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Out-of-field teaching and instructional practices in Years 7-10 mathematics classes in Australia: evidence from TALIS 2018¹

Chandra Shah², Helen M. G. Watt³ and Paul W. Richardson⁴

Abstract

To compare 'in-field' versus 'out-of-field' teachers of Years 7-10 mathematics in Australia on key demographic and instructional dimensions, we analysed nationally representative system data collected by the OECD Teaching and Learning International Survey (TALIS), one of the world's largest survey of teachers and school leaders. Latest available TALIS 2018 data from teachers teaching Years 7-10 mathematics ($N = 1,120$; 284 of whom taught mathematics out-of-field) showed out-of-field teachers were mostly from a STEM background qualified to teach science and/or technology, and were less commonly older or more experienced. Out-of-field teachers were more concentrated in public schools, having less principal autonomy, lower academic pressure, with greater school delinquency and violence. There were no statistically significant differences between in-field and out-of-field teachers on their non-mathematics specific motivations, values, self-efficacy, professional development needs and barriers, professional engagement or wellbeing.

Specific to mathematics teaching, we compared 'in-field' versus 'out-of-field' Years 7-10 mathematics teacher reports of key instructional practices specific to a 'target' mathematics class ($N = 472$; 65 of whom taught mathematics out-of-field), which revealed likely negative consequences for student engagement and learning. Out-of-field teachers spent more time than in-field teachers on classroom management and disciplining students, lost more time due to student interruption, reported much disruptive noise in class, only occasionally presented tasks for which there was no obvious solution, and spent less time teaching, although they did not differ on time spent in practices related to instructional clarity. Out-of-field teachers also reported more time setting students extended projects to complete, letting students evaluate their own progress, and providing immediate feedback when observing students working on particular tasks. Targeted mathematics classes taught by out-of-field teachers had higher concentrations of low-achievers, indicating a bias in which students are assigned teachers not specialised to teach mathematics. Recommendations are advanced regarding professional development priorities for teachers teaching mathematics out-of-field.

JEL classification: I210, I222, I240, I280, I290, J240

Keywords: out-of-field teaching in mathematics, teacher efficacy, instructional practice

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Introduction

While student-related characteristics including family values, personal abilities, motivations and wellbeing are powerful influences on the ways students acquire new skills, knowledge, values and attitudes (OECD 2024), school-related factors also have a significant role. Among school-related factors, teacher quality has long been considered the most important factor in determining student outcomes (Goldhaber 2016; Hattie 2009; OECD 2005).

'Teacher' quality has sometimes been differentiated from 'teaching' quality:

Teacher quality might be thought of as the bundle of personal traits, skills, and understandings an individual brings to teaching, including dispositions to behave in certain ways. Teaching quality refers to strong instruction that enables a wide range of students to learn. Teaching quality is in part a function of teacher quality—teachers' knowledge, skills, and dispositions—but it is also strongly influenced by the context of instruction: the curriculum and assessment system; the "fit" between teachers' qualifications and what they are asked to teach; and teaching conditions, such as time, class size, facilities, and materials. If teaching is to be effective, policymakers must address the teaching and learning environment as well as the capacity of individual teachers (Darling-Hammond 2012, p. 1).

As Darling-Hammond (2012) noted, teaching quality is a function of teacher quality but it is also strongly influenced by the context of instruction. In particular, the fit between teachers' qualifications and the subjects they are asked to teach can affect teachers' instructional practices and consequently teaching quality. A fit between teachers' qualifications and the subjects they are asked to teach is commonly referred to as 'in-field' teaching and a lack of such a fit as 'out-of-field' teaching (for example, when a teacher with qualifications to teach only English is assigned to teach mathematics). An out-of-field teacher is likely to lack content and pedagogical content knowledge in the subject they are asked to teach, both of which are important dimensions of teacher quality (Shulman 1986). Although teachers assigned to teach mathematics out-of-field possess content and pedagogical content knowledge of another subject(s), and may possess content knowledge in mathematics, this may be insufficient for the grade level they are teaching or for formal recognition.

The extent of out-of-field teaching in mathematics varies across countries. In the United States, the estimates range from 18% to 35%, from 1988 to 2015 (Hill & Gruber 2011; Hill, Stearns & Owens 2015; Morton et al. 2008; Seastrom et al. 2004; Shah et al. 2019). In Australia the rate has been consistently estimated at more than 20% at the lower secondary level (Shah et al. 2022; Weldon 2016). Rates vary across school contexts (e.g., sector, size and location) and teacher characteristics (e.g., age and employment contract) (Shah et al. 2022). As mathematics is compulsory through grades 7-10, this affects many students. A number of empirical studies have associated higher student achievement in mathematics with being taught by in-field, rather than out-of-field, teachers (Clotfelter, Ladd & Vigdor 2010; Dee & Cohodes 2008; Goldhaber & Brewer 2000). Not surprisingly, out-of-field teaching in mathematics is a policy concern in many countries, including Australia.

Teaching quality refers to the strong classroom instruction that enables a wide range of students to learn (Darling-Hammond 2012). OECD (2019a) notes teachers' instructional practices and strategies in the classroom as instrumental in influencing the quality of teacher-student interactions and teaching overall. Since Waller's (1932) classic, *The sociology of teaching*, qualitative researchers have argued that interactions between students and teachers in the classroom form a whole that is greater than the sum of its parts, which can significantly alter students' initial knowledge and attitudes (see Wenglinsky

2002). Instructional practices have been demonstrated to have the strongest direct influence on student learning (Baumert et al. 2010; Echazarra et al. 2016; Kunter et al. 2013; Le Donné, Fraser & Bousquet 2016; Muijs et al. 2014; OECD 2021; Wenglinsky 2002). In turn, student-related characteristics can affect teachers' instructional practices (Skinner & Belmont 1993).

It would seem that a necessary condition for mathematics teachers to be able to provide high-quality classroom instruction would be for them to have content and pedagogical content knowledge of mathematics. In other words, they should be teaching mathematics 'in-field'. Quality classroom instructional practices may be negatively impacted for out-of-field teachers of mathematics. Yet to our knowledge, no research has systematically compared instructional practices of in-field versus out-of-field mathematics teachers. This is surprising given the extent of out-of-field teaching in mathematics, and such research can provide insights into the challenges out-of-field teachers face in the classroom to inform the design of professional development programmes and mitigate potential effects on student outcomes. Such research may also help school principals make better decisions on the assignment of teachers to classes.

The main purpose of this report is to investigate the differences in the instructional practices of in-field and out-of-field teachers in Years 7-10 mathematics classes, using Australian data from teachers and principals from the latest available OECD Teaching and Learning International Survey data (TALIS 2018). The TALIS data contain considerable information about teachers' backgrounds and the school contexts in which they teach. In particular, TALIS includes explicit information on teachers' instructional practices in a target classroom.

Dimensions of teacher and teaching quality

Significant conceptual (e.g., specifying a theoretical model of how school resources might affect student outcomes) and methodological challenges exist (e.g., accounting for endogeneity resulting from the non-random allocation of students and teachers to schools) in identifying the factors affecting students' learning outcomes (e.g., Castellano, Rabe-Hesketh & Skrondal 2014; Chetty, Friedman & Rockoff 2014a; Hanchane & Mostafa 2010; Nye, Konstantopoulos & Hedges 2004; OECD 2005; Steele, Vignoles & Jenkins 2007). Notwithstanding, teachers have consistently been identified as a key influence, even after accounting for prior student learning and family background (Chetty, Friedman & Rockoff 2014a; Chetty, Friedman & Rockoff 2014b; Goldhaber 2016; Hattie 2009; OECD 2021; Jackson 2018; Jackson, Rockoff & Staiger 2014; Kane, Rockoff & Staiger 2008; Kane & Staiger 2008; Nye, Konstantopoulos & Hedges 2004; OECD 2005; Rivkin, Hanushek & Kain 2005). Not all teachers have the same effects on student outcomes and identifying teacher qualities that make a difference is a complex and multifaceted task. Many easily measured personal traits of teachers, such as gender, age, educational attainment and licensure, have less frequently been found to associate with student outcomes. Improvement with experience generally occurs early in teachers' careers, with gains in quality seldom detected after five years (Goldhaber 2016).

The Three Basic Dimensions (TBD) model

Klieme and his colleagues (Klieme et al. 2006, 2009) distilled three components, often referred to as the “the three basic dimensions”, crucial for insightful learning:

1. the degree of cognitive challenge and activation offered to students;
2. degree of learning support provided through individual monitoring of the learning process;
3. and, effective classroom management.

Motivation and self-regulation

Kunter et al. (2013) suggested motivation and self-regulation as additional dimensions of teacher quality. Teachers are typically offered few direct incentives or rewards to enhance their commitment to the profession. However, motivated teachers are able to maintain high levels of occupational enjoyment and commitment. This relates to their tolerance for frustration despite constant high demands on their attention and energy. Motivational characteristics are likely to be correlated with self-efficacy. Self-regulatory characteristics include teachers' ability to regulate their intensity of engagement with work while at the same time coping effectively with the stress that such engagement can create for their wellbeing (De Clercq, Watt & Richardson 2022; Klusmann et al. 2008; Sáez-Delgado et al. 2022).

Shulman (1986) conceptualised teacher quality across several different knowledge dimensions:

1. content—knowledge of subject matter and its organising structures;
2. pedagogical content—knowledge of content and pedagogy;
3. general pedagogical—principles and strategies of classroom management and organisation that are cross-curricular;
4. curriculum—subject and grade-specific knowledge of materials and programs;
5. learners and their characteristics;
6. educational contexts—knowledge of classrooms, governance and financing of school districts, the culture of the school community;
7. educational ends, purposes, values, and their philosophical and historical grounds.

Blömeke and Delaney (2012) refer to Shulman's first three dimensions as ‘cognitive abilities’ (professional knowledge). Content knowledge is necessary to the development of pedagogical content knowledge in mathematics, which is profession-specific and not incidental general mathematical knowledge that is casually picked up. Pedagogical content knowledge goes beyond the knowledge of the subject matter per se to how to teach the subject matter.

General pedagogical knowledge can be differentiated into two main components:

1. pedagogical knowledge:
 - teaching methods—having a command of various teaching methods, knowing when and how to apply each;
 - classroom assessment—knowledge of different forms and purposes of formative and summative assessments;

- how different frames of reference (e.g., social, individual, criterion-based) impact students' motivation;
- structure—structuring of learning objectives and the lesson process, lesson planning and evaluation;
- adaptivity—dealing with heterogeneous learning groups in the classroom.

2. psychological knowledge:

- learning processes—supporting and fostering individual learning progress by having knowledge of various cognitive and motivational learning processes (e.g., learning strategies, impact of prior knowledge, effects and quality characteristics of praise);
- individual student characteristics—the sources of student cognitive, motivational, and emotional heterogeneity (König et al. 2011; Kunter et al. 2013).

However, few empirical studies have assessed the various components of teachers' knowledge, although many studies have used distal measures such as qualifications, as a proxy for content knowledge. Baumert et al. (2010) conducted one of few such studies that created knowledge tests to assess teachers' knowledge directly, and then analyse the effects on student outcomes.⁵ Their study was able to distinguish content knowledge from pedagogical content knowledge in a nationally representative sample of 194 German secondary school mathematics teachers. The results showed positive effects of pedagogical content knowledge on students' learning gains mediated by instructional practices such as cognitive activation and individual learning support for students. While content knowledge was highly correlated with pedagogical content knowledge, it did not uniquely predict student progress above the effects of pedagogical content knowledge.

Baumert et al. (2010) tentatively concluded that initial mathematics teacher training programs that compromise on subject matter or content training were less effective in developing pedagogical content knowledge, which consequently adversely affected teachers' instructional quality and students' progress. Differences in content knowledge that emerged during preservice teacher education also tended to persist in teachers' later teaching careers. The authors propose that preservice mathematics teachers' preparation need not include mathematics coursework to the same level as students majoring in mathematics, and recommend that sound understanding of the discipline could be achieved with reference to school mathematics topics without loss of mathematical rigour. They highlight a challenge for future research as determining whether and how this can be achieved (Baumert et al. 2010). These are important considerations for those designing in-service professional development for out-of-field teachers.

Krauss, Baumert and Blum (2008) proposed different levels of mathematical content knowledge, also suggesting the second to be an appropriate level for secondary school mathematics teachers:

1. the academic knowledge generated at institutes of higher education,
2. a profound mathematical understanding of the mathematics taught at school,
3. a command of the school mathematics covered at the level taught, and
4. the mathematical everyday knowledge that adults retain after leaving school.

⁵ König et al. (2011) focused on general pedagogical knowledge of a sample of future teachers who were in their final year of training before becoming eligible practising mathematics teachers.

Epistemological beliefs

In the context of teaching and learning mathematics, two beliefs about the nature of teaching and learning are described—transmissive and constructivist. Students of teachers who hold constructivist beliefs show better learning outcomes (Dubberke et al. 2008; Staub & Stern 2002). Transmissive teaching involves students receiving information passively, whereas constructivist teaching involves active student learning and knowledge construction, within a social context.

Wenglinsky (2002, p. 23) labelled teachers with transmissive beliefs 'passive', who "leave students to perform as well as their own resources will allow". In mathematics, this means reducing the subject to its simplest components, with "all lessons taught at a similar level of abstraction; problems solved in a single step and only one solution admitted; and all students treated as if they had entered the class with the same level of preparation and the same learning styles" (Ibid).

In contrast, teachers with constructivist beliefs he labelled 'active', who press all students to 'grow' regardless of their backgrounds. Mathematics lessons conducted by active teachers "work at multiple levels of abstraction, from the most mundane problem to the most general theorem; problems involve multiple steps and allow multiple paths to their solution; and teachers tailor their methods to the knowledge and experience of each individual student".

Using the United States 1996 National Assessment of Educational Progress data, Wenglinsky showed the effects of classroom practices, when added to those of other teacher characteristics, were comparable in size to the effects of student background. This suggests that teachers can contribute as much to student learning as students themselves. Active teaching in particular, which includes a focus on higher order thinking skills, associates with improved student performance.

TALIS 2018 lower secondary teachers' data

TALIS 2018 is the third and most recent iteration of the OECD Teaching and Learning International Survey (TALIS). It collected internationally comparable data from teachers and principals about the learning environment and working conditions in primary, lower secondary and upper secondary schools in 49 school systems.⁶ Forty-eight countries and territories participated in the 'core' survey which covered lower secondary schools, including Australia.⁷ For this core survey, a two-stage sampling design was used which required a random sample of at least 200 schools at the first stage and a random sample of 20 grade 7-10 teachers⁸ from each school at the second stage.⁹ A unique common school identifier allowed data from the principals' survey to be linked to the teachers' data.

In the Australian sample, schools were stratified by jurisdiction, sector and geographic location. Altogether, 3,573 Years 7-10 teachers and 230 principals completed their respective questionnaires.¹⁰ The principals' survey contained questions about the school context, such as size, location and sector. Principals were also asked about school autonomy in decision-making, the school's experience of staff shortages, the academic pressure on staff and level of delinquency and violence in the school.

The teachers' survey included questions about teachers' background, such as their demographic characteristics, employment contract, hours of work and experience. It included questions about the subjects they taught and whether they had qualifications to teach those subjects. Teachers were also asked questions about their self-efficacy, professional development experience, professional practices and relationships with students.

An important aim of TALIS 2018 was to learn about what happens in the classroom, including student behaviour and teachers' instructional practices. To achieve this aim, the teacher survey included questions about what happened in a 'target' class¹¹ chosen at random from the teacher's timetable.

Many principals' and teachers' perceptions and behaviours are latent traits or constructs and cannot be observed directly but only through expressed opinions or behaviour reported by participants in the surveys. Examples of such latent constructs include principals' reports of academic pressure on teachers, teachers' self-efficacy, and reported instructional practices in the target classroom. The responses of participants in the surveys to relevant questions were combined into scales or indexes and included in the TALIS 2018 dataset. Details of how these indices were constructed can be found in OECD (2019b).

⁶ In the Southern Hemisphere surveys were conducted between September and December of 2017 and in the Northern Hemisphere between March and May of 2018.

⁷ Some countries conducted the survey in schools that participated in the 2015 Programme for International Student Assessment (PISA). However, the teachers in the TALIS survey were not necessarily the teachers of students in PISA (OECD 2019b) and only a subsample of the teachers in the main TALIS were in this TALIS-PISA Link survey.

⁸ A teacher was defined as 'one whose primary or major activity in the school is student instruction, involving the delivery of lessons to students' (OECD 2014, p. 28). Teacher aides, pedagogical support staff and health and social support staff were excluded, as were substitute, emergency or occasional teachers, teachers teaching adults exclusively and teachers on long-term leave.

⁹ In schools where the total number of teachers was 20 or less, all teachers were included in the survey.

¹⁰ The initial response rate for the principals' survey was just below 50%. Even though after replacement the response rate was about 76%, the OECD rated the outcome as insufficient to yield reliable information. The teacher survey was rated as fair (OECD 2019b).

¹¹ The first class taught at Year 7-10 by the teacher in the school after 11 a.m. on the last Tuesday before the survey was completed. If the teacher did not teach a class at this level on Tuesday, then it was the class taught on a day following the last Tuesday.

Out-of-field teaching by subject

Before presenting the results on out-of-field teaching in mathematics, we first show how out-of-field teaching varied by subject. The teachers' survey did not contain a specific question on out-of-field teaching, but included the following:

Were the following subject categories included in your formal education or training and do you teach them during the current school year to any Year 7-10 students in this school?

Teachers' responses to this question were collected in a matrix of two columns and twelve rows. The two columns were headed: 'Included in my teacher education or training' and 'I teach it to Years 7-10 students in this year'. The rows listed twelve subjects, including mathematics, with the last row labelled 'Other'. Respondents selected all relevant boxes in this matrix. For each subject, a binary variable was constructed to indicate if a teacher taught the subject in-field or out-of-field, with 1 indicating out-of-field teaching and 0 indicating in-field teaching.¹² The variable value was set as missing if the teacher did not teach the subject. No variable was defined for the 'Other' subject, necessarily excluded from analyses. A separate question determined the subject taught in the target class. The responses to this question were contrasted with teachers' subject qualifications to construct, for each subject, a binary variable to indicate whether the target class was taught in-field or out-of-field.

Many teachers reported teaching more than one subject at Years 7-10, some in-field and others out-of-field. Table 1 reports the aggregate out-of-field teaching and includes all the subjects each teacher taught. The out-of-field rate in mathematics at 22.6% is comparable to the 21.0% rate Weldon et al. (2014) found in the 2013 *Staff in Australia's Schools* (SiAS) survey, but is higher than the 20.0% Shah et al. (2022) found in the PISA 2015 survey of Year 10 teachers. The higher rate in TALIS 2018 may be because it includes lower Year-level classes where out-of-field teaching may be more prevalent. The overall out-of-field teaching rate of 25.4% indicates almost one in every four classes at Years 7-10 was taught out-of-field.¹³

The relatively low out-of-field teaching rates in science and social studies reflect the fact that these subjects are composed of subdomains which are not identified in the data, where aggregation of the subdomains into a single subject loses information. For example, teachers teaching physics but who were qualified to teach only biology and chemistry are classified as teaching science in-field when in reality they are teaching out-of-field. As such, the out-of-field teaching rates in science and social studies do not reflect the true levels of out-of-field teaching in those subjects. The relatively high out-of-field teaching rates in some subjects such as ancient languages, reflect not only a teacher shortage but also low student demand for those subjects. Schools on tight budgets may find it difficult to justify hiring a specialist teacher for the sake of a few students in these elective subjects. Despite their higher rates of out-of-field teaching, a much smaller number of students is affected, compared to the number of students affected by out-of-field teaching in mathematics which is a compulsory subject through Years 7-10.

¹² A tick in both columns indicated in-field teaching; a tick in only the left column indicated qualified to teach subject but not currently teaching; and a tick in only the right column indicated out-of-field teaching.

¹³ The estimate includes information on all subjects each teacher provided in the survey. It does not include information on multiple classes taught in the same subject.

Table 1 Out-of-field teaching in Years 7-10, by subject, Australia, 2018 (%)

Subject	Sample size (n) ¹	% Out-of-field	S.E.	95% Confidence interval	
Mathematics	1120	22.6	1.3	19.9	25.2
Ancient languages ²	46	72.9	8.4	56.1	89.6
Religion/ethics	360	48.8	3.1	42.7	55.0
Vocational education ³	629	42.6	2.4	37.8	47.3
Technology ⁴	1101	36.8	1.9	33.0	40.5
Modern languages	235	32.6	3.7	25.4	39.9
Physical education	679	23.4	1.9	19.6	27.3
English	1780	20.6	1.0	18.6	22.6
Social studies ⁵	1053	19.4	1.3	16.8	21.9
Arts ⁶	639	14.7	1.9	11.0	18.4
Science ⁷	948	13.0	1.2	10.7	15.4
Overall	3275	25.4	0.8	23.9	27.0

Source: OECD, TALIS 2018 Database.

Notes: Weighted estimates. S.E. refers to the standard error.

1 The sample size denotes the number of teacher records that contributed in the calculation of the statistics. Some teachers taught more than one subject and, therefore, are counted in more than one row. Consequently, the sum of the column is larger than the overall sample size.

2 Ancient languages include ancient Greek and Latin.

3 Vocational education includes vocational skills (preparation for a specific occupation), technics, domestic science, accountancy, business studies, career education, clothing and textiles, driving, home economics, polytechnic courses, secretarial studies, tourism and hospitality, and handicraft.

4 Technology includes orientation in technology, including information technology, computer studies, construction/surveying, electronics, graphics and design, keyboard skills, word processing, workshop technology and design technology.

5 Social studies include social studies, community studies, contemporary studies, economics, environmental studies, geography, history, humanities, legal studies, studies of their own country, social sciences, ethical thinking and philosophy.

6 Arts includes arts, music, visual arts, practical art, drama, performance music, photography, drawing, creative handicraft and creative needlework.

7 Science includes science, physics, physical science, chemistry, biology, human biology, environmental science and agriculture/horticulture/forestry.

Out-of-field teaching in mathematics

This section focuses on *all* teachers who taught mathematics. It shows how in the out-of-field and in-field teaching rates varied among subgroups of these teachers, defined by their personal characteristics and school context.

Subject qualifications of in-field and out-of-field teachers

Teachers teaching mathematics were qualified to teach a range of combinations of different subjects (Table 2). Teachers qualified to teach just mathematics comprised 5.5% of all teachers. About half of teachers teaching mathematics had qualifications to teach mathematics and at least two other subjects. Although most teachers specialise to teach two subjects in initial teacher education courses in Australia, in the humanities the number can be higher. It is surprising that such a high proportion of teachers reported qualifications to teach three or more subjects which included mathematics.

Table 2 Subject qualifications of in-field and out-of-field mathematics teachers, Years 7-10, Australia, 2018 (%)

Teaching mode	Subjects qualified to teach	Sample size (n)	%	S.E.	95% Confidence interval	
In-field	Mathematics, STEM ¹ and Others ²	569	51.1	1.7	47.7	54.5
	Mathematics & STEM	153	15.0	1.2	12.8	17.6
	Mathematics & Others	73	5.7	0.8	4.4	7.6
	Mathematics only	41	5.5	0.8	4.1	7.5
Out-of-field	STEM & Others	149	12.4	0.9	10.7	14.4
	Others only	67	5.5	0.9	4.0	7.6
	STEM only	37	2.4	0.5	1.6	3.5
Unknown	Not stated	31	2.3	0.4	1.6	3.3
Total		1120	100.0			

Source: OECD, TALIS 2018 Database.

Notes: Weighted estimates. S.E. refers to the standard error.

1 STEM includes science or technology (not mathematics).

2 Others includes at least one of English, modern languages, ancient languages, arts, physical education, religion/ethics and vocational education.

Teachers' demographic characteristics

Previous research has shown the assignment of teachers to out-of-field teaching is not random (see Shah et al. 2022). Table 3 shows this to be also true with respect to the TALIS 2018 data which reveals significant variation in out-of-field and in-field rates across teachers' age cohorts. The out-of-field teaching rate for the 30-39 years cohort was 34.1% compared to 14.6% for the oldest ≥ 50 years cohort; 65.9% and 84.4% were the corresponding in-field rates. Somewhat surprising is the relatively lower rate for the youngest cohort, which includes mostly teachers who are at the beginning of their teaching careers.

Age and experience were highly correlated, with out-of-field teaching significantly less common for teachers having more teaching experience. While out-of-field teaching rates were similar for full-time and part-time teachers, teachers who worked less than 40 hours on tasks related to their job in their school in the previous week were significantly more likely to be teaching out-of-field than teachers who worked more than these hours. These results are generally consistent with what was observed in the PISA 2015 data (Shah et al. 2022). Although the final teaching assignment decision may be that of the school, it seems senior teachers can exert influence on what classes they are assigned, favouring teaching in-field.

Table 3 In-field and out-of-field teaching in mathematics, by teacher background characteristics, Years 7-10, Australia, 2018 (%)

Background	Level	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
Gender	Female	75.9	2.0	24.1	2.0
	Male	79.2	2.1	20.8	2.1
Age (years)***	< 30	76.3	3.7	23.7	3.7
	30-39	65.9	4.1	34.1	4.1
	40-49	79.7	3.4	20.3	3.4
	≥ 50	85.4	2.0	14.6	2.0
Qualification level	Below Bachelor	80.4	0.6	19.6	6.3
	Bachelor	76.9	1.6	23.1	1.6
	Above Bachelor	78.9	1.6	21.1	3.6
Teaching qualification	Concurrent ¹	76.7	1.8	23.3	2.2
	Consecutive ²	79.2	1.9	20.8	1.7
	Other	72.4	1.3	27.6	4.3
Employment contract	Permanent	78.6	1.3	21.4	1.4
	Fixed-term	69.6	1.3	30.4	5.1
Hours of work	Full-time	77.9	1.0	22.1	1.5
	Part-time	73.8	1.0	26.2	4.4
Hours worked last week**	≤ 40	71.7	1.5	28.3	2.4
	> 40	80.5	1.5	19.5	1.8
Experience in current school (years)**	≤ 5	73.7	1.7	26.3	2.2
	> 5	81.3	1.7	18.7	1.7
Total teaching experience (years)	≤ 5	71.9	1.7	28.1	3.3
	> 5	79.2	1.7	20.8	1.7
Total		77.4	1.6	22.6	1.6

Source: OECD, TALIS 2018 Database.

Notes: Weighted estimates. S.E. refers to the standard error.

1 Pedagogy and subject content learning undertaken concurrently in the same course, for example, Bachelor of education.

2 Content learning undertaken first in degree course followed by a course to learn pedagogy.

* $p < .05$, ** $p < .01$, *** $p < .001$

Teachers' motivation, values, self-efficacy, professional engagement and wellbeing (not mathematics-specific)

This section compares in-field and out-of-field teachers of mathematics on measured latent constructs, constructed from their reported opinions and behaviours about teaching in general - not specifically related to mathematics. Results reveal no statistically significant differences between in-field and out-of-field teachers at the $p < .05$ threshold.

Teacher motivation and perceptions

Two measures of teachers' motivation to teach, 'personal utility value' and 'social utility value' (items from Watt & Richardson, 2007), and one of 'perceptions of value and policy influence' (e.g., teachers being valued by policymakers and the media, and their influence on educational policy) were constructed. Mean scores were similar for all three across in-field and out-of-field teachers (Table 4).

Self-efficacy

The five measures of teacher self-efficacy reported in Table 4 relate to teachers' general perceptions about teaching, not specific to mathematics. A composite measure was derived from three subscales tapping each of self-efficacy for instruction, student engagement, and classroom management.

Instruction referred to teachers' confidence to perform certain teaching tasks, such as crafting good

questions for students and using a variety of assessment strategies. Student engagement captured teachers' confidence to engage students, such as helping students value learning and think critically. Classroom management focused on teachers' confidence to control a class, including management of disruptive student behaviour. Self-efficacy in multicultural classrooms captured teachers' confidence in using strategies to teach culturally diverse classes, such as adapting their teaching to culturally diverse students. There were no statistically significant differences on either the composite or specific self-efficacy scores for in-field versus out-of-field teachers.

Job satisfaction

Teachers' job satisfaction had two dimensions: satisfaction with the current work environment and satisfaction with the profession. Table 4 shows that in-field teachers reported marginally higher job satisfaction than out-of-field teachers ($p < .10$).

The overall measure was derived from these subscales capturing whether teachers:

1. would like to change schools;
2. regretted becoming a teacher;
3. believed their job negatively impacted their mental and physical health;
4. had too much administrative work to do;
5. were intimidated or verbally abused by students;
6. believed teaching offered them a secure job.

Workplace wellbeing and stress

Workplace wellbeing and stress captured the overall stress teachers suffered as well as whether the job had a negative impact on their personal life and physical and mental health. Workload stress included issues such as teachers feeling that they had too much lesson preparation, too many lessons to teach, too much administration and too many extra duties due to absent teachers. It also included issues related to classroom discipline and responsibility for students' achievement. Participation among stakeholders mainly captured teachers' views on whether the school had a culture which included teachers, parents and students in decision making. Average workplace wellbeing and stress did not significantly differ for in-field and out-of-field teachers (Table 4).

Professional practices

Measures of professional practice included teachers' cooperation with each other such as sharing teaching materials, joint teaching in the same class, and striving to develop new ideas for teaching and learning. The overall measure was similar for out-of-field and in-field teachers, although professional collaboration in lessons was rated marginally significantly higher by out-of-field than in-field teachers.

Professional development

Professional development could be important in mitigating out-of-field teaching. It could upskill suitable teachers to some minimum standard when they do not have a specialist qualification. None of the questions on professional development in the survey was specific about teaching mathematics. Issues captured by professional development needs included whether the activity appropriately focused on the content and the pedagogy needed to teach subject matter (although the subject was

undefined), teaching culturally diverse students, characteristics of effective professional development (e.g., activities that built on teachers' prior knowledge, adapted to teachers' personal development needs, had a coherent structure) and barriers to undertaking needed professional development (e.g., work-schedule conflict and cost). There were no statistically significant differences in the responses by in-field and out-of-field teachers (see Table 4), likely because the questions did not target mathematics and out-of-field teachers of mathematics might have had their specialist subject instead or additionally in mind.

Table 4 Differences in teachers' general perceptions about aspects of teaching, for in-field and out-of-field teachers of mathematics, Years 7-10, Australia, 2018

Latent construct	In-field		Out-of-field		Difference in means
	Mean	S.E.	Mean	S.E.	p-value
Motivation to teach					
<i>Personal utility value</i>	10.6	0.10	10.9	0.16	.134
<i>Social utility value</i>	12.0	0.07	12.2	0.15	.303
<i>Perceptions of value and policy influence</i>	8.6	0.11	8.3	0.21	.203
Teacher self-efficacy					
<i>Overall¹</i>	12.5	0.09	12.6	0.18	.686
<i>In instruction</i>	12.5	0.09	12.4	0.13	.682
<i>In student engagement</i>	11.8	0.11	11.7	0.20	.845
<i>In classroom management</i>	12.5	0.10	12.8	0.18	.110
<i>In multicultural classrooms</i>	10.7	0.11	11.1	0.23	.117
Teacher satisfaction					
<i>Job satisfaction overall²</i>	12.1	0.11	11.7	0.15	.069
<i>Job satisfaction with work environment³</i>	12.0	0.11	11.7	0.15	.094
<i>Job satisfaction with profession</i>	11.4	0.10	11.2	0.15	.152
Workplace wellbeing and stress					
<i>Workplace wellbeing and stress</i>	9.4	0.09	9.6	0.15	.215
<i>Workload stress</i>	9.1	0.07	9.3	0.14	.225
<i>Student behaviour stress</i>	9.4	0.08	9.7	0.18	.112
<i>Teacher-student relations</i>	13.3	0.09	13.0	0.14	.143
<i>Participation among stakeholders, teachers</i>	11.3	0.08	11.2	0.15	.915
Professional practices					
<i>Teacher cooperation overall³</i>	9.8	0.08	10.1	0.16	.223
<i>Professional collaboration in lessons among teachers</i>	9.0	0.08	9.4	0.15	.092
<i>Exchange and co-ordination among teachers</i>	10.9	0.09	11.0	0.18	.694
<i>Team innovativeness</i>	11.4	0.09	11.1	0.11	.134
Professional development (PD)					
<i>Need PD in subject matter and pedagogy</i>	9.4	0.09	9.5	0.13	.505
<i>Need PD for teaching for diversity</i>	9.8	0.07	10.1	0.15	.080
<i>Effective PD</i>	12.2	0.08	12.2	0.19	.960
<i>PD barriers</i>	9.3	0.08	9.6	0.15	.119

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates. S.E. refers to the standard error.

1 The overall self-efficacy is a composite measure derived by averaging the three sub-scales: 1) self-efficacy in instruction 2) self-efficacy in student engagement 3) self-efficacy in classroom management.

2 The overall job satisfaction is a composite scale derived by averaging the two sub-scales: 1) job satisfaction with the work environment 2) job satisfaction with the profession.

3. The overall teacher cooperation is a composite scale derived by averaging the two sub-scales: 1) professional collaboration in lessons among teachers 2) exchange and cooperation among teachers.

4. The overall teacher practices is a composite scale derived by averaging the three sub-scales: 1) clarity of instruction 2) classroom management 3) cognitive activation.

School contexts

Many aspects of school context have been identified as important determinants of out-of-field teaching in mathematics (Shah et al. 2022). Below we examine whether these results apply in TALIS 2018 data. School context data were derived from the principals' survey and linked to teachers' data using the unique school identifier. Table 5 shows in-field and out-of-field teaching rates in mathematics for teachers in different school contexts.

Geographic location

Rural schools are generally smaller because of the sparse population where they are located. In such locations teacher labour markets are thinner. Combined with the fact that mathematics is a compulsory subject in the curriculum until the end of Year 10 for which schools are obliged to provide minimum instruction to all students, means these schools are often likely to be short of specialist teachers. Consequently, higher rates of out-of-field teaching in mathematics could be expected in rural than city schools. However, TALIS 2018 data provided only weak evidence in support of this argument (see Table 5). It should be noted that the definition of rurality (≤ 3000 population) restricted the sample size of teachers in rural schools to a rather small number making the estimation of the out-of-field teaching rate for this group less precise.

School size

Smaller schools, often located in rural locations, have the problem of economy of scale, which means they are likely to lack the resources to employ specialist teachers across all subjects. In large compulsory subjects such as mathematics, these schools often have little choice but to assign teachers to teach out-of-field. Table 5 shows few differences in out-of-field teaching rates by school size.

Students per teacher ratio

Table 5 shows that the out-of-field teaching rates increased with school student to teacher ratios, although the difference in rates was not statistically significant. A possible explanation lies in the fact that smaller student to teacher ratios generally associate with high levels of financial resources, which impact differences in out-of-field teaching rates between schools (Shah et al. 2022).

School sector

Out-of-field teaching rates were significantly higher for teachers in public than private schools. These differences are very much associated with the differences in financial resources available to schools in the two sectors. Additional resources give private schools a competitive advantage in the teacher labour market, especially for mathematics teachers who seem to be in perennial demand. It also allows these schools to maintain a 'buffer' of qualified mathematics teachers on their staff, affording them added flexibility when assigning teachers to classes and reducing their need to engage in the riskier short-term teacher labour market for immediate needs.

School autonomy

The principals' survey contained questions assessing the level of autonomy schools had over budget, staffing, instruction, educational policies and curriculum. Autonomy is associated with school sector, where private schools enjoy more autonomy. Table 5 shows lower rates of out-of-field teaching in schools which enjoyed full autonomy than limited or no autonomy, except in the case of curriculum, which is generally stipulated at the state level and which all schools are required to follow.

Staff shortage

Principals were asked if the school's capacity to provide quality instruction was hindered by a lack of qualified staff. The question was asked in general terms, not specific to a shortage in any particular subject. Table 5 shows no statistically significant difference in out-of-field mathematics teaching rates for schools experiencing shortages or not, consistent with PISA 2015 data (Shah et al. 2022).

Table 5 In-field and out-of-field teaching in mathematics, by school context, Years 7-10, Australia, 2018 (%)

Context	Level	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
Location ¹	Rural	72.4	7.5	27.6	7.5
	Town	74.8	2.8	25.2	2.8
	City	79.2	1.6	20.8	1.6
School size	< 500	72.3	7.2	27.7	7.2
	500-999	75.2	7.2	24.8	7.2
	≥ 1000	80.9	7.2	19.1	7.2
Students per teacher	< 10	83.8	4.6	16.2	4.6
	10-15	77	1.5	23.0	1.5
	> 15	73.6	3.4	26.4	3.4
School sector**	Public	73.7	1.7	26.3	1.7
	Private	82.8	2.4	17.2	2.4
School autonomy ² : budget***	None/shared	72.3	1.7	27.7	1.7
	Full	87	2.2	13.0	2.2
School autonomy: staffing**	None/shared	70.8	2.6	29.2	2.6
	Full	80.6	1.8	19.4	1.8
School autonomy: instruction*	None/shared	73.4	1.9	26.6	1.9
	Full	81.2	2.1	18.8	2.1
School autonomy: educational policies*	None/shared	72.1	2.7	27.9	2.7
	Full	79.2	1.6	20.8	1.6
School autonomy: curriculum	None/shared	73.8	2.7	26.2	2.7
	Full	79	1.6	21.0	1.6
Staff shortage	No ³	77.5	1.5	22.5	1.5
	Yes ⁴	77.6	3.2	22.4	3.2
Total		77.4	1.6	22.6	1.6

Source: OECD, TALIS 2018 Database.

Notes: Weighted estimates. S.E. refers to the standard error.

1 Rural ≤ 3,000, Town 3,001-100,000, City > 100,000.

2 School autonomy in decision-making were derived from information from the school principal questionnaire. School principals had to indicate who, among a range of stakeholders had a considerable responsibility in making decisions relating to a number of tasks. Stakeholders included: 1) school-level (principal, school management team, teachers not part of the school management team, school governing board) 2) external authority (local, state or national government) and both could share the responsibility.

3 'No' indicates shortage was not a problem.

4 'Yes' indicates shortage was either a problem or a bit of a problem.

* $p < .05$, ** $p < .01$, *** $p < .001$

Academic pressure and school delinquency

Academic pressure captured principals' assessment of the extent to which teachers in their school understood the school's curriculum and succeeded in implementing it, whether teachers had high expectations of student achievement, and the extent of students' desire to do well in school. School delinquency captured aspects of student behaviour (e.g., vandalism, theft, intimidation, bullying, physical violence among students, and intimidation or abuse of teachers). The two scales were constructed from principals' responses to related questions within each theme. Table 6 shows that academic pressure was significantly higher in schools where teachers taught in-field. On the other hand, delinquency was higher in schools with teachers teaching out-of-field. This does not necessarily mean that schools with high levels of delinquency assign teachers to out-of-field teaching by choice. It is more likely to relate to circumstances such as not having sufficient resources, or not being able to attract teachers to work in challenging environments. In schools with higher academic pressure, sufficient resources seem more available to ensure in-field teaching occurs.

Table 6 Differences in academic pressure and delinquency in schools where in-field and out-of-field mathematics teachers worked, Years 7-10, Australia, 2018

Latent variable	In-field		Out-of-field		Difference in means
	Mean	S.E.	Mean	S.E.	p-value
Academic pressure	12.5	0.07	12.0	0.16	.008
School delinquency and violence	7.0	0.08	7.6	0.18	.005

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates. S.E. refers to the standard error.

Mathematics teaching in ‘target’ class

This section focuses on in-field versus out-of-field teachers’ reported behaviours and observations in a ‘target’ class. Only teachers teaching mathematics as their target class are included in these analyses. Questions regarding the target class asked about the student cohort and behaviour, as well as the teachers’ instructional and assessment practices. Not all teachers included in Table 1 completed the questions about the target class. Of the 2,771 who did, 472 taught mathematics of whom 11.4% taught mathematics out-of-field.

Student cohort characteristics

Each class was categorised as having a ‘high’ or ‘low’ concentration of students with respect to six characteristics: > 10% of students in a class possessing the characteristic was considered a high concentration otherwise the concentration was considered low. For each characteristic, we calculated out-of-field teaching rates in high versus low concentration classes (see Table 7).

Out-of-field teaching varied by class size, being significantly lower in smaller (< 18 students) than larger classes (≥ 18 students). It was significantly lower in classes having a high concentration of gifted students, and higher in classes having a high concentration of low-achieving students. On the other hand, it was similar in classes having different concentrations of disadvantaged students; students whose first language was not English; immigrant students; and behaviour problem students.

These results demonstrate the differential effect of out-of-field teaching in mathematics on students. It indicates a bias at the system level in how teachers are assigned to classes which may be due to self-selection of students and teachers to schools. Students from advantaged backgrounds are more likely to enrol in private schools which are generally better funded and thus more likely to attract qualified mathematics teachers. The attraction for teachers to such schools is often better pay and conditions.

Table 7 In-field and out-of-field teaching in mathematics, by target class composition, Years 7-10, Australia, 2018 (%)

Student cohort	Level	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
% of class with first language not English	≤ 10	87.5	2.0	12.5	2.0
	> 10	91.4	2.4	8.6	2.4
% of class immigrants	≤ 10	88.5	2.1	11.5	2.1
	> 10	88.6	2.6	11.4	2.6
% of class from disadvantaged background	≤ 10	90.7	1.9	9.3	1.9
	> 10	84.6	3.0	15.4	3.0
% of class low academic achievers**	≤ 10	93.6	1.8	6.4	1.8
	> 10	83.9	2.6	16.1	2.6
% of class academically gifted**	≤ 10	85.1	2.3	14.9	2.3
	> 10	95.4	1.6	4.6	1.6
% of class with behaviour problems	≤ 10	90.2	2.0	9.8	2.0
	> 10	85.2	3.0	14.8	3.0
Class size**	< 18	97.3	2.0	2.7	2.0
	18-25	87.0	2.7	13.0	2.7
	> 25	88.8	2.4	11.2	2.4
Total		88.6	1.6	11.4	1.6

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates. S.E. refers to the standard error.

* $p < .05$, ** $p < .01$, *** $p < .001$

Planning and teaching control

Teachers were asked their level of agreement or disagreement on issues relating to planning and teaching, such as determining content and disciplining students. Table 8 shows the out-of-field teaching rates for teachers who disagreed and agreed with each issue. There were no statistically significant differences¹⁴; assignment to teach mathematics out-of-field had no significant influence on teachers' sense of control of teaching and planning in the target class. Teachers' responses were used to construct a scale tapping satisfaction with their degree of autonomy in the target class overall; this was also similar for in-field and out-of-field teachers.

Table 8 In-field and out-of-field teaching in mathematics, by planning and control aspects of target class, Years 7-10, Australia, 2018 (%)

Aspect of teaching and planning	Level	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
Control over determining content	Disagree ¹	87.8	2.4	12.2	2.4
	Agree ²	89.4	2.3	10.6	2.3
Control over selecting teaching methods	Disagree	88.1	7.0	11.9	7.0
	Agree	88.8	1.6	11.2	1.6
Control over assessing students' learning	Disagree	92.9	2.9	7.1	2.9
	Agree	87.9	1.9	12.1	1.9
Control over disciplining students	Disagree	91.8	5.1	8.2	5.1
	Agree	88.6	1.7	11.4	1.7
Control over amount of homework to be assigned	Disagree	87.0	5.9	13.0	5.9
	Agree	88.9	1.7	11.1	1.7
Total		88.6	1.6	11.4	1.6

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates. S.E. refers to the standard error.

1 Includes 'strongly disagree' and 'disagree' responses.

2 Includes 'agree' and 'strongly agree' responses.

Classroom environment

When teachers teach out-of-field they can lack confidence in the subject content and the pedagogy to teach it. For some students this lack of confidence in the teacher, especially among those who are young and inexperienced, can be a sign of weakness which some exploit by becoming disruptive in class. This can mean much of the teacher's time is taken up disciplining students and managing the class. Table 9 tends to confirm this theory. It shows increasing class time spent disciplining students correlated with higher rates of out-of-field teaching, and increasing class time spent on teaching associated with lower rates of out-of-field teaching. Further, teachers who lost a lot of class time due to student interruption, and who experienced more classroom disruptions were significantly more likely to be teaching out-of-field than teachers who did not. A scale was constructed from all these responses to measure perceived disciplinary climate in the target class. It showed that the perceived disciplinary climate was significantly¹⁵ worse for teachers teaching out-of-field than in-field. It is important not to conclude causation, because of other school and class context variables that affect teacher and student behaviours.

¹⁴ Data not included in the table show that an overwhelming proportion of teachers agreed they had control over teaching methods, disciplining students and the amount of homework assigned.

¹⁵ $p < .05$

Table 9 In-field and out-of-field teaching in mathematics, by target class environment, Years 7-10, Australia, 2018 (%)

Teaching environment	Level	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
% of class time disciplining***	≤ 10	96.8	1.3	3.2	1.3
	11-20	85.8	3.0	14.2	3.0
	> 21	78.2	5.0	21.8	5.0
% of class time teaching**	< 67	78.6	4.8	21.4	4.8
	≥ 67	91.6	1.7	8.4	1.7
Have to wait long time for students to quieten down	Disagree ¹	89.4	1.9	10.6	1.9
	Agree ²	86.8	4.0	13.2	4.0
Students create pleasant learning environment	Disagree	83.4	4.2	16.6	4.2
	Agree	91.2	1.6	8.8	1.6
Lose a lot of time due to student interruption**	Disagree	92.0	1.7	8.0	1.7
	Agree	81.3	3.9	18.7	3.9
Much disruptive noise in class**	Disagree	92.0	1.7	8.0	1.7
	Agree	80.5	4.3	19.5	4.3
Total		88.6	1.6	11.4	1.6

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates. S.E. refers to the standard error.

1 Includes 'strongly disagree' and 'disagree' responses.

2 Includes 'agree' and 'strongly agree' responses.

* $p < .05$, ** $p < .01$, *** $p < .001$

Assessment practices

Providing students feedback on their learning progress is an important part of teaching. In TALIS 2018, teachers were asked the frequency with which they used four assessment practices in the target class. Table 10 shows that out-of-field teachers were more likely to let students evaluate their own progress, and provide immediate feedback when observing students working on particular tasks. Most teachers frequently used three of the four practices, but fewer than half of all teachers let students evaluate their own progress on a frequent basis, who were more likely to be teaching out-of-field than occasional users.

Table 10 In-field and out-of-field teaching in mathematics, by assessment practice usage in target class, Years 7-10, Australia, 2018

Assessment practice	Usage	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
Administer own assessment	Occasional ¹	91.2	2.7	9.8	2.3
	Frequent ²	88.2	2.7	11.8	2.2
Provide written feedback	Occasional	88.3	2.7	11.7	3.7
	Frequent	89.2	2.7	10.8	1.8
Let students evaluate own progress*	Occasional	92.1	3.2	7.9	1.9
	Frequent	84.2	3.2	15.8	3.1
Observe students when working on particular tasks and provide immediate feedback**	Occasional	97.6	2.2	2.4	1.5
	Frequent	87.5	2.2	12.5	1.9
Total		88.6	1.6	11.4	1.6

Source: TALIS 2018.

Note: Weighted estimates. S.E. refers to the standard error. * $p < .05$, ** $p < .01$, *** $p < .001$

1 Includes 'never or almost never' and 'occasionally' responses. 2 Includes 'frequently' and 'always' responses.

Instructional practices

Ainley and Carstens (2018) recognised the important role of instructional practices on student learning when conceptualising the design of TALIS 2018. Appropriate instructional practices are vital in motivating students to learn and achieve in subjects such as mathematics and first-language learning. Rjosk et al. (2014) showed that the effect of socioeconomic composition on achievement may be mediated partially by the teacher's focus on *language* during instruction. Such a focus refers to the targeted attention a teacher pays to language-related aspects like writing or speaking grammatically correctly.

Instructional practices can be assessed through students' reports of classroom activities (Marsh et al. 2012), classroom observations (Schlesinger & Jentsch 2016), and teacher reports (Wagner et al. 2016). Teachers' self-reports can be challenging to interpret because they can reflect what teachers perceive to be socially desirable (Little, Goe & Bell 2007; van de Vijver & He 2014). This often occurs when responders are asked about their level of agreement or disagreement, ranging from high to low, on a particular topic. In TALIS 2018, the problem of social desirability is avoided by using frequency response scales to assess how often a particular instructional practice (e.g., cognitive activation) occurred during lessons. According to Ainley and Carstens (2018), there are two implications from using such a scale. First, the responses represent the frequency with which the teacher uses an instructional practice rather than its quality. Second, because the reports provide a description of teachers' actions in the classroom, they capture the context of the classroom environment. Although TALIS 2018 refers to instructional practices, the measure draws on theory and research focused on instructional quality and recognises its multidimensional nature.

In TALIS 2018, teachers were asked the frequency (never or almost never, occasionally, frequently or always) with which they used specific instructional practices in the target class. Table 11 shows the variation in out-of-field teaching between occasional and frequent users of various instructional practices. There were four categories of questions, with the first three reflecting the 'three basic dimensions' (Klieme, Lipowsky & Rakoczy 2006):

1. classroom management;
2. clarity of instruction;
3. cognitive activation;
4. enhanced activities.

There were more similarities than differences between in-field and out-of-field teachers. Significant differences were evident on single aspects of each of classroom management, cognitive activation and enhanced activities, but not clarity of instruction.

Classroom management

Classroom management, including a safe and orderly classroom environment as reported by teachers, has been found to be an important predictor of student achievement (Baumert et al. 2010; Klusmann et al. 2008; Le Donné, Fraser & Bousquet 2016; van Tartwijk & Hammerness 2011; Wang & Degol 2016). It captures teachers' actions in the class for maintaining order, without which effective student learning may be difficult. A positive disciplinary climate in the target class serves as an indicator of effective classroom management.

Table 10 shows that a higher proportion of frequent than occasional users of classroom management practices taught mathematics out-of-field. By the same token a higher proportion of occasional than frequent users taught mathematics in-field. This suggests that when teachers lack content knowledge and pedagogical content knowledge, as they are more likely to when teaching out-of-field, classroom management becomes a challenge, taking up more time and effort from the teacher. Some students, when they perceive teachers lack confidence in what they are teaching, can become disruptive, distracting other students and forcing teachers to spend more time on classroom management.

Clarity of instruction

Clarity of instruction leads to positive student learning (Kyriakides & Creemers 2008; Scherer & Gustafsson 2015; Seidel, Rimmelle & Prenzel 2005). It refers to clear and comprehensive instruction and learning goals, ability to connect new and old topics, and providing students with a summary of the lesson at the end of class (Hospel & Galand 2016; Kane & Cantrell 2010; Seidel, Rimmelle & Prenzel 2005). It also includes practices such as providing extra help when needed, listening to and respecting students' ideas and questions, caring about and encouraging students, and providing them with emotional support (Klieme, Pauli & Reusser 2009). OECD (2019a) showed that most teachers, across all countries in TALIS 2018, frequently used practices that provided clarity of instruction. Our analyses, shown in Table 10, found no significant differences between the frequency with which teachers used clarity of instruction practices and out-of-field teaching.

Cognitive activation

Cognitive activation consists of instructional practices that require students to evaluate, integrate and apply knowledge within the context of problem solving (Lipowsky et al. 2009) and are central quality characteristics of teaching. They are demanding, complex and most closely connected to the subject domain (Baumert et al. 2010; Hiebert & Grouws 2007; Klieme, Pauli & Reusser 2009). Across all TALIS 2018 countries, including in Australia, cognitive activation was less widely practised than clarity of instruction (OECD 2019a). The frequency with which teachers used cognitive activation practices was generally not associated with out-of-field teaching; the exception was the practice of presenting tasks to students for which there was no obvious solution, where a significantly smaller proportion of frequent than occasional practitioners were teaching mathematics out-of-field.

Enhanced activities

Teachers were asked the frequency with which they asked students to do two types of enhanced activities: let students use ICT for projects, and set students extended projects to complete. Teachers who frequently asked students to do the second activity were more likely to be teaching out-of-field.

Table 11 In-field and out-of-field teaching in mathematics, by instructional practices usage in target class, Years 7-10, Australia, 2018 (%)

Instructional practice	Usage	Teaching in-field		Teaching out-of-field	
		%	S.E.	%	S.E.
Classroom management					
Tell students to follow classroom rules	Occasional ¹	92.4	2.1	7.6	2.1
	Frequent ²	86.2	2.4	13.8	2.4
Tell students to listen to what I say*	Occasional	93.7	1.6	6.3	1.6
	Frequent	85.8	2.5	14.2	2.5
Calm students who are disruptive	Occasional	91.5	2.1	8.5	2.1
	Frequent	86.7	2.5	13.3	2.5
When class begins, ask students to quieten down quickly	Occasional	92.3	2.2	7.7	2.2
	Frequent	86.9	2.3	13.1	2.3
Clarity of instruction					
Explain what I expect students to learn	Occasional	92.4	7.2	7.6	7.2
	Frequent	88.5	1.6	11.5	1.6
Explain how new and old topics are related	Occasional	93.3	2.8	6.7	2.8
	Frequent	88.1	1.8	11.9	1.8
Set goals at the beginning of instruction	Occasional	87.2	4.8	12.8	4.8
	Frequent	89.2	1.6	10.8	1.6
Refer to a problem from everyday life or work to demonstrate why new knowledge is useful	Occasional	90.2	3.4	9.8	3.4
	Frequent	88.2	1.9	11.8	1.9
Present summary of recently learned content	Occasional	90.8	3.3	9.2	3.3
	Frequent	88.2	1.9	11.8	1.9
Let students practise similar tasks until I know that all students have understood the subject matter	Occasional	87.5	4.6	12.5	4.6
	Frequent	89.2	1.6	10.8	1.6
Cognitive activation					
Give tasks which require students to think critically	Occasional	89.5	2.3	10.5	2.3
	Frequent	88.3	2.3	11.7	2.3
Have students work in small groups to come up with a joint solution to a problem or task	Occasional	89.8	1.8	10.2	1.8
	Frequent	86.7	3.8	13.3	3.8
Ask students to decide on their own procedures for solving complex tasks	Occasional	89.9	2.1	10.1	2.1
	Frequent	87.3	2.7	12.7	2.7
Present tasks for which there is no obvious solution*	Occasional	86.9	2.2	13.1	2.2
	Frequent	93.5	1.7	6.5	1.7
Enhanced activities					
Let students use ICT for projects or classwork	Occasional	91.7	1.8	8.3	1.8
	Frequent	87.1	2.3	12.9	2.3
Give students projects that require at last one week to complete*	Occasional	90.7	1.7	9.3	1.7
	Frequent	81.1	4.8	18.9	4.8
Total		88.6	1.6	11.4	1.6

Source: OECD, TALIS 2018 Database.

Note: Weighted estimates.

1 Includes 'never or almost never' and 'occasionally' responses.

2 Includes 'frequently' and 'always' responses.

* $p < .05$, ** $p < .01$, *** $p < .001$

TALIS 2018 data also included scales constructed from the responses to individual questions, to summarise instructional practices. While the mean for the overall measure of teaching practices and each of the Three Basic Dimension factors were similar for out-of-field and in-field teachers (see Table 12), particular aspects of classroom management and cognitive activation were rated differently (see Table 11).

Table 12 Differences in instructional practices in target class of in-field and out-of-field mathematics teachers, Years 7-10, Australia, 2018

Latent variable	In-field		Out-of-field		Difference in means
	Mean	S.E.	Mean	S.E.	p-value
Teacher practices overall ¹	11.2	0.1	11.7	0.2	.06
Clarity of instruction	12.4	0.1	12.7	0.4	.42
Classroom management	10.8	0.1	11.4	0.2	.02
Cognitive activation	9.6	0.1	9.6	0.2	.75

Source: TALIS 2018.

Note: Weighted estimates. S.E. refers to the standard error. Scales were standardised across all countries with a mean of 10 and standard deviation of 2.

1 Teacher practices overall was a composite scale derived by averaging the three subscales: 1) clarity of instruction 2) classroom management 3) cognitive activation. The values ranged from 2.4 to 17.0 for the overall scale, 3.8 to 15.5 for clarity of instruction, 6.5 to 14.3 for classroom management, and 4.4 to 15.0 for cognitive activation.

Concluding comments

This report investigated out-of-field teaching in mathematics in Years 7-10 in Australian schools using the most recent TALIS 2018 data which surveyed teachers and principals. These data uniquely feature information on teachers' instructional practices with respect to a target class, enabling identification of how in-field and out-of-field teachers' practice differs on specific aspects of their teaching of mathematics. The data also include broader information (not specific to the target class) on school context and teacher demographics, as well as general teaching motivations, self-efficacy, wellbeing, professional practice and professional development.

Differences in out-of-field teachers' instructional practice specific to mathematics revealed likely negative consequences for student engagement and learning. These teachers spent more time than in-field teachers on classroom management and disciplining students, lost more time due to student interruption, reported much disruptive noise in class, and spent less time spent teaching. One way to interpret these results is that when teachers have less content and pedagogical content knowledge, as is more likely when teaching out-of-field, then classroom management becomes their major focus. Out-of-field teachers significantly less often presented mathematical tasks to students for which there is no obvious solution, consistent with the reviewed literature which has shown a close relationship between cognitive activation practices and content and pedagogical content knowledge. In-field and out-of-field teachers reported similar amount of time on practices related to instructional clarity.

This report also shows that the assignment of teachers to out-of-field teaching in mathematics is not random, that both teacher characteristics and school context are important determinants. The results relating to age and experience show them to be significant factors determining whether teachers are teaching out-of-field. This suggests senior teachers have an influence in the school's decision as to what classes they teach.

School context results indicate the inequity in the effects of out-of-field teaching on students, which are systemic and symptomatic of increasing segregation of which main drivers are choice and unequal funding. Choice is available to parents who have the means to send their children to private schools, but also to those who are well educated and able to navigate and exploit the state system which in some states have a large number of selective schools. Choice is also available to parents who can buy or rent in neighbourhoods that have sought-after schools. The rest of schools include residual students whose parents have little choice. As such there is self-selection of students to schools, as well as that of teachers being attracted to schools with offers of better working conditions and pay. Their segregation is reflected in our results: higher rates of out-of-field teaching were observed in public schools, in schools with high levels of delinquency and classes with large students to teacher ratio, higher numbers of low-achieving and fewer gifted students. Gifted students are often offered scholarships to attend private schools, but disproportionate numbers are found in selective schools. Exposure to higher incidence of out-of-field teaching compounds the inequity that already exists for less advantaged students.

School autonomy, particularly in relation to staffing and educational policies, strongly associated with lower rates of out-of-field teaching in mathematics. However, the higher levels of autonomy enjoyed by private schools would unlikely be effective without the large amount of funding available to them. Their better funding enables them to compete for the best qualified teachers, and maintain a 'buffer' in their staffing profile to meet short-term demand internally, and obviate the need to compete in the short-term teacher labour market with its inherent risks. Schools on tight budgets do not have the

luxury of having such buffers of qualified staff to fall back on for short-term needs, and often need to resort to the short-term teacher labour market to fill needs, which carries the risk of not finding appropriately qualified staff.

Out-of-field teaching in mathematics is difficult to eliminate in its entirety because of structural problems, constraints in funding and the vagaries of the teacher labour market. However, its effects can be more equitably managed at the system level mainly through redistribution of funding. At the local level, schools can ensure that some students are not disproportionately exposed to out-of-field teaching as accumulated effects can be longer-term and difficult to mitigate. If professional development is the answer to alleviating the effects of out-of-field teaching, then its design, implementation and accessibility are of critical importance for educators, employers and policymakers to consider. Professional development that compromises on content knowledge or subject matter could adversely affect teachers' instructional quality. It should be of sufficient rigour to develop a profound understanding of mathematical knowledge commensurate with the level that teachers would be expected to teach, however, content does not have to be at the same level as for students majoring in mathematics according to Baumert and his colleagues (Baumert et al. 2010; Krauss et al. 2008). Close consideration is necessary regarding the mathematical content knowledge to best prepare teachers of mathematics, including professional development offerings to teachers teaching mathematics out-of-field.

Professional development offered to teachers teaching mathematics out-of-field needs to address the degree to which these teachers are obliged to come to terms with the level of mathematics they are teaching together with the pedagogical content knowledge necessary to effectively teach that content. Professional development for out-of-field teachers of mathematics needs to acknowledge and take account of the classroom realities these teachers contend with daily. They are more often assigned to teach low achievers, spend a disproportionate amount of time on classroom management and disciplining students who are noisier and more disruptive, resulting in less time spent on teaching. Professional development opportunities that ignore these daily realities will not align with the needs of out-of-field teachers of mathematics and will not be enthusiastically taken up by teachers who frequently need to undertake these courses in their own time. The potential of suitably designed professional development delivered online, or otherwise accessible during the working day with time release from other duties, would open up opportunities for teachers who are excessively busy but who conscientiously seek to meet the needs of their students, even when teaching outside their disciplinary expertise and specialist pedagogical education.

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