortage subjects, including the sciences. In 2022-2023, recruitment for new entrants to the profession was 17% of target for physics, for biology it was 85% and chemistry 86% (Department for Education, 2022). Although there has been an increase in recruitment since that year, numbers for physics and chemistry are still significantly below target.

These concerns about the supply and quality of science teachers are long-standing, and problems remain relating to out-of-field teaching, where teachers work outside their main subject specialism. The shortfall in teachers of science leads to significant proportions of out-of-field teachers and/or teachers lacking appropriate subject and pedagogical knowledge, as identified in a recent large-scale national study that additionally highlighted how understaffing aligns with existing inequalities (Royal Society of Chemistry, 2022).

One solution to the problem of out-of-field teachers (Hobbs & Törner, 2019) is the development of long-term programmes to support teachers to develop an additional specialism in shortage subjects such as physics and chemistry. Since 2009 several national professional development programs have been implemented, such as the forty-day Science Additional Specialism Programmes (SASP), and the shorter Subject Knowledge Enhancement (SKE+) courses that replaced them. These programmes provided extended, highly structured support which aimed to enhance teachers' subject and pedagogical knowledge. For some, these programmes were transformative, supporting science teachers to build their confidence and practice in a new specialism (de Winter, 2011). Regular face-to-face contact with tutors and being part of a community with other teachers added to the value of these professional learning experiences (Hobson et al., 2012).

However, although some studies have explored the design, implementation and impact of SASP and SKE courses for qualified teachers (e.g. Campbell, 2011; Inglis et al., 2013; Tynan et al., 2016) no longitudinal study was ever completed, despite the significant investment in these programmes by the government and the participating teachers and their schools. Therefore, in order to identify potential solutions to the ongoing crisis in teacher supply, it is beneficial to revisit these programmes, to evaluate their impact on the teachers involved and share these findings with policy makers and school and Multi-Academy Trust leaders.

A recent small-scale scoping study funded by Gatsby, focussing on the SASP programmes (Perry, de Winter & Hartley, 2024), identified several benefits for participants, including:

- better knowledge and understanding of teaching the out-of-field (additional specialism) subject, including subject and pedagogical knowledge
- greater confidence and positivity about teaching
- a toolkit of new approaches to teaching, which were still in use by participants throughout their careers

- connections with programme facilitators and teachers from other schools, which, for some, lasted beyond the programme
- enhanced and new opportunities for career progression

These benefits derived from a range of factors including:

- sustained, regular programme sessions throughout a school year, providing opportunities to trial, revisit and review learning with other teachers
- experienced facilitators who chose evidence-informed content relevant to practice
- opportunities to collaborate with teachers from other schools, thereby widening their professional support networks within and beyond the programme's duration
- financial support for schools, enabling participating teachers to be released without significant additional workload to either themselves or colleagues

All participants felt that such programmes would be of benefit in today's education system, providing a route to tackling teacher shortages and, potentially, promoting greater retention and career progression.

The findings from the scoping study demonstrated the value of subject specific professional development in supporting out-of-field teachers to develop their knowledge and skills. These professional development activities also appear to increase the likelihood of teachers remaining in the profession, leading to positive impacts on pupils' educational outcomes (Atteberry et al., 2017; Ronfeldt et al., 2013).

The outcomes of the scoping study show the value of a particular programme of sustained subject specific professional development for out-of-field teachers: the forty-day Science Additional Specialism Programme (SASP). To better understand how these and similar programmes achieve their aims, and to have a strong evidence base through which to advocate for similar professional development programmes, further work is needed.

Evidence review

Previous studies have recommended an international comparison of the phenomenon and related programmes of teacher development (Hobbs & Porsch, 2022), but we are not aware of any recent review of the evidence on professional development for out-of-field teachers. While this evidence base may be quite limited, and include research focussed on subjects other than science, it is beneficial to review and analyse it, through a targeted evidence review, in order to explore the following research questions:

1. Where are research studies being published which investigate teachers working out-of-field?
2. What professional development activities are available to support teachers working out-of-field, and what are their characteristics and features?
3. What evidence is there of the impacts of professional development activities?

Our focus is on support for out-of-field teachers, which we define for the purposes of this study as teachers working outside their subject specialism, such as biology teachers teaching physics, and teachers of other subjects, such as PE, teaching science. We use 'out-of-field' teachers as the term more widely used internationally, to avoid the use of 'non-specialist' teachers, which, although often used in England, has a negative connotation of a deficit of teacher expertise, and can refer to teachers using practice such as embedding literacy within their subject.

Our intention is to consider, where possible, teachers working outside their field in science, particularly physics, in secondary schools and their equivalents internationally, but to explore other subjects and phases where appropriate and supported by available evidence. This approach may provide useful additional information where it is lacking in a science-specific context, and improve the transferability of findings to other subject areas.

This report describes the findings of the evidence review, complementing the earlier interim report (Appendix A).

Methods

We used systematic review procedures adapted from PRISMA (Page et al., 2021), following established protocols, to identify and screen recent literature from countries and jurisdictions with significant proportions of out-of-field teachers.

Texts were identified using the broad search terms of 'out-of-field' and 'teach*'[1] within a date range of 2004-2024[2]. Prior scoping analysis of text was used to identify alternative used terms to include in the searches. Additional terms used for the searches were: "out of field", "non-specialist*", "teach* across specialisations", "inadequately qualified", "underqualified", "uncertified", "beyond the field", "outside specialism", "unsuitably qualified", "not suitably qualified", and "outside area of expertise".

Studies were then screened for relevance and quality, selecting only those focused on post-qualification out-of-field teachers. This excluded, for example, pre-initial training Subject Knowledge Enhancement courses and alternative routes into teaching', such as Teach for America (USA), Teach First (UK), and TeachNZ scholarships (New Zealand). Furthermore, to be included, studies had to examine the attributes, processes, or activities associated with the subject-specific professional development of out-of-field teachers. Studies focusing solely on the out-of-field teaching experience—such as those investigating student attainment, student experiences, teacher identity, dispositions, or informal work-based learning—were excluded. However, studies addressing the out-of-field teaching experience were tagged and analysed separately to provide contextual insights for our first review question. This was complemented by an analysis of some key texts, such as published evaluations of programmes of subject specialist professional development, studies of out-of-field teachers, and international comparative studies, identified through internet searches and direct communication with experts working in specific countries and jurisdictions, including the United States, Taiwan and the Netherlands.

