Inside the primary classroom: What happens in Fourth Class?

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Chapter 1: Overview of TIMSS 2015

TIMSS (**T**rends in **I**nternational **M**athematics and **S**cience **S**tudy) is among the largest and most in-depth studies of educational achievement in the world. Fifty-six countries, including Ireland, took part in the most recent cycle of TIMSS, in 2015. This chapter provides a brief introduction to the study and its implementation in Ireland.

What is TIMSS?

TIMSS is designed to assess the mathematics and science skills of students in Fourth grade (equivalent to Fourth Class in Ireland) and Eighth grade (Second Year) in participating countries, thereby providing national and cross-national comparative information for policy-makers and educators. The study is organised under the auspices of the International Association for the Evaluation of Educational Achievement (IEA), a non-profit consortium of research institutes. The Educational Research Centre (ERC) managed Ireland's participation in TIMSS 2015 on behalf of the Department of Education and Skills (DES). TIMSS takes place every four years. The first implementation of TIMSS was in 1995; the most recent, in 2015, was the sixth. Ireland has participated on three occasions – in 1995 and 2015 (at both primary and post-primary levels) and in 2011 (at primary level only).

An initial report for TIMSS 2015 in Ireland was published in November 2016 (Clerkin, Perkins & Cunningham, 2016), timed to coincide with the international launch of the results (Martin, Mullis, Foy & Hooper, 2016; Mullis, Martin, Foy & Hooper, 2016). The initial report focused on describing the achievement of Irish students in Fourth Class and Second Year on the TIMSS mathematics and science assessments and also included a comparison of the Irish curriculum, together with teachers' coverage of various topics in class, relative to the TIMSS assessment frameworks.

Which countries participated in TIMSS 2015?

As noted above, 56 countries participated in the study in at least one grade level (47 at Fourth grade and 39 at Eighth grade).[1] However, in order to facilitate a clear presentation of findings, international comparisons that are presented in tables or graphics in this report will be limited to a small group of countries that are of particular interest as comparators, rather than the full set of countries that took part in the study. This set of countries was selected as a result of high average performance on TIMSS 2015 (and, usually, other recent international assessments) or due to their cultural and linguistic similarities to Ireland. The selected countries are given in Table 1.1, in alphabetical order.

These countries provide the main focus for comparison alongside Ireland and the TIMSS (international) average. Maintaining a consistent group of comparison countries in this manner provides a coherent and stable basis for comparison across differing national and thematic contexts. Other countries may also be referred to in text where especially noteworthy findings are observed.

1 Seven benchmarking participants also took part. Benchmarking participants must follow the same procedures and meet the same data quality standards as countries, and can use the resulting (equivalent) data to benchmark their performance against national and international comparators.

Table 1.1: Selected comparison countries		
	Grade levels	**Primary reason for inclusion**
Australia	4 and 8	Cultural/linguistic similarity
England	4 and 8	Cultural/linguistic similarity
Finland	4	High performance (science)
Hong Kong SAR	4 and 8	High performance
New Zealand	4 and 8	Cultural/linguistic similarity
Northern Ireland	4	Cultural/linguistic similarity
Rep. of Korea	4 and 8	High performance
Russian Fed.	4 and 8	High performance
Singapore	4 and 8	High performance
Slovenia	4 and 8	High performance (science)
United States	4 and 8	Cultural/linguistic similarity

Readers should note that, when making reference to other countries, the internationally-comparable terms 'Fourth grade' and 'Eighth grade' are used. 'Fourth Class' and 'Second Year' are only ever used to refer specifically to students in Ireland.

How did Irish students perform?

Students' performance on each domain is reported on a scale that is set to an international 'centrepoint' of 500. This centrepoint has been maintained since the first TIMSS, in 1995, as a constant point of reference against which countries can monitor changes in their students' performance over time. It does not change with each cycle, unlike an international average, which would be expected to vary between cycles due to changes in performance within countries and different sets of countries taking part in each assessment year.

In general, Irish students achieved at a reasonably high level in TIMSS 2015, relative to other countries. At both grade levels, Irish students achieved mean mathematics and science scores that were significantly above both the centrepoint and the international average. Fourth Class pupils achieved a mathematics score that was significantly lower than pupils in seven countries, similar to pupils in four countries, and significantly higher than pupils in 37 countries. Performance in science was more moderate, with Fourth Class pupils achieving a score that was significantly lower than pupils in 15 countries, similar to nine countries, and significantly higher than 22 countries. Second Year students achieved a mean mathematics score that was significantly lower than students in six countries, similar to five countries, and significantly higher than 27 countries. Their science performance was significantly lower than seven countries, similar to six countries, and significantly higher than 25 countries.

Table 1.2 presents a summary of the differences in performance between students in Ireland and those in our selected comparison countries, along with the TIMSS average, for both domains at both grade levels. Statistically significant differences in scores are noted, where present, along with the difference for each country from Ireland's mean score.

Students in four countries – Hong Kong, Republic of Korea, Russian Federation and Singapore – achieved higher mean scores than Irish students on both domains and at both grade levels. In some other countries, students achieved a higher score than Irish students in one domain but a lower score in the other domain, either at Fourth grade (Finland, Northern Ireland, United States) or at both grade levels (Slovenia).

Table 1.2: Differences in performance between Ireland and comparison countries

	Fourth grade				Eighth grade			
	Maths		Science		Maths		Science	
	Sig.	Difference from IRL	Sig.	Difference from IRL	Sig.	Difference from IRL	Sig.	Difference from IRL
Australia	↓	-30	↔	-5	↓	-19	↓	-18
England	↔	-1	↑	7	↔	-5	↔	7
Finland	↓	-12	↑	25	n/a	n/a	n/a	n/a
Hong Kong	↑	67	↑	28	↑	71	↑	16
Ireland		547		529		523		530
New Zealand	↓	-57	↓	-23	↓	-31	↓	-17
Northern Ireland	↑	23	↓	-9	n/a	n/a	n/a	n/a
Rep. of Korea	↑	61	↑	60	↑	82	↑	25
Russian Fed.	↑	17	↑	38	↑	15	↑	14
Singapore	↑	70	↑	62	↑	97	↑	67
Slovenia	↓	-27	↑	14	↓	-7	↑	21
United States	↓	-8	↑	17	↔	-5	↔	0
TIMSS average	↓	-38	↓	-23	↓	-42	↓	-44

Countries are ordered alphabetically.