Included texts were then analysed in detail, extracting information on the country or jurisdiction, the out-of-field subject, and teachers' existing specialisms or qualifications (if available). Key details about the professional development activity – such as duration, design features, and reported outcomes – were also extracted. Additionally, we examined research methodology and methods to assess the strength and reliability of the evidence behind a given programme.

This systematic approach allowed us to identify key patterns in the prevalence of out-of-field teaching around the world, and in the design, implementation and impact of professional development activities for out-of-field teachers, providing a robust foundation for the findings presented in the next section.

[1] Using the asterisk at the end of 'teach' ensured that it included all relevant forms of the word, including teacher, teachers, and teaching.
[2] Searches were conducted in November 2024.

Findings

Our presentation of findings is grouped according to our guiding research questions:

1. Where are research studies being published which investigate teachers working out-of-field?
2. What professional development activities are available to support teachers working out-of-field, and what are their characteristics and features?
3. What evidence is there of the impacts of professional development activities?

We also consider the unanswered questions that remain, which could be addressed through further research.

Several research studies report on the Professional Diploma for Mathematics Teaching (PDMT) in Ireland, a two-year part-time programme run through universities and funding by government. Therefore, as part of our findings, we also present a case study of this programme, triangulating data from different methods to describe the programme's features, mechanisms and moderating factors in more detail.

Where are research studies being published which investigate teachers working out-of-field?

In bringing together the field of research on out-of-field teaching, recent scholarship notes the importance of local and international context, and a drive to understand what the "fundamental characteristics out-of-field teaching [are] internationally" (Hobbs & Porch, 2022, p. 380). The following section speaks to this mapping of international contexts and outlines our findings from the review of literature on the distribution of research related to out-of-field teaching, before moving to the synthesis of out-of-field professional development and outcomes from this international perspective in addressing the subsequent research questions. We include studies here that were subsequently excluded from the research due to a lack of focus on out-of-field teacher *professional development*, but which were retained through 'tagging' for their reference to out-of-field teaching in a specific country or jurisdiction. The inclusion of literature here is therefore indicative of the distribution of research only. Further to this, we are aware that literature from the same country or jurisdiction may be multiple items in reference to one study focus or programme, as is the case with the Professional Diploma for Mathematics Teaching in Ireland, and so a quantity of research does not necessarily correlate with a quantity of out-of-field teaching practice or professional development programmes.

Challenges with a shortfall in teacher recruitment in shortage subjects are a major issue that results in the need for out of field teaching. These challenges are widespread: a 2024 report showed that nine out of 21 education systems reported unfilled vacancies across all subjects,

and another nine had shortages in specific subject areas (OECD, 2024). We identified 492 items that reported on out-of-field teaching in an international context that was identifiable through title and abstract screening (see Table 1 for frequencies by continent). These studies offered evidence of research into teaching out-of-field from across the globe, including African States (e.g. Namibia), Asia-Pacific States (e.g. Malaysia), and Eastern European States (e.g. Bulgaria).

Whilst research related out-of-field teaching was apparent internationally, several countries were represented more often within the literature. We located 212 items related to out-of-field teaching practice in the USA, 72 from Australia, 60 from the United Kingdom and 15 from Germany. We recognise that this distribution may reflect the location of research output density and geographic bias within publishing (Skopec et al., 2020) as much as it does the prevalence of out-of-field teaching, and is further influenced by our search criteria (e.g. excluding those not written in English, searching with English terminology).

Table 1. Frequency of literature in regional groupings

Regional grouping[3]	**Count of items**
African states	23
Asia-Pacific States	28
Eastern European States	7
Latin American and Caribbean States	9
Western European and other States[4]	412
Multiple/international research	13

There are also policy contexts that appear to influence the prevalence and reporting of out-of-field teaching. For example, in the United States, the No Child Left Behind Act of 2001 mandated that all schools have highly qualified teachers (Kolarik, 2010) and is contextually relevant to the prevalence of research on out-of-field teaching, with many returns referencing this policy. Meanwhile, in Germany, the reason for out-of-field teaching is generally a lack of teachers of specific subjects, understood as teachers with specialist qualifications, and with state examinations qualifying pre-service teachers for particular types of school (Campbell et al., 2019) Finally, in the Republic of Korea (South Korea), out-of-field teaching has been attributed to decreasing student numbers, due to educational policy reforms, alongside the

[3] Regional Groupings of Member States, United Nations (https://www.un.org/dgacm/en/content/regional-groups)
[4] Including Australia, Canada, Israel, New Zealand, Türkiye and United States of Ameria

permanence of teaching contracts, resulting in teachers being assigned to classes outside of their discipline (Kwak, 2019).

What professional development activities are available to support teachers working out-of-field, and what are their characteristics and features?

Several countries and jurisdictions are adapting their approaches to teacher recruitment and deployment, rather than or in addition to focussing on professional development, in order to address teacher shortages across all subjects, or in particular subject areas. For example, according to the OECD, many countries have implemented policies to try to attract more teachers, or deploy new or qualified teachers differently, although few have focussed on specific shortage areas.

For example, in Western Australia, final year pre-service teachers are able to work as 'relief' teachers, alleviating immediate shortages. Meanwhile, in the Netherlands, some schools trialled the deployment of 'external professionals' for teaching up to 22 hours per month without formal qualifications. The UK nations are unusual in offering financial bursaries for teachers of particular subjects.

We have identified some evidence of professional development being offered to support teachers working out-of-field. However, compared to the number of studies that reported on out-of-field teaching occurring in a given country or jurisdiction (492 studies), the number of studies describing or evaluating professional development activities or programmes was relatively limited (31 studies – Appendix B).

These professional development activities or programmes covered a range of subjects (Table 2) but were dominated by mathematics and the sciences. While the screening process established that out-of-field teaching affects the humanities and social sciences subjects too, we found no published evidence of professional development support for teachers in those disciplines. While we clearly cannot draw any conclusions from a lack of evidence, it is possible that these subjects face lower teacher shortages and so professional development may be seen as less of a priority.

Table 2. Out-of-field professional development activities per subject

Out-of-field subject	**No. of studies**	**References**
Mathematics	14	Barańska & Zambrowski (2022), Crisan & Rod (2017), Faulkner et al. (2019), Goos & Guerin (2021), Goos (2020), Goos, Lane, Ní Ríordáin & Faulkner (2019), Goos et al. (2023), Hatisaru (2024), Lane & Ní Ríordáin (2020), Lünne et al. (2021), Ní Ríordáin, Paolucci & O'Dwyer

Out-of-field subject	No. of studies	References
		(2017), Ní Ríordáin, Paolucci & Lyons (2017), Ní Ríordáin, Goos, Faulkner et al. (2022), O'Meara & Faulkner (2021), Perry, de Winter & Hartley (2024), Sani & Burghes (2022), Shepherd (2008)
Physics	7	Campbell (2011), Carpendale & Hume (2020), Carpendale & Hume (2022), de Winter (2011), Perl-Nussbaum et al. (2022), Perry, Wang, Garrett et al. (2024), Shepherd (2008)
Chemistry	2	Jones et al. (2008), Mizzi (2021)
Sciences	3	Donitsa-Schmidt et al. (2021), Huntoon & Baltensperger (2012), Perry, de Winter & Hartley (2024)
Geography	1	Moll & Dorn (2023)
Agriculture and Food Technologies	1	Manning et al. (2024)
Multiple/not specific	3	Kenny et al. (2020), Ndlovu et al. (2020); Ni Riordain, Paolucci & Lyons (2019)

In terms of the characteristics and features of effective professional development for out-of-field teachers, our analysis of the studies found similar features across contexts, subjects and countries that appear broadly aligned with other studies of professional development in general (e.g. Desimone 2009). Of the 31 studies, we identified the following key features: sustained professional development, collaboration with experts, workshops and opportunities for experimentation, subject and pedagogical content focus. These will be considered individually in the sections that follow.

Sustained Professional Development

The majority of studies report on out-of-field teachers engaging in professional development which lasts for at least a month (see Table 2). Many are much longer, with some running over an academic year (e.g. Hatisaru, 2024) or two years (e.g. Donitsa-Schmidt 2021, Huntoon, 2012, and the PDMT programme in Ireland). Of the two studies with a short duration, there was a one-off session where out-of-field teachers collaborated with in field teachers (Carpendale & Hume 2020, 2022); and an intensive four-day credit bearing professional development programme evaluated by NFER (Jones et al. 2008). These intensive weeks are also evident in longer professional development programmes (e.g. PDMT in Ireland – see Case Study below).

Table 3. Duration of out-of-field professional development

Duration	No. of studies	References
Long-term (>1 month)	22	Barańska & Zambrowska (2022), Campbell (2011), Crisan (2017), de Winter (2011), Donitsa-Schmidt et al. (2021), Goos & Guerin (2021), Goos, O'Donoghue, Ní Ríordáin et al. (2020), Goos, Lane, Ní Ríordáin, & Faulkner (2019), Goos, Ní Ríordáin, Faulkner et al (2023), Hatisaru (2024), Huntoon & Baltensperger (2012), Kenny et al. (2020), Lane & Ní Ríordáin (2020), Lünne et al. (2021), Mizzi (2021), Ní Ríordáin, Goos, Faulkner et al. (2022), Ní Ríordáin, Paolucci & O'Dwyer (2017), Ní Ríordáin, Paolucci & Lyons (2019), O'Meara & Faulkner (2021), Perry, de Winter & Hartley (2024), Sani & Burghes (2022), Shepherd (2008)
Medium term (< 1 month)	2	Moll & Dorn (2023), Perry, Wang, Garrett et al (2024)
One-off / short term (< 1 week)	4	Carpendale & Hume (2020), Carpendale & Hume (2022), Jones et al. (2008), Perl-Nussbaum et al. (2022),
Unknown	2	Manning et al. (2024), Ndlovu et al (2020)

Collaboration with experts, including experienced teachers

Invariably the professional development involved a knowledgeable other working with the out-of-field teachers, whether that be as a facilitator or in-field teachers collaborating with out-of-field teachers. Our analysis of the literature shows multiple professional development involving university-based facilitators (e.g. de Winter 2011, Goos & Guerin 2021, Perry, de Winter & Hartley 2024, Perry, Wang, Garrett et al. 2024). On occasion, professional development activities included out-of-field teachers collaborating with in-field teachers (e.g. Carpendale & Hume 2020, Carpendale & Hume 2022) or out-of-field teachers being mentored by experienced in-field teachers (such as Kenny, Hobbs & Whannell 2020).

While much published research on out-of-field teaching purposefully focuses on experienced teachers so that challenges and lived experiences identified are attributable to out-of-field

teaching rather than experience, the screening process revealed that in some contexts, out-of-field teachers were more likely to be novice teachers (e.g. Fraser et al. 2019[5]). Therefore, alongside targeted professional development programmes, the literature also identifies the importance of in-school support, in particular in the form of teaching materials and in-school mentoring structures to support out-of-field teachers, mentoring also being identified as a key component of out-of-field professional development programmes (Kenny, Hobbs & Whannell 2020, Ndlovu et al 2020, Sani & Burghes 2022).

The screening process also highlighted research studies that have aimed at developing frameworks that may support out-of-field teachers in their job, and have done so through collaboration between out-of-field and in-field teachers (e.g. Beswick et al. 2016[6]; Perl-Nussbaum et al. 2022). This shows that support for out-of-field teachers can consist of a combination of supporting schools and in-field teachers to provide resources (teaching as well as planning and reflection materials) and targeted mentoring.

Active learning and experimentation opportunities

Collaborative workshops are a staple of many professional development programmes, allowing out-of-field teachers a safe space away from their classrooms to engage with pedagogy and subject knowledge discussions. This included collaboration and discussions with university facilitators (e.g. de Winter 2011, Goos & Guerin 2021, Perry, de Winter & Hartley 2024, Perry, Wang, Garrett et al. 2024).

In all cases where the professional development lasted longer than a week, out-of-field teachers were expected to experiment within their own practice, informed by their new knowledge. Support for this varied from out-of-field teachers engaging with mentors in between workshops (Kenny, Hobbs & Whannell 2020), to out-of-field teachers reflecting on their experiences in follow up workshops (e.g. Mizzi 2021).

Whilst there were lecture style sessions to share information with out-of-field teachers, there were also many opportunities during workshops for out-of-field teachers to engage in subject activities. For example, Hatisaru (2024) asked out-of-field teachers to attempt mathematics questions ahead of the workshops/meetings with the facilitator and other out-of-field teachers; Carpendale and Hume (2020) report on out-of-field teachers discussing physics questions

[5] Fraser et al. (2019) is a study on out-of-field teacher knowledge that provided information on, and was tagged for, country/jurisdiction (research question 1). However, as it did not report on a professional development for out-of-field teachers, it was excluded from the final set of included studies.

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from a pedagogical viewpoint with in-field teachers; and the professional development evaluated for NFER (Jones et al. 2008) gave out-of-field teachers opportunities to practice chemistry practical work and teacher demonstrations. Supporting the development of out-of-field teachers' own subject and pedagogical knowledge through active learning is a significant common thread in all reports of professional development programme content.

Subject and pedagogical content focus of professional development

Across the reviewed studies, the content of professional development programmes for out-of-field teachers consistently emphasised both subject knowledge and pedagogical content knowledge. While the balance between these two dimensions varied across programmes and disciplinary contexts, their combined inclusion was broadly regarded as essential to effective support.

In terms of subject knowledge, several studies highlighted the importance of developing technical fluency with more challenging or abstract content, particularly at higher levels of secondary education (e.g., Crisan, 2017). Carpendale and Hume (2020, 2022) further underscored the value of supporting teachers in developing robust content representations (i.e. structures that help make disciplinary knowledge accessible and teachable) which was seen as especially important for out-of-field teachers unfamiliar with the nuances of the subject.

In science-focused programmes, an integrated approach combining key conceptual content with hands-on experiences, including student practical work and teacher-led demonstrations, emerged as a common and valued feature (e.g., Jones et al., 2008). These activities not only enhanced subject knowledge but also supported teachers' confidence and ability to translate scientific ideas into meaningful classroom experiences.

The relative focus on subject versus pedagogical content varied considerably by programme. For instance, Ireland's Professional Diploma in Mathematics for Teaching (PDMT) adopted a weighting of 60 credits for subject knowledge and 15 credits for pedagogical components (Ní Ríordáin, Goos, Faulkner, et al., 2022), reflecting a strong emphasis on disciplinary fluency. In contrast, science-focused programmes, such as those described by Perry, Wang, Garrett et al. (2024), tended to offer a more balanced integration of subject and pedagogical content.

Together, these findings suggest that effective professional development for out-of-field teachers must address both the conceptual demands of the subject and the pedagogical strategies required to teach it effectively, these being needs that are particularly acute for teachers working outside their disciplinary specialism. As de Winter (2011, p.160) aptly notes, "[g]etting the balance right between a more didactic, subject-knowledge-based approach and more explorative and discursive pedagogical sessions is a challenge for

programme tutors." Striking this balance is critical for building teachers' confidence and competence, and to ensure that professional development is responsive to the complex realities of out-of-field teaching.

What evidence is there of the impacts of professional development activities?

The international evidence base relating to the impacts of professional development for out-of-field teachers appears to be quite limited. Several studies identify a need for more research into the effects of professional development for out-of-field teachers. Of the 31 studies included in this review, only 21 studies directly measured and reported on the impact of professional development activities for out-of-field teachers.

The remaining 10 studies did not assess impact. Instead, they either: (1) synthesized existing research on out-of-field professional development programmes (3 studies); (2) provided a theoretical analysis or description of an out-of-field professional development programme, such as evaluating it against established frameworks of effective teacher learning (3 studies); or (3) focused their empirical investigation on teachers' motivations for and experiences of the programme, rather than its short- or long-term impact (4 studies).

Among the 21 studies that did measure impact, all reported on changes in teachers' knowledge, practice, and attitudes (see Table 4 for details). Additionally, five of these studies (Carpendale & Hume, 2022; Jones et al. 2008, Ni Riordian, Goos, Faulkner et al., 2022, Perry, Wang, Garrett et al. 2024) – these being from a range of contexts (US, Ireland, England and New Zealand) and subjects (Physics, Chemistry and Maths) – also noted broader effects on the school community. These included improvements in pedagogical content knowledge, increased collaboration within departments, out-of-field teachers taking on new roles, and assuming greater responsibilities in their subject areas, including leading professional development activities within their department.

Table 4. Reported out-of-field professional development outcomes

Outcome	No. of studies	References
Teacher confidence/self-efficacy	11	Campbell (2011), de Winter (2011), Donitsa-Schmidt et al. (2021), Jones et al. (2008), Kenny et al. (2020), Lane & Ní Ríordáin (2020), Mizzi (2021), Ní Ríordáin, Goos, Faulker et al. (2022), O'Meara & Faulkner (2022), Perry, de Winter & Hartley (2024), Perry, Wang, Garrett et al. (2024)

Outcome	No. of studies	References
Content knowledge	10	Campbell (2011), Carpendale & Hume (2020), Donitsa-Schmidt et al. (2021), Hatisaru (2024), Huntoon & Baltensperger (2012), Jones et al. (2008), Moll & Dorn (2023), Perry, de Winter & Hartley (2024), Perry, Wang, Garrett et al (2024), Sani & Burghes (2022)
Pedagogical content knowledge	15	Campbell (2011), Carpendale & Hume (2020), Carpendale & Hume 2022, de Winter (2011), Donitsa-Schmidt et al. (2021), Goos & Guerin 2021, Goos, Ní Ríordáin, Faulkner et al. (2023), Hatisaru (2024), Huntoon & Baltensperger (2012), Kenny et al. (2020), Moll & Dorn (2023), Ní Ríordáin, Goos, Faulkner et al. (2022), O'Meara & Faulkner (2021), Perry, de Winter & Hartley (2024), Sani & Burghes (2022)
Curriculum knowledge	2	Carpendale & Hume (2022); Perry, Wang, Garrett et al. (2024)
Motivation/beliefs/attitudes	3	Jones et al. (2008), Lane & Ní Ríordáin (2020), Mizzi (2021)
Teacher identity	2	Crisan (2017); Mizzi (2021)
Job satisfaction	1	Ní Ríordáin, Goos, Faulkner et al. (2022);

However, only one of the studies conducted longitudinal follow-ups to assess the lasting impact of these programmes on teachers' careers (Perry, de Winter & Hartley, 2024). While some studies mentioned short-term changes, such as out-of-field teachers adopting new departmental roles, the absence of long-term data makes it difficult to determine whether these courses influenced teachers' career trajectories. The scoping study focussed on the SASP programmes completed for Gatsby (Perry, de Winter & Hartley, 2024), which followed up with teachers ten years after the course, therefore appears to be unique in its longitudinal focus. Beyond improved teacher confidence and content and pedagogical content knowledge, this study found positive impacts of the SASP Chemistry and Physics course on teacher employability, highlighting an increase in the range of schools and positions to which participants could apply.

Beyond the Professional Diploma for Mathematics Teaching (PDMT) in Ireland (see Case Study below), another out-of-field professional development initiative with a strong evidence base is the Summer Workshop developed by Arizona's Alliance Summer Geography Institute

(ASGI) (Moll & Dorn, 2023). The effectiveness of this programme was evaluated through robust data triangulation, including four rounds of content knowledge surveys, daily feedback surveys, semi-structured interviews, and lesson plan analyses conducted by researchers. The study found that the workshop significantly enhanced teachers' content knowledge and pedagogical content knowledge. The mentoring component of the programme was particularly highlighted as a key factor driving this impact. Additionally, field trips were shown to be highly effective in helping teachers grasp key geographic concepts, while social interactions fostered a sense of connection through a shared commitment to geographic instruction and the advancement of geographic literacy (Moll & Dorn, 2023).

Nevertheless, there is conflicting evidence in terms of the extent of the impacts on teacher knowledge, skills and attitudes: while some studies report that teachers participating in the professional development "were 'talking the talk' about what it takes to be a mathematics teacher" (Crisan, 2017), there was also be a sense that out-of-field teachers are not brought entirely 'in-field' by programmes of professional development, and thus inhabit a space between in- and out-of-field. Research in Poland (Barańska & Zambrowska, 2022) suggests that even after teachers have acquired the necessary postgraduate qualifications to teach beyond their subject specialism they are not always considered fully in-field. There are strict employment laws in Poland that limit out-of-field teaching to circumstances warranting special regional dispensation, which may contribute to this perception.

Where the impact of out-of-field professional development activities has been questioned, this has at times been related to duration of the programme. For example, researchers have questioned the feasibility of a year-long programme, running alongside teachers' other commitments, to provide sufficient professional knowledge when compared with more traditional training routes. Moreover, while not the focus of our review, the review process foregrounded that the motivations of out-of-field teachers to participate in professional development may be different from those of in-field teachers. Several reasons for this are suggested in the literature, including lack of interest in the out-of-field subject and fear of being permanently moved to the out-of-field subject, and conversely the often temporary nature of an out-of-field teaching assignment. These differences in teacher motivations are likely to result in a different impact for out-of-field professional development, compared to in-field programmes.

There is also limited study of, or evidence relating to, what makes a successful professional development programme for teachers working out-of-field and whether/how this differs from other professional development activities. However, the characteristics identified in the previous section look very similar to other lists of effective professional development (e.g. Desimone, 2009). Kenny, Hobbs and Whannell (2020) took the evidence from their study to "suggest that the principles of professional development needed to support out-of-field teachers are in some ways similar to those of in-field teachers" (p511).

Case study: The Professional Diploma in Mathematics for Teaching in Ireland

The Professional Diploma in Mathematics for Teaching (PDMT) from Ireland represents the most comprehensively designed and reflectively researched example of out-of-field teacher professional development that we identified through our systematic review. We present the following case study as an example of the characteristics of a successful programme design, and to highlight the knowledge base that supports its functioning and development.

Background

The PDMT, is a university accredited programme for out-of-field teachers of mathematics in Ireland. It was developed against a policy backdrop of the introduction of a child-centred curriculum, and new accreditation requirements for subject teachers from the Teaching Council of Ireland (Goos & Guerin, 2021). Further, whilst strict qualification guidelines exist on what constitutes an in-field teacher, headteachers have the ability to hire staff and determine their subject and teaching responsibilities at their discretion (Goos, Ní Ríordáin, Faulkner et al., 2023). In parallel with these contextual factors, research into the prevalence of out-of-field mathematics teaching in Ireland revealed that 48% of mathematics teachers did not have the required qualifications (Ní Ríordáin & Hannigan, 2009[7]). This frequency of out-of-field mathematics teaching was further demonstrated in data on PDMT participants. Survey findings from an early cohort on entry to the programme found that almost three-quarters described their mathematics background as 'moderate', with more than half having taught highest level of curriculum in Ireland (Ní Ríordáin, Paolucci, & O'Dwyer, 2017).

The programme of professional development

The PDMT is a two-year, part-time, university-accredited programme of professional development, that is based on a blended-learning model that is intended to run alongside full-time employment during evenings, weekends and holidays (Goos, O'Donoghue, Ní Ríordáin et al., 2020). It is funded by the Irish Government to address the subject content knowledge and qualification deficits of mathematics teachers in Ireland (Goos, O'Donoghue, Ní Ríordáin et al., 2020), and the tender to provide the qualification was led by two Irish Universities and included a consortium of thirteen Higher Education Institutions (O'Meara & Faulkner, 2021).

Design features and impact

The two major strands of the PDMT programme design are mathematics content and pedagogy knowledge. Table 5 outlines the key features of the programme design. The following discussion outlines several of related studies in relation to these design features.

Table 5. Adapted from Goos and Guerin (2021)

Mathematics content knowledge modules	Mathematics pedagogy modules
• Ten undergraduate mathematics modules • Delivered online • 30-hour blocks across 6 weeks • Face-to-face and online support	• Two yearlong pedagogy modules • Face-to-face via workshops • Weekends and summer holidays • Includes and action research project

A core component of the PDMT is the enhancement of participants' mathematics content knowledge (Goos, Lane, Ní Ríordáin & Faulkner, 2019). This need was identified by Ní Ríordáin, Paolucci, and O'Dwyer (2017), in findings that highlighted the discrepancy between out-of-field mathematics teachers' confidence in their content knowledge and their demonstrated achievement. Comparison of results from two national surveys of out-of-field Mathematics teaching in Ireland found that unqualified teaching in the subject area has fallen from 48% in 2009 to 25% in 2018 (Goos, Ní Ríordáin, Faulkner et al., 2023). These findings, not attributable to any other known changes in teacher supply, demonstrate the effectiveness of the PDMT programme in reducing out-of-field mathematics teaching, which the authors recognise was a core aim of the programme and the funding it was attached to.

Research comparing pre- and post-qualification self-reported practices, found that reported teaching styles had changed for the majority of participants and were more closely aligned with best practice, as covered in the PDMT training (O'Meara & Faulkner, 2021). Participation in the PDMT sustained professional development was also found to be related to increased job satisfaction and feelings of self-efficacy around instructional practices (Goos & Guerrin, 2021). In terms of the reported increase in job satisfaction, it was found that some teachers did not experience this improvement due to a perceived lack of opportunities to apply their new qualification (Ní Ríordáin, Goos, Faulkner, et al. 2022), suggesting that school-levels contextual differences also influence the extent to which out-of-field professional development impacts are experienced.

In addition, analysis of action research projects undertaken by participating teachers, suggests that this aspect of the programme design is a successful means of developing out-of-field mathematics teachers' beliefs and practices (Lane & Ní Ríordáin, 2019). Analysis of the programme's blended learning approach identifies the combination of in-person and online resources as supporting the core intentions of the programme for developing mathematical and pedagogical content knowledge, alongside a "degree of access, flexibility and cost effectiveness at scale" that this medium affords (Goos, O'Donoghue, Ní Ríordáin, et al., 2020 p. 903).

A further intention of the programme was to align teaching practices with the [new] national curriculum for mathematics, and particularly the focus on child-centred learning (Goos & Guerrin 2021). In a small-scale comparison of in-field, out-of-field and PDMT graduate mathematics teachers, tentatively found greater similarity between in-field and 'upskilled' teachers (Goos & Guerin, 2021). Furthermore, whilst unable to provide a baseline as comparator to their findings, Goos, Ní Ríordáin, Faulkner et al. (2023) report that graduates of the PDMT held beliefs about mathematics and mathematics teaching and learning that were consistent with changes in policy and updated curriculum principles. Teachers' beliefs and practices were child-centred post PDMT (but no baseline) (Goos, Lane, Ní Ríordáin & Faulkner, 2019)

[7] Ní Ríordáin & Hannigan (2009) provided information on the Irish context as a background to the PDMT and was tagged for country/jurisdiction (research question 1). However, it did not specifically report on the PDMT programme and outcomes and was therefore excluded from the final set of included studies.

Moderators

Noting a number of contextual constraints that inhibited engagement in the programme, Goos, O'Donoghue, Ní Ríordáin et al. (2020) reflect on the weight of the commitment that a 2-year programme poses, especially for teachers who are completing the qualification voluntarily and alongside their teaching roles. Changes to programme design over time were introduced to mitigate against these challenges, including online tutorials and lecture notes (Goos, O'Donoghue, Ní Ríordáin, et al., 2020).

What unanswered questions remain?

It seems evident that structured, sustained professional development, with experienced subject specific facilitators and mentors, can, in the right circumstances (such as adequate funding), offer effective support for teachers working out-of-field. However, questions remain about the details of those professional development activities, their impacts and the moderating factors (including contextual influences and teachers' own motivations) which influence their success.

The design features and characteristics of successful subject specific professional development for out-of-field teachers	There is still a need to understand the extent to which the features of professional development we have identified are essential to the positive impacts of those activities and programmes, including comparison to evidence about other professional development activities, gaining understanding of the 'minimum' activity required for support (including proportion of time spent on disciplinary content), and identifying variations across age phases and subjects where appropriate.
The role of subject specialist practitioners in supporting out-of-field teachers	Many of the professional development activities for out-of-field teachers include support from experienced subject specialist teachers. However, the nature of those collaborations, and what makes them effective, is largely unexplored. Further research in this area will enhance our understanding of how subject specialist professional development supports out-of-field teachers, including elucidating potential roles for subject associations and in-school mentors.
The subject and pedagogic outcomes of subject specific professional development for out-of-field teachers	After teachers working out-of-field have participated in professional development, it may or may not be appropriate to re-classify them as 'subject specialists'. Therefore, there is a need to better understand the nature of subject specialism, what is classified as in- or out-of-field, what marks a transition from one to the other, and how these issues relate to the outcomes of professional development for out-of-field teachers.

The impact of supporting out-of-field teachers on their retention in the profession	In our scoping study, we identified preliminary evidence of the impact of supporting out-of-field teachers on their retention in the profession. There is benefit in further exploring this in order to gain greater understanding of the connections between the support and retention, and the moderating factors which help or hinder those impacts.
The motivations of out-of-field teachers to participate in subject specific professional development	There appears to be little study of why out-of-field teachers choose to participate in subject specific professional development. There are likely to be a variety of motivations, ranging from self- or manager-led identification of a need, to career enhancement and progression. Understanding these motivations and orientations, as well as the transitional reality of many out-of-field teaching assignments, are crucial to the success of any targeted professional development programme.

The questions can be answered, at least in part, through primary data collection (survey and interviews) with out-of-field teachers, and their colleagues, who have participated in sustained programmes of professional development, generating case studies of those participants. Those case studies would include, where possible:

- comparison of programmes in order to consider the benefits and drawbacks of different models of support
- identification of motivations for participation and elucidation of the roles of subject specialist teachers in the professional development
- comparison of impacts to national averages (such as retention, via the school workforce census)
- identification of moderating factors in the school environment, such as curriculum, resourcing, school leader support and other professional development activities, which contribute to those impacts.

We also recommend further work around understanding the nature of ‘subject specialism’ as it relates to teacher accreditation and varying routes into teaching, and to the outcomes of professional development programmes for in- and out-of-field teachers. This might take the form of, largely, desk-based activity reviewing routes into teaching in varying national and state contexts and the influence of operational factors such as curriculum and school structures, supported by interviews or roundtable discussions with stakeholders including teachers, school leaders, and those directly involved in the provision of support for out-of-field teachers.

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Appendix A – Interim report

Understanding subject specific professional development for out-of-field teachers: Evidence review - preliminary findings

Introduction

We are in the midst of a teacher recruitment and retention crisis. In 2022-2023, recruitment for new entrants to the profession was 17% of target for physics, for biology it was 85% and chemistry 86% (Department for Education, 2022). Although there has been an increase in recruitment since that year, numbers for physics and chemistry are still significantly below target.

These concerns about the supply and quality of science teachers are long-standing, and problems remain relating to out-of-field teaching, where teachers work outside their main subject specialism. The shortfall in teachers of science leads to significant proportions of out-of-field teachers and/or lacking appropriate subject and pedagogical knowledge, as identified in a recent large-scale national study that additionally highlighted how understaffing aligns with existing inequalities (Royal Society of Chemistry, 2022).

One solution to the problem of 'out-of-field' teachers (Hobbs & Törner, 2019) is the development of long-term programmes to support teachers to develop an additional specialism in shortage subjects such as physics and chemistry. Since 2009 several national professional development programs have been implemented, such as the forty-day Science Additional Specialism Programmes (SASP), and the shorter Subject Knowledge Enhancement (SKE+) courses that replaced them. These programmes provided extended, highly structured support which aimed to enhance teachers' subject and pedagogical knowledge. For some, these programmes were transformative, supporting science teachers to build their confidence and practice in a new specialism (de Winter, 2011). Regular face-to-face contact with tutors and being part of a community with other teachers added to the value of these professional learning experiences (Hobson et al., 2012).

However, although some studies have explored the design, implementation and impact of SASP and SKE courses for qualified teachers (e.g. Campbell, 2011; Inglis et al., 2013; Tynan et al., 2016) no longitudinal study was ever completed, despite the significant investment in these programmes by the government and the participating teachers and their schools. Therefore, in order to identify potential solutions to the ongoing crisis in teacher supply, it is beneficial to revisit these programmes, to evaluate their impact on the teachers

involved and share these findings with policy makers and school and Multi-Academy Trust leaders.

Funded by Gatsby, we recently carried out a small-scale scoping study, focussed on the SASP programmes (Perry et al., 2024) in which we identified benefits for participants including:

- better knowledge and understanding of teaching the out-of-field (additional specialism) subject, including subject and pedagogical knowledge
- greater confidence and positivity about teaching
- a toolkit of new approaches to teaching, which were still in use by participants throughout their careers
- connections with programme facilitators and teachers from other schools, which, for some, lasted beyond the programme
- enhanced and new opportunities for career progression

These benefits derived from a range of factors including:

- sustained, regular programme sessions throughout a school year, providing opportunities to trial, revisit and review learning with other teachers
- experienced facilitators who chose evidence-informed content relevant to practice
- opportunities to collaborate with teachers from other schools, thereby widening their professional support networks within and beyond the programme's duration
- financial support for schools, enabling participating teachers to be released without significant additional workload to either themselves or colleagues

All participants felt that such programmes would be of benefit in today's education system, providing a route to tackling teacher shortages and, potentially, promoting greater retention and career progression.

Our findings demonstrated the value of subject specific professional development in supporting out-of-field teachers to develop their knowledge and skills. These professional development activities also appear to increase the likelihood of teachers remaining in the profession, leading to positive impacts on pupils' educational outcomes (Atteberry et al., 2017; Ronfeldt et al., 2013).

The outcomes of the scoping study show the value of a particular programme of sustained subject specific professional development for out-of-field teachers: the forty-day Science Additional Specialism Programme (SASP). In order to better understand how these and similar programmes achieve their aims, and to have a strong evidence base through which to advocate for similar professional development programmes, further work is needed.

Evidence review

Previous studies have recommended an international comparison of the phenomenon and related programmes of teacher development (Hobbs and Porsch, 2022), but we are not aware of any recent review of the evidence on professional development for out-of-field teachers. While this evidence base may be quite limited, and include research focussed on subjects other than science, it is beneficial to review and analyse it, through a targeted evidence review, in order to gain understanding of the following:

- which other countries/jurisdictions have teachers working out-of-field
- how teachers in those countries/jurisdictions are supported through subject specific professional development activities
- what evidence exists for the impacts, successful design features, and moderating influences, of those professional development activities

We used a literature search, following established protocols, to identify and screen recent literature from selected countries and jurisdictions with comparable education systems and teachers' working conditions, including significant proportions of out-of-field teachers. This was complemented by an analysis of some key texts, such as published evaluations of programmes of subject specialist professional development, studies of out-of-field teachers, and international comparative studies.

Our focus is on support for out-of-field teachers, which we define for the purposes of this study as teachers of science working outside their subject specialism, such as biology teachers teaching physics, and teachers of other subjects, such as PE, teaching science. We use 'out-of-field' teachers as the term more widely used internationally, to avoid the use of 'non-specialist' teachers, which, although often used in England, has a negative connotation of a deficit of teacher expertise, and can refer to teachers using practice such as embedding literacy within their subject.

Our intention is to focus, where possible, on teachers working outside their field in science, particularly physics, in secondary schools and their equivalents internationally, but to explore other subjects and phases where appropriate. This approach may provide useful additional information where it is lacking in a science-specific context, and improve the transferability of findings to other subject areas.

Preliminary findings

We present here preliminary, interim findings of the review, which give a snapshot of our findings as they stand. We will follow this preliminary report with a report containing details of our search protocols, the outcomes of the search, and a full set of findings and references.

We focus our emerging findings around four key questions:

- Where are teachers working out-of-field and what circumstances have led to this?
- What professional development activities and programmes are available to support teachers working out-of-field?
- What evidence is there of the impacts of those professional development activities and programmes?
- What unanswered questions remain which could be addressed through further research?

Where are teachers working out-of-field?

Internationally, the shortfall in teacher recruitment is widespread: a 2024 report showed that nine out of 21 education systems reported unfilled vacancies across all subjects, and another nine had shortages in specific subject areas (OECD, 2024).

We found evidence in varying international contexts of teachers working out-of-field. These countries and jurisdictions included:

- USA states including California
- European countries including Germany, Georgia, Poland, Slovenia and Bulgaria
- Ireland
- South Africa
- South Korea
- Australia

The reasons for this were generally similar to those in England: a shortage of teachers qualified in particular subjects (such as physics, chemistry and mathematics), and therefore these countries and jurisdictions fill gaps in teacher supply through out-of-field teaching.

For example, in Germany, the reason for out-of-field teaching is generally a lack of teachers in specific areas, chemistry and physics among them, but also the class-teacher principle that continues from primary into lower secondary education, whereby all lessons and subjects are taught by the same teacher.

In Australia, increasing numbers of school students studying mathematics, in combination with a reduction in mathematics university graduates, has also resulted in out-of-field teaching.

Meanwhile, in the Republic of Korea (South Korea), out-of-field teaching has been attributed to decreasing student numbers, due to educational policy reforms, alongside the permanence of teaching contracts, resulting in teachers being assigned to classes outside of their discipline.

Finally, studies on out-of-field teaching in South Africa foreground the legacy of Apartheid in the shortage of teachers in particular subjects. For example, Apartheid education entrenched

racial and economic disparities, leaving many Black teachers with minimal opportunities to teach mathematics. As a result, South Africa's curriculum reforms have prioritised rectifying this legacy, primarily through professional development programmes for teachers.

In places which do not report large proportions of teachers working out-of-field, this may be because of better teacher recruitment, different models of teacher qualification and/or curriculum or school organisational structures. For example, in New York, USA, which has one of the country's most rigorous entry requirements for teacher certification (a master's degree), it is expected that teachers work outside their 'area of certification', so that teachers who have qualified in physics also often teach mathematics or chemistry. Similarly, Poland has clear employment policies regarding appropriately qualified staff, and requires specific dispensation for schools to employ teachers outside of these parameters. This national approach is supported by the availability of postgraduate qualifications that enable teachers to teach subjects beyond their primary qualifications.

Where are teachers working out-of-field?

Several countries and jurisdictions are adapting their approaches to teacher recruitment and deployment, rather than or in addition to focussing on professional development, in order to address teacher shortages across all subjects, or in particular subject areas. For example, according to the OECD, many countries have implemented policies to try to attract more teachers, although few have focussed on specific shortage areas.

Some countries have employed approaches which bring additional teachers into the system or deploy new or qualified teachers differently. For example, in Western Australia, final year pre-service teachers are able to work as 'relief' teachers, alleviating immediate shortages. Meanwhile, in the Netherlands, some schools trialled the deployment of 'external professionals' for teaching up to 22 hours per month without formal qualifications. The UK nations are unusual in offering financial bursaries for teachers of particular subjects.

We have identified some evidence of professional development being offered to support teachers working out-of-field. For example, in Bulgaria, a government-funded programme supports teachers working out-of-field in physics, mathematics, chemistry or ICT. This programme runs through universities, which receive a subsidy to train the teachers, and lasts for a year.

Several research studies report on a programme in Ireland: the Professional Diploma in Mathematics for Teaching. This two-year part-time programme, run through universities and funded by the government, supports out-of-field teachers of mathematics in secondary schools. It combines online and in-person activities, scheduled outside school time, and primarily focuses on mathematics-specific content knowledge and pedagogy.

Out-of-field teachers are more likely to be novice teachers. Therefore, alongside targeted professional development programmes, the evidence also identifies the importance of in-school support, in particular in the form of teaching materials and in-school mentoring structures to support out-of-field teachers. Several research studies have aimed at developing frameworks that may support out-of-field teachers in their job, and have done so through collaboration between out-of-field and in-field teachers. This shows that support for out-of-field teachers can consist of a combination of supporting schools and in-field teachers to provide resources (teaching as well as planning and reflection materials) and targeted mentoring.

The motivations of out-of-field teachers to participate in professional development may be different from those of in-field teachers. Several reasons for this are suggested in the literature, including lack of interest in the out-of-field subject and fear of being permanently moved to the out-of-field subject, and conversely the often temporary nature of an out-of-field teaching assignment.

What evidence is there of the impacts of professional development activities?

Although we are still reviewing the full set of literature, at this stage the international evidence base relating to the impacts of professional development for out-of-field teachers appears to be quite limited. Several studies identify a need for more research into the impacts of professional development for out-of-field teachers.

Several studies have investigated the mathematics professional development programme in Ireland described above, and identified how participation in that sustained professional development is related to increased job satisfaction and feelings of self-efficacy around instructional practices. Based on a small sample comparing ‘upskilled teachers’ who participated in the programme with out-of-field and in-field teachers as ‘controls’, there is some tentative evidence to suggest that this programme results in teachers adopting pedagogical practices more like those of in-field teachers. This was especially true in relation to promoting ‘Intellectual Quality’, which included ‘higher order thinking and deep knowledge’. There also was an increase in teachers’ ability to promote a problem-based curriculum, which was taken as evidence for their enhanced understanding of the connectedness between core concepts within mathematics (Goos & Guerrin, 2021).

Where the impact of such professional development activities has been questioned, this has at times been related to duration of the programme. For example, researchers have questioned the feasibility of a year-long programme, running alongside teachers’ other commitments, to provide sufficient professional knowledge when compared with more traditional training routes.

There is also limited study of, or evidence relating to, what makes a successful professional development programme for teachers working out-of-field and whether/how this differs from other professional development activities.

Meanwhile, there may also be a sense that out-of-field teachers are not brought entirely 'in-field' by programmes of professional development, and thus inhabit a space between in- and out-of-field. Research in Poland suggests that even after teachers have acquired the necessary postgraduate qualifications to teach beyond their subject specialism they are not always considered fully in-field. There are strict employment laws in Poland that limit out-of-field teaching to circumstances warranting special regional dispensation, which may contribute to this perception.

What unanswered questions remain?

It seems evident that structured, sustained professional development, with experienced subject specific facilitators and mentors, can, in the right circumstances (such as adequate funding), offer effective support for teachers working out-of-field. However, questions remain about the details of those professional development activities, their impacts and the moderating factors (including contextual influences and teachers' own motivations) which influence their success.

The design features and characteristics of successful subject specific professional development for out-of-field teachers	There is still a need to understand the extent to which the features of professional development we have identified are essential to the positive impacts of those activities and programmes, including comparison to evidence about other professional development activities, gaining understanding of the 'minimum' activity required for support (including proportion of time spent on disciplinary content), and identifying variations across age phases and subjects where appropriate.
The role of subject specialist practitioners in supporting out-of-field teachers	Many of the professional development activities for out-of-field teachers include support from experienced subject specialist teachers. However, the nature of those collaborations, and what makes them effective, is largely unexplored. Further research in this area will enhance our understanding of how subject specialist professional development supports out-of-field teachers, including elucidating potential roles for subject associations and in-school mentors.
The subject and pedagogic outcomes of subject specific professional development for out-of-field teachers	After teachers working out-of-field have participated in professional development, it may or may not be appropriate to re-classify them as 'subject specialists'. Therefore, there is a need to better understand the nature of subject specialism, what is classified as in- or out-of-field, what marks a transition from

	one to the other, and how these issues relate to the outcomes of professional development for out-of-field teachers.
The impact of supporting out-of-field teachers on their retention in the profession	In our scoping study, we identified preliminary evidence of the impact of supporting out-of-field teachers on their retention in the profession. There is benefit in further exploring this in order to gain greater understanding of the connections between the support and retention, and the moderating factors which help or hinder those impacts.
The motivations of out-of-field teachers to participate in subject specific professional development	There appears to be little study of why out-of-field teachers choose to participate in subject specific professional development. There are likely to be a variety of motivations, ranging from self- or manager-led identification of a need, to career enhancement and progression. Understanding these motivations and orientations, as well as the transitional reality of many out-of-field teaching assignments, are crucial to the success of any targeted professional development programme.

The questions can be answered, at least in part, through primary data collection (survey and interviews) with out-of-field teachers, and their colleagues, who have participated in sustained programmes of professional development, generating case studies of those participants. Those case studies would include, where possible:

- comparison of programmes in order to consider the benefits and drawbacks of different models of support
- identification of motivations for participation and elucidation of the roles of subject specialist teachers in the professional development
- comparison of impacts to national averages (such as retention, via the school workforce census)
- identification of moderating factors in the school environment, such as curriculum, resourcing, school leader support and other professional development activities, which contribute to those impacts.

We also recommend further work around understanding the nature of ‘subject specialism’ as it relates to teacher accreditation and varying routes into teaching, and to the outcomes of professional development programmes for in- and out-of-field teachers. This might take the form of, largely, desk-based activity reviewing routes into teaching in varying national and state contexts and the influence of operational factors such as curriculum and school structures, supported by interviews or roundtable discussions with stakeholders including teachers, school leaders, and those directly involved in the provision of support for out-of-field teachers.

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