↑ indicates a significantly higher mean score than Ireland.

↓ indicates a significantly lower mean score than Ireland.

↔ indicates that the score is not significantly different from Ireland's.

The strong focus on trend data in TIMSS also allows us to look beyond within-cycle comparisons. Significant improvements in both mathematics and science were found among Fourth Class pupils in 2015, with most of this improvement occurring since 2011. At Second Year, significant improvements since 1995 were found for science performance, but not for mathematics. It was particularly notable that performance in both domains has increased since 1995 (and since 2011 for Fourth Class pupils) among lower- and medium-performing students, but not among the highest-achieving students. For a more detailed discussion of mathematics and science achievement, and for details on the administration of the survey, readers are referred to the initial report (Clerkin et al., 2016).

Contextual information for Ireland: Research series

This report is one of several TIMSS thematic reports that will be released as part of our ERC Research Report Series. TIMSS 2015 provides detailed information on students' personal experiences and attitudes; their home environment; their classroom environment and the teaching practices they experience; the school-level policies and practice that influence their daily lives; as well as national-level policies and the curricula for both grade levels. The study is designed to allow us to generalise these data to the national populations of Fourth Class and Second Year students, delivering robust information on their educational experiences.

In order to present this wealth of contextual data in the clearest fashion, each thematic report will focus on a particular topic in detail. Topics include the characteristics and practices of teachers in the classroom, student engagement and the broader student experience, interactions between the school and the home, the use of technology for teaching and learning, and structural features of the Irish education system. All reports will be made available for download from www.erc.ie/timss as they are published. [2]

2 An e-appendix accompanying each report will also be available from www.erc.ie/timss, where relevant. These will contain additional statistical information (e.g., standard errors) that may be omitted from the main reports in order to facilitate a clear presentation of findings.

Chapter 2: Introduction: The primary classroom

The focus of the current report is on the characteristics of the teachers of Fourth Class pupils and on the practices in which they engage in their classrooms. Where appropriate, comparisons will be drawn between the responses of Fourth Class teachers in 2011 and in 2015. These comparisons are primarily made with reference to the corresponding discussion of teaching practices among teachers of Fourth Class pupils provided in Clerkin (2013).

Previous studies have shown some consistency in relation to the typical profile of primary school teachers in Ireland. Data from TIMSS 1995, PIRLS and TIMSS 2011 and repeated cycles of the National Assessments show clearly that most primary-level children are taught by a female teacher (Clerkin, 2013; Eivers et al., 2010; Eivers, Shiel, Perkins & Cosgrove, 2005; Kavanagh, Shiel, Gilleece & Kiniry, 2015; Mullis, Martin, Beaton, Gonzalez, Kelly & Smith, 1997). In general, pupils in higher grade levels are more likely to be taught by a male teacher, especially in single-sex boys schools, albeit still as a minority. The studies just cited indicate that roughly one-in-ten pupils have a male teacher at First Class and Second Class, rising to roughly three-in-ten pupils at Fourth Class and Sixth Class. The research evidence suggests that whether children are taught by a teacher of the same gender makes little difference to achievement or engagement in school (Carrington, Francis, Hutchings, Skelton, Read, & Hall, 2007; Drudy, 2008; Lahelma, 2000).

Other characteristics of teachers have seen greater change. Mullis, Martin and Loveless (2016) note that many countries have taken steps to enhance initial teacher education in recent years, with about half of the countries that took part in both TIMSS 1995 and TIMSS 2015 reporting that they have raised the requirements for qualifying as a primary school teacher during the intervening period. In Ireland, this can be seen with the move from a three-year degree to a four-year degree for initial teacher education in 2012. In addition, the TIMSS 2015 Encyclopaedia (Mullis, Martin, Goh & Cotter, 2016) details numerous examples of the increasing recognition worldwide for the need to support teachers on an ongoing basis through regular professional development in terms of content, pedagogy, skills (e.g., using ICT effectively), and in teachers' engagement with (or ongoing commitment to) the profession.

International research underlines the difference that teachers and high-quality teaching can make to a student's educational career. Indeed, the manner in which a school deploys its resources, including its teachers, is often seen to be as important as the level of resourcing. For example, although class size is popularly regarded as a determinant of classroom success, Hanushek and Woessman (2017; see also Shen & Konstantopolous, 2017) suggest that it is largely unrelated to student achievement when teachers are qualified and skilled (that is, they find that some benefits to smaller classes are evident in developing countries where there is wider variation in teachers' qualifications and training, but no comparable effects are observed in developed nations such as Ireland, where teachers are generally highly-trained). This is supported by the lack of any significant association in Irish schools between class size and performance in reading, mathematics, or science in PIRLS & TIMSS 2011, once other factors were accounted for (Cosgrove & Creaven, 2013).

However, smaller class sizes can be conducive to effective teaching in certain circumstances, particularly during the early years of schooling (e.g., up to 7 or 8 years old) and for more disadvantaged students (Blatchford, 2012; Blatchford, Bassett, Goldstein & Martin, 2003; Kelleher & Weir, 2017;

Zyngier, 2014). Pedder (2006) observes that the "ambiguous and inconsistent" (p. 214) messages that sometimes emerge from studies of class size and educational achievement obscure the key point that reducing class sizes is not a silver bullet. Indeed, some of the highest-performing countries in large-scale international assessments also report some of the largest class sizes (e.g., 35 pupils per class in Singapore and 27 pupils per class in Hong Kong; Eivers & Chubb, 2017). Instead, it is the interaction between class size and other key features of the classroom – organisation and classroom management, pupils' prior learning and engagement, and teaching practices – that contribute to a positive educational experience for pupils.

Similarly, there is some evidence that instructional time – the amount of time spent teaching a particular subject – may be positively related to student achievement, but these findings are qualified by the proviso that such teaching occurs in a well-managed classroom that provides a conducive environment for student learning (Gromada & Shrewbridge, 2016; Sandoval-Hernandez, Aghakasiri, Wild & Rutkowski, 2013; Woessman, 2016). In particular, lower-performing students, or students in need of greater support, can benefit from the educational opportunities offered in such circumstances, thereby potentially leading to a narrowing of the difference between higher- and lower-performing students. The crucial role of the teacher in creating and managing the opportunities for high-quality learning is recognised by the Department of Education and Skills and the National Council for Curriculum and Assessment (DES/NCCA, 1999a). For these reasons, this report focuses specifically on the preparation, experiences, teaching practices, and challenges faced by the teachers of Fourth Class pupils in Ireland. Other features of the primary education system – including levels of resourcing and system-level policies – are addressed in other thematic reports.

An important component of teachers' day-to-day practice is the interaction between their *subject content knowledge* and their *pedagogical content knowledge.* This distinction was introduced by Shulman (1986) as a means of focusing attention on teachers' capacity to teach what they know to students beyond merely possessing content knowledge of a subject. That is, content knowledge refers to having the knowledge *that* something is the case, while pedagogical content knowledge refers to the ability to teach another person *how* or *why* it is the case (Delaney, 2010; Shulman, 1986). For example, pedagogical content knowledge of a particular topic would be expressed by a teacher's ability to convey concepts and facts being taught through the appropriate use of analogy, demonstration, explanation, and examples, as well as by understanding and anticipating potential misconceptions held by students and addressing conceptual misunderstandings.

Irish teachers' pedagogical content knowledge, in particular, is worth considering in light of the difficulties reported by some teachers in accurately evaluating pupils' degree of mathematical understanding (Delaney, 2010). Similar concerns have been raised in relation to primary teachers' understanding of science content by Murphy and Smith (2012), who document a series of misconceptions about basic scientific facts. Recent surveys have found that substantial proportions of primary school teachers in Ireland report limited confidence in answering pupils' questions about science (Clerkin, 2013) and in teaching pupils to reason mathematically and to use mathematical language in their teaching (Kavanagh et al., 2015). This may be related to the finding from TIMSS 2011 that almost all Fourth Class pupils were taught by a teacher with a degree-level qualification, but few of them (11-14%) had a teacher who had also specialised in mathematics or science (Clerkin, 2013). As Delaney (2010) notes, problems arising from (actual or self-perceived) weaknesses in professional preparation can be exacerbated in the teaching profession to a greater degree than in many other careers because of the relative isolation in which teachers spend much of their working day. This is particularly true in Ireland, where activities such as visiting other teachers' classrooms to observe their teaching or discussing pedagogy with colleagues tend to occur less frequently than in many other countries (Clerkin, 2013; Gilleece, Shiel, Perkins & Proctor, 2009). From the perspective that "teacher

knowledge is the crucial link between mathematics teacher education and student achievement in mathematics" (Blömeke & Delaney, 2012), supporting teachers in preparing to teach subject content and skills to pupils thus presents itself as an issue for continuing professional development (CPD).

The last cycle of TIMSS, in 2011, found that half of Fourth Class pupils had a teacher with less than eight years' teaching experience, with teachers in Ireland generally exhibiting a more youthful profile than their peers in many other countries (Clerkin, 2013). Developments in initial teacher education in Ireland over recent years can be seen in the tendency for more recently-qualified teachers to use active teaching methodologies in their regular practice to a greater extent (McCoy, Smyth & Banks, 2012). Examples of active teaching methodologies include encouraging pupils to ask each other questions in class, giving pupils the opportunity to engage in hands-on learning activities, and getting pupils to work in pairs or small groups. However, it should be recognised that variation in these practices is also confounded with variation in class size (smaller classes facilitating more active methods) and with schools' DEIS status (active methods being less frequently used in Urban Band 1 – the most disadvantaged – schools) (McCoy et al., 2012).

Teachers have previously identified a need for greater support in differentiating their teaching to address the needs of individual pupils in the classroom, both for higher-achieving pupils and for pupils in need of additional support (Clerkin, 2013; DES, 2016; Kavanagh et al., 2015). It is therefore noteworthy that McCoy et al. (2012) report that the use of differentiated activities in the classroom (tailoring activities to pupils' individual needs) is more common in smaller classes. As well as underlining the discussion above on the complexities of research findings related to class size, this finding hints at some of the challenges faced by teachers in their daily practice, which can vary from year to year and from class group to class group. Teachers must therefore draw upon a wide range of teaching practices and classroom management techniques in response to vastly differing circumstances.

The rest of this research brief is structured as follows: Chapter 3 describes Fourth Class teachers in Ireland, including qualifications, gender, and teaching experience. Chapter 4 presents some characteristics of the classrooms they teach – the size of the class and the number of pupils with language difficulties. Chapter 5 presents the teaching practices used in the classroom, reporting the instructional time spent on mathematics and science and the use of various instructional approaches, assessment, and technology. Chapter 6 discusses issues relating to teachers' professional development, such as their confidence in various aspects of mathematics and science teaching and participation in formal and informal professional development. Chapter 7 highlights some of the potential challenges reported by teachers, both in the classroom and in the wider school environment, together with teachers' views of their own career satisfaction. Finally, Chapter 8 discusses the main findings and presents some conclusions.

> Readers should note that the information provided here is given at the pupil level, unless specified otherwise. TIMSS 2015, like most similar large-scale surveys, is designed to be representative of pupils – their achievement, their experiences, and so on. This means that the teachers and principals who took part in the study are not necessarily representative of all teachers and principals in Ireland. However, we *can* say that the experience of the pupils that took part in TIMSS 2015 is representative of the experience of Fourth Class pupils more generally. Therefore, we say that "25% of pupils were taught by teachers who did X" rather than "25% of teachers did X". In this way, the following chapters present generalisable information describing *pupils'* experience of education in Ireland.

Chapter 3: Characteristics of Fourth Class teachers

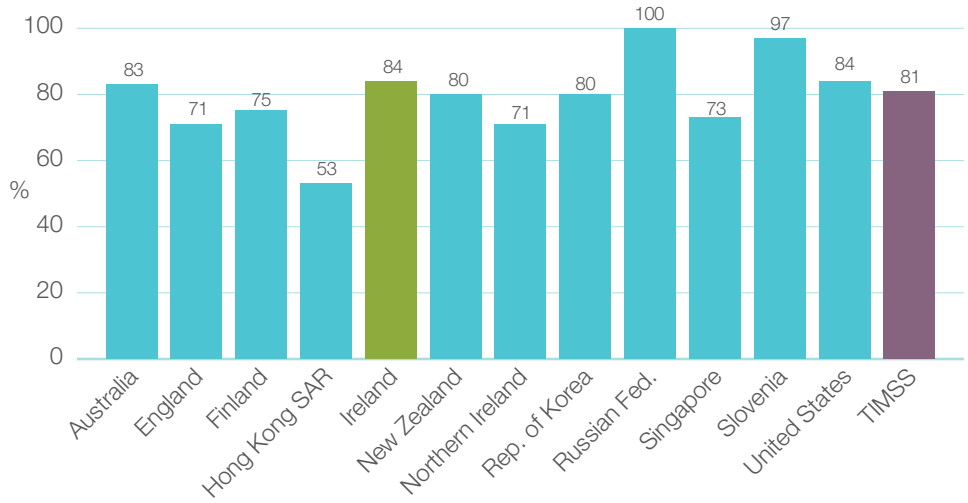
This chapter describes the characteristics of Fourth Class teachers, including gender, age, teaching experience, and qualifications.

Gender

In Ireland, 84% of the Fourth Class pupils who took part in TIMSS 2015 were taught by female teachers (Figure 3.1). This is higher than the 71% of Fourth Class pupils who had a female teacher in TIMSS 2011 (Clerkin, 2013) and the 69% taught by a female teacher in 1995 (Mullis et al., 1997). Irish pupils who attended single-sex girls schools (92%) or mixed schools (85%) were more likely to have a female teacher than those in single-sex boys schools (67%).

The percentage of pupils taught by female teachers in Ireland is similar to the international average, although there are substantial differences between countries. For example, all Fourth grade pupils in the Russian Federation were taught by female teachers (100%), compared to only half (53%) in Hong Kong. Examining our comparison countries that took part in 1995 and 2015, the percentages of pupils taught by female teachers have increased in Australia, New Zealand, the Republic of Korea, and Slovenia, and decreased in Hong Kong and Singapore.

Figure 3.1: Percentage of pupils taught by female teachers



Age and teaching experience

Irish pupils tended to be taught by teachers who were younger and had fewer years of teaching experience than their counterparts in other TIMSS countries (Table 3.1). For instance, almost twice as many pupils in Ireland (24%) as internationally (13%) were taught by a teacher under the age of 30,

while much fewer pupils in Ireland had a teacher over the age of 40 (30% in Ireland vs 58% across all TIMSS countries). The age profile in Ireland was broadly similar to those in England and in Singapore. Pupils were taught by somewhat older teachers in the Russian Federation, Slovenia, and Finland.

The age profile of Fourth Class teachers in 2015 is similar to that reported for the teachers who participated in 2011 (Clerkin, 2013). However, it is markedly different to the profile of teachers in TIMSS 1995, when more than half (53%) of Fourth Class pupils had a teacher who was 40 years old or older (Mullis et al., 1997). As was the case in 2011 (Clerkin, 2013), teachers in densely-populated urban areas tended to be younger, with 41% of urban pupils taught by teachers aged under 30 years of age compared to just 8% of pupils taught by teachers aged 40 years or more. The opposite pattern was observed in rural areas (5% vs 35%, respectively).

Table 3.1: Percentage of pupils taught by teachers of various ages, and teachers' average teaching experience (mean and median)

	Teacher age					Years teaching experience	
	Under 25	25-29	30-39	40-49	50+	Mean	Median
Australia	5	15	20	27	34	15.2	13
England	9	22	32	24	13	10.6	8
Finland	0	7	28	35	29	16.4	16
Hong Kong SAR	1	12	40	34	13	14.8	15
Ireland	9	15	46	17	13	13.4	10
New Zealand	4	12	25	30	29	14.3	12
Northern Ireland	4	19	26	33	18	15.0	15
Rep. of Korea	6	15	30	30	19	15.5	15
Russian Fed.	1	4	14	45	36	25.2	26
Singapore	4	19	44	23	10	10.6	8
Slovenia	0	2	19	32	47	23.7	26
United States	4	13	28	28	28	13.1	12
TIMSS	3	10	30	31	27	17.1	16.2

As might be expected, the relatively youthful profile of Irish teachers means that they tend to report less teaching experience than teachers in other countries – 13.4 years in Ireland, on average, compared to 17.1 years internationally. The median teaching experience (the 50th percentile) is 10 years in Ireland. This means that half of Fourth class pupils are taught by a teacher with less than 10 years' teaching experience and half are taught by a more experienced teacher. This is less than the current TIMSS international median (16.2 years), but higher than the median of 8 years' teaching experience found in Irish classes in TIMSS 2011 (Clerkin, 2013).

Qualifications

About 84% of Fourth Class pupils were taught by teachers whose highest qualification was a Bachelor's degree (compared to 58% internationally), and an additional 13% of pupils were taught by teachers holding a Master's degree (compared to 27% internationally). The remaining 3% of pupils had teachers who reported third-level certificates or diplomas, most of whom had more than 40 years' teaching experience and may therefore pre-date the introduction of the BEd programmes in teacher education colleges in 1974 (Coolahan, 2004). These figures are similar to those reported for teachers of Fourth Class pupils in TIMSS 2011 (Clerkin, 2013). Both studies show that the proportions of pupils being taught by qualified teachers has increased since the early 2000s, when 4-13% of pupils at various primary grades

were reported to have teachers without any teaching qualification (such as a BEd, a graduate diploma in education, or the older National Teaching Diploma) (Eivers et al., 2005; Eivers, Shiel & Shortt, 2004).

As was the case four years ago, the general pattern found in TIMSS 2015 is that relatively more pupils in Ireland than internationally are taught by a teacher holding at least an undergraduate degree, but fewer are taught by a teacher with a postgraduate degree. In some countries – such as Finland, the Czech Republic, and the Slovak Republic – Master's-level qualification is a prerequisite for primary teaching and initial teacher education confers a Master's degree upon graduates, whereas in Ireland teacher education can be an undergraduate qualification. Across all countries, the highest percentages of pupils taught by a teacher with a Master's were reported in Georgia (85%), Finland (89%), the Czech Republic (92%), Poland (96%) and the Slovak Republic (98%). Further information on the structural characteristics of the education systems across countries, including requirements for new teachers, can be found in the TIMSS 2015 Encyclopaedia (Mullis, Martin, Goh & Cotter, 2016) and in Eivers and Chubb (2017).

Teachers were asked whether their primary degree had been in primary education or in another area, and also whether they had specialised in mathematics or science (e.g., taken an elective course) as part of their third-level education. Table 3.2 presents the most pertinent combinations of teachers' qualifications in primary education and subject-specific specialisations, for Ireland and our comparison countries.

Most pupils in Ireland were taught by teachers who had specialised in primary education but not mathematics (78% of pupils) or science (86%). Twelve percent had a teacher who had specialised in both primary education and mathematics, while only 5% had a teacher with specialisations in both primary education and science. For mathematics, these percentages are similar to those reported in TIMSS 2011 (Clerkin, 2013), but fewer pupils were taught by a teacher with a specialisation in primary teaching and science in 2015 (5%) than four years earlier (11%). The percentages of pupils in Ireland whose teachers had specialised in education and either mathematics or science were substantially lower than the international averages (27% and 23%, respectively).

Table 3.2: Percentage of pupils, by teachers' specialisation in primary education and/or maths or science

	Major in primary education			Major in primary education		
	Yes	Yes	No	Yes	Yes	No
	Maths specialisation			Science specialisation		
	Yes	No	Yes	Yes	No	Yes
Australia	13	80	1	16	77	0
England	12	57	4	17	52	10
Finland	10	82	0	12	81	0
Hong Kong	64	23	10	25	50	9
Ireland	12	78	3	5	86	3
Korea, Rep.	19	75	0	13	81	2
New Zealand	17	65	1	9	71	3
N. Ireland	12	86	0	9	78	1
Russian Fed.	44	53	1	41	54	3
Singapore	59	14	14	54	17	15
Slovenia	5	94	0	7	93	0
United States	13	73	2	11	74	5
TIMSS	27	46	14	23	49	15

There was no clear relationship between teachers' specialisations and pupil achievement at the country level. For example, among the high-performing countries included in our set of comparison countries, specialisations in mathematics and primary education were common in Hong Kong, the Russian Federation, and Singapore, but less so in the Republic of Korea. Similarly, specialisations in science and education were common in the Russian Federation and Singapore, but were relatively rare in Slovenia, Finland, and the Republic of Korea.

Chapter 4: Characteristics of the classroom

This chapter describes two aspects of the classrooms in which Fourth grade pupils learn. The first section covers class size, and the second describes the number of pupils with language difficulties in the classroom in Ireland and internationally.

Class size

Two related, but distinct, indicators of class size were provided by teachers. The first reported the *total number of pupils in their classroom* (including pupils at other grade levels, such as Third Class or Fifth Class, if teachers had multigrade classes). The second indicator reported the total number of pupils in their class *who were in Fourth Class*.

In Ireland, the average overall class size reported by Fourth Class teachers was 25.8 pupils (Table 4.1). This is slightly above the international average (24.6) but is very similar to the average class size of 26 reported in Ireland in 1995 (Mullis et al., 1997). Internationally, there was considerable variation in class size, with particularly high overall class sizes reported by teachers in Singapore (35.4 pupils) but much smaller class sizes in Finland (20.2) and Slovenia (20.9).

The average number of *Fourth Class pupils* in Irish classrooms (22.3) was slightly lower than the overall class size. A large minority (29%) of Irish pupils were in a multi-grade classroom (considerably higher than the international average of 12%). In Ireland, the average multi-grade class size was 25.9 pupils, comprising 14.9 pupils in Fourth Class (and 11 at other grade levels). The average multigrade class for Fourth Class pupils, therefore, was similar in size to the average single-grade class size.

The use of multigrade classes varied widely between countries. For example, Fourth grade pupils were universally taught in single-grade groups in some countries (e.g., Singapore) but multigrade classes were very common in some countries (e.g., 44% of pupils in Australia and 78% in New Zealand). The reasons for organising pupils into multigrade classes vary across countries – for example, in Ireland it is often related to small school size, whereas in Australia and New Zealand it may be a decision based on the organisation of the curriculum into developmental bands (Eivers & Chubb, 2017).

Table 4.1: Mean class sizes (overall and Fourth grade) and percentage in multigrade classes

	N (all pupils)	N (pupils in Fourth grade)	% Fourth Class pupils in multigrade classes
Australia	26.3	20.7	44
England	26.9	25.1	17
Finland	20.2	18.7	17
Hong Kong SAR	27.3	27.4	1
Ireland	25.8	22.3	29
New Zealand	26.7	15.9	78
Northern Ireland	25.7	23.5	20
Rep. of Korea	25.5	25.4	6
Russian Fed.	24.2	–	–
Singapore	35.4	35.4	0
Slovenia	20.9	19.9	9
United States	24.2	23.9	5
TIMSS	24.6	23.3	12

A dash (–) indicates that data was not available.

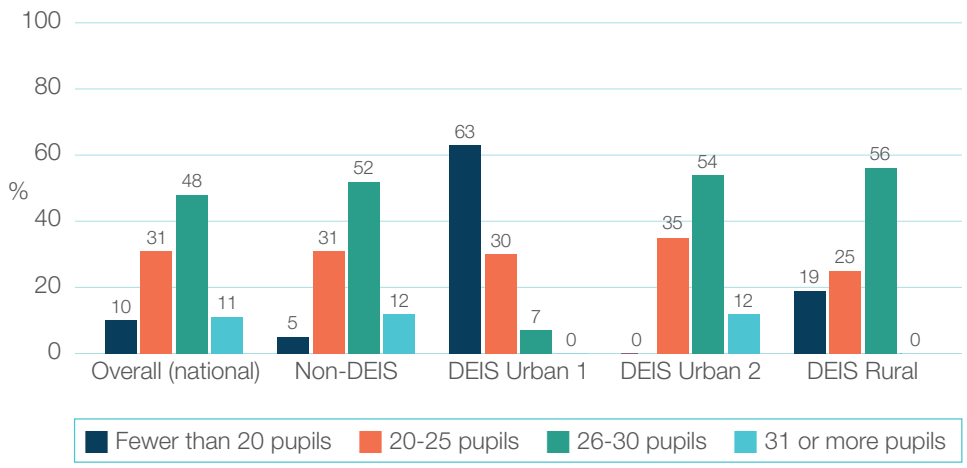
Nationally, a large majority of Fourth Class pupils (79%) were in classes of between 20 and 30 pupils (Figure 4.1). The remaining pupils were evenly split between those attending smaller (10%) or larger (11%) classes. Class size and multigrade status varied by schools' DEIS status and the school location. In DEIS Urban Band 1 schools – those classified as having the highest levels of disadvantage, and thus in receipt of the greatest supports – most pupils (63%) were taught in classes of fewer than 20 pupils.[3] This was a much higher percentage than for any other school category (the next-highest being 19% of pupils in DEIS Rural schools, compared for 5% of pupils in non-DEIS schools and no pupils in DEIS Urban band 2 schools).[4]

Related to the small class sizes, Fourth Class pupils in Urban Band 1 schools were generally organised as single grade levels, with only 5% of pupils in multigrade classes. On the other hand, substantial percentages of pupils in DEIS Rural schools (67%) and in non-DEIS schools (31%) were taught in multigrade classes. This is also related to schools' location in rural or urban settings. Nationally, about half (53%) of Fourth Class pupils in schools situated in rural areas or small towns (up to 3000 people) were taught in multigrade classes, as were 23% of pupils in towns of 3000-15,000 people and 9% of pupils in towns of 15,001-30,000 inhabitants. By contrast, all Fourth Class pupils in schools located in large towns (>30,000 people) or cities were taught in single-grade class groups.

3 20 pupils is often taken as a guideline target figure for 'small' class sizes (see Kelleher & Weir, 2017) and has been used as the lower cutoff point in similar analyses of class size in relation to DEIS (e.g., Weir & McAvinue, 2012).

4 For more information on differences and changes in class size related to participation in DEIS, see Weir and McAvinue (2012) and Kelleher and Weir (2017).

Figure 4.1: Variation in total class size of classes taught by Fourth Class teachers, by DEIS status



Pupils with language difficulties

Nationally, the average number of Fourth Class pupils who were described by their teachers as experiencing difficulties understanding spoken English was less than one per classroom (0.7), lower than the TIMSS average of 1.9. Among our comparison countries, similar figures for pupils who have difficulty understanding the language they were tested in were reported in Australia, Finland, Northern Ireland, New Zealand and the Russian Federation (0.7-0.9). Teachers in England, Slovenia, the United States and Singapore reported a much higher incidence of pupils with language difficulties in their classes (1.3-1.9). Among TIMSS countries more generally, the equivalent figure ranged from lows of 0.1 (Japan) and 0.2 pupils per class (Republic of Korea) to a high of 7.6 pupils per class in Morocco.

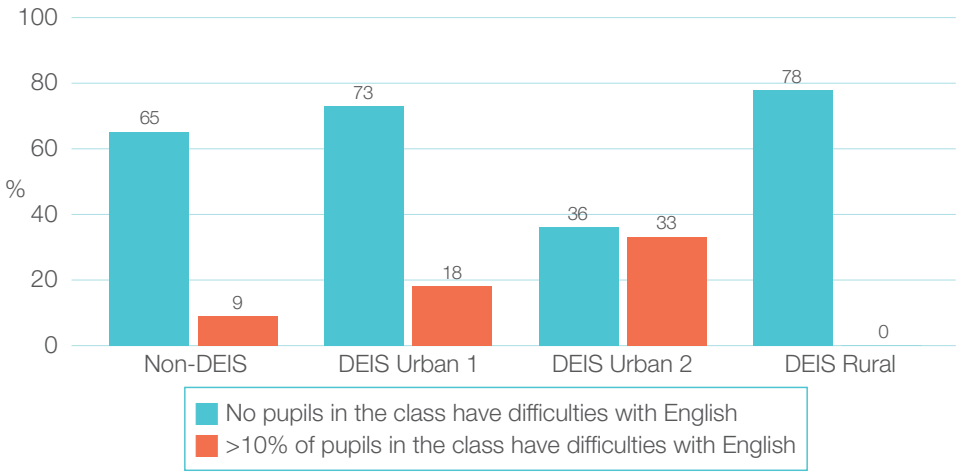
These figures are averages; however, in practice, students with language difficulties are not distributed equally across all classrooms. Figure 4.2 and Figure 4.3 show the actual distribution of pupils with language difficulties across Irish classrooms in two different, but complementary, ways. First (in the blue bar), the percentage of pupils in classrooms where *no Fourth Class pupils* are reported to have difficulties understanding spoken English is shown. Second (in the red bar), the extent of clustering of pupils with language difficulties within classes is estimated, defined here as any classroom where the teacher reported *more than 10% of their pupils* to have language difficulties.[5]

Just under two-thirds of Fourth Class pupils nationally (65%) were in a classroom where teachers reported that no pupils had difficulty understanding English. This is similar to the proportion in 2011 reported by Eivers (2013). Further variation on this measure is evident by school's DEIS status (Figure 4.2). A much lower percentage of pupils in DEIS Urban Band 2 schools (36%) were in a class where

5 Note that, while a greater degree of clustering could indicate a higher level of challenge for teachers, it may also be the case that a teacher could teach more pupils who have language difficulties but as a smaller proportion of the whole class (e.g., 2 pupils with language difficulties are 17% of a class of 12 pupils, but 3 pupils with language difficulties are 10% of a class of 30 pupils). This caveat is important to remember given the smaller overall class sizes found in, for example, DEIS Urban Band 1 schools.

no pupils had language difficulties. In general, pupils in rural areas or smaller towns were about as likely as those in larger towns or cities to have one or more classmates with language difficulties (Figure 4.3).

Figure 4.2: Percentage of pupils in classes where *no Fourth Class pupils* or *more than 10% of Fourth Class pupils* have difficulties understanding English, by DEIS status



Pupils who had difficulties with spoken English were also found to be particularly *concentrated* within DEIS Urban schools (Figure 4.2). Almost one-fifth (18%) of pupils in Urban Band 1 schools and one-third (33%) of pupils in Urban Band 2 schools were in a classroom where more than 10% of the pupils were reported to have difficulties understanding English. By comparison, this was the case for about one-tenth (9%) of pupils in non-DEIS schools and for no pupils in DEIS Rural schools.

The extent of concentration of language difficulties was found to be related to schools' location (Figure 4.3). Few pupils (3%) attending schools in rural areas or towns up to 15,000 people were in a class where more than 10% of pupils had language difficulties, compared to one-fifth of pupils (19%) attending schools in more urbanised areas.

Figure 4.3: Percentage of pupils in classes where *no Fourth Class pupils* or *more than 10% of Fourth Class pupils* have difficulties understanding English, by school location

Chapter 5: Teaching practices

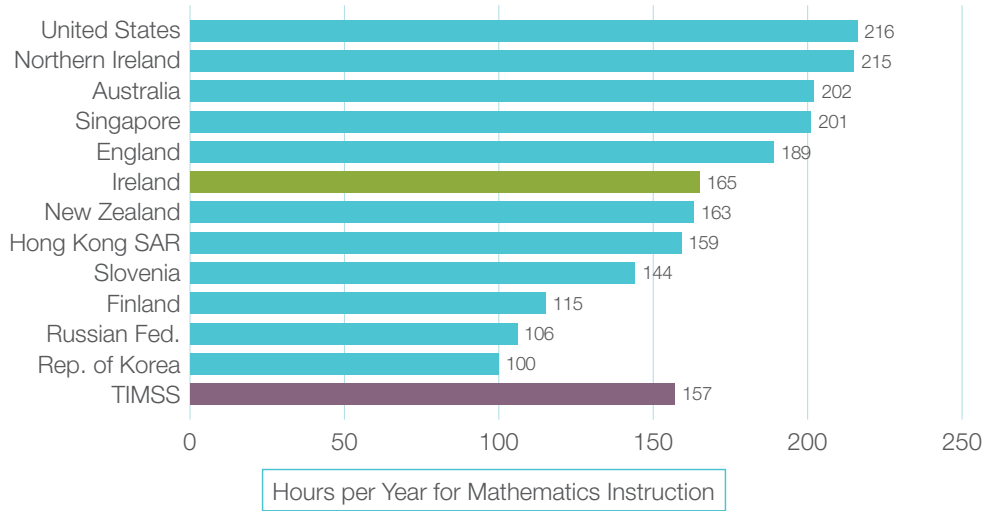
This chapter focuses on pupils' daily experience of the classroom and on the instructional practices that teachers use. It covers four main areas: the amount of instructional time spent on mathematics and science, both in absolute and in relative terms; the types of strategies and practices that teachers use in teaching their Fourth Class pupils; teachers' use of various forms of assessment for monitoring pupils' progress in mathematics and science; and, finally, the availability and use of technology in the classroom.

Instructional time

Teachers' reports indicate that Fourth Class pupils received, on average, 165 hours per year of mathematics instruction (Figure 5.1). This corresponds to about 19% of the total available instructional time. In both regards, the amount of instructional time devoted to mathematics in Ireland was close to, but slightly higher than, the international average (157 hours or 18% of total instructional time). The amount of time spent teaching mathematics in 2015 was higher than the 150 hours reported by Irish teachers in TIMSS 2011 (Lewis & Archer, 2013). Similar increases in the time devoted to mathematics in Second Class and Sixth Class were found in the 2014 National Assessments (Kavanagh et al., 2015) and can be attributed to the implementation of the *National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020* (Circular 0056/2011).

There was wide variation across countries, with teachers in the Republic of Korea reporting 100 hours per annum and teachers in Portugal reporting 275 hours of mathematics instruction per year. In relative terms, Portuguese teachers spent the greatest percentage of their time on mathematics (32%), followed by Belgium (Flemish), Italy, France, and Northern Ireland (22-23%). At the other extreme, Sweden and Chinese Taipei spent only 13% of instructional time on mathematics.

Figure 5.1: Total instructional hours per year for mathematics



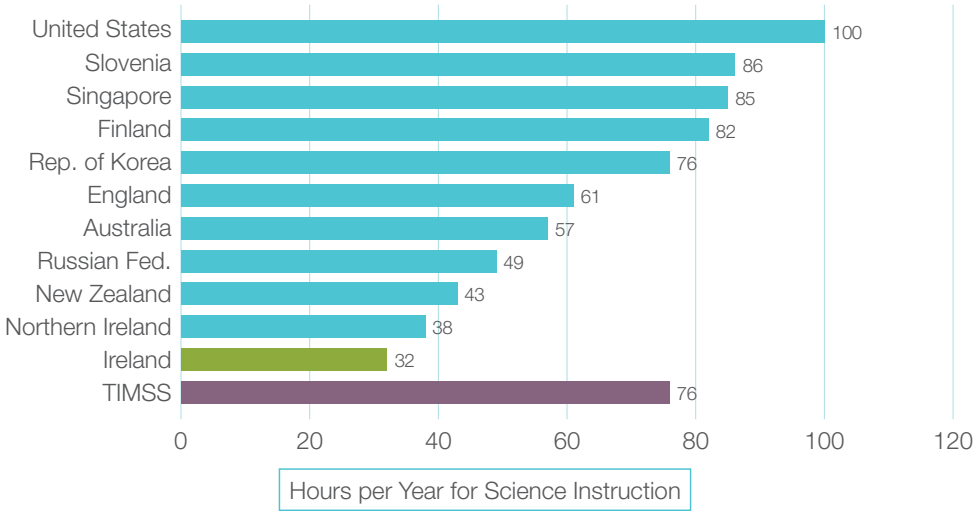
In contrast to the 165 hours spent in mathematics lessons, Fourth Class pupils received just 32 hours of science instruction over the course of the school year, or 4% of the available instructional

time (Figure 5.2). This represents less than half of the corresponding international average (76 hours or 9% of available time).[6] Pupils in Ireland received less time on science instruction – in both absolute and relative terms – than their peers in any other country that participated in TIMSS. Furthermore, the time devoted to teaching science in Irish primary schools has nearly halved since TIMSS 2011 (63 hours; Lewis & Archer, 2013).

One caveat that should be noted is that the TIMSS Earth Science content area generally covers topics that are included as part of the Geography curriculum in Ireland, so some of this content is likely to have been covered as part of a 'geography' lesson, rather than a 'science' lesson. The same caveat may also apply to some other countries, but the extent to which this occurs is unclear (see Mullis, Martin & Loveless, 2016, pp. 30-31).

Internationally, on average, science instruction is allocated almost half the amount of time that is allocated to mathematics (compare Figures 5.1 and 5.2). In Ireland, by contrast, science is allocated only about one-fifth of the time devoted to mathematics. The time spent on science instruction was also notably low in Northern Ireland, New Zealand, and the Russian Federation.

Figure 5.2: Total instructional hours per year for science



General teaching practices

As well as practices specific to the teaching of either mathematics or science, teachers were asked about general strategies that they use to engage their pupils' interest in the classroom. The most frequent practices reported in Ireland were teachers' attempts to link new material being taught to pupils' existing knowledge, encouraging pupils to express their own ideas in class, and asking pupils to explain their answers (Table 5.1).

Fourth Class pupils were somewhat more likely than their peers internationally to be asked to take part in a classroom discussion, but less likely to be asked to decide their own problem-solving procedures. Irish pupils were also slightly less likely to have a teacher who reported bringing interesting materials to class on a regular basis.

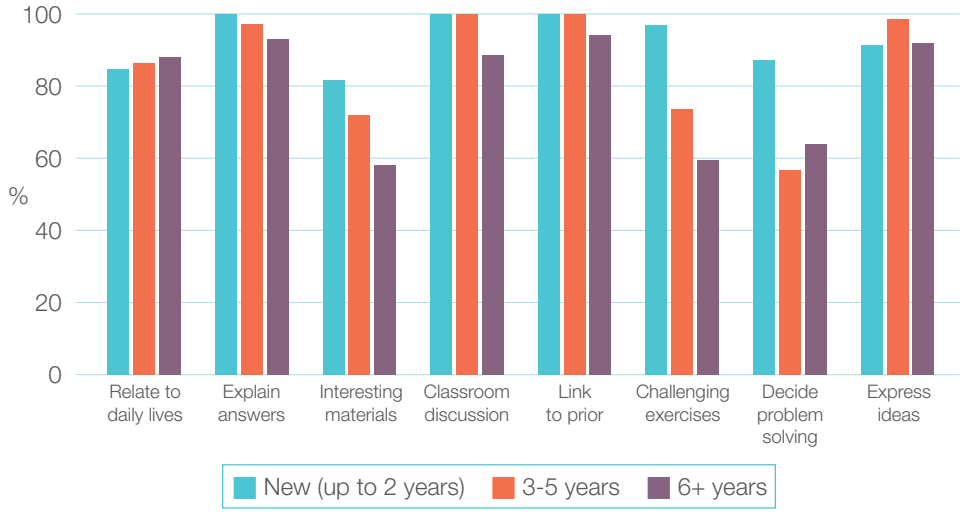
6 Figures for science instructional time are not available for Hong Kong as data were provided for less than 50% of pupils.

Table 5.1: Percentage of pupils, by frequency of teaching strategies to engage pupils in lessons (in general)

		Every or almost every lesson	About half of lessons	Some lessons	Never
Relate the lesson to pupils' daily lives	IRL	54	33	13	0
	TIMSS	56	28	16	<1
Ask pupils to explain their answers	IRL	66	28	6	0
	TIMSS	69	22	8	<1
Bring interesting materials to class	IRL	14	47	39	0
	TIMSS	23	41	35	1
Encourage classroom discussions among pupils	IRL	58	32	9	<1
	TIMSS	42	30	26	1
Link new content to pupils' prior knowledge	IRL	78	19	4	0
	TIMSS	72	21	6	<1
Ask pupils to complete challenging exercises that require them to go beyond the instruction	IRL	18	46	35	1
	TIMSS	17	31	46	6
Ask pupils to decide their own problem solving procedures	IRL	25	40	35	1
	TIMSS	40	36	23	1
Encourage pupils to express their ideas in class	IRL	67	26	7	0
	TIMSS	69	22	9	<1

Some variation in classroom practice was found when considered against teachers' experience (Figure 5.3). Pupils in Ireland who were taught by 'new' teachers (defined here as those in their first two years of teaching) were much more likely to be asked to complete challenging exercises that went beyond their classroom instruction, and were also asked to decide their own problem-solving procedures on a more frequent basis.

Figure 5.3: General teaching practices, by teachers' years of experience (percentage pupils engaging in each activity in *at least half the lessons*)



Teaching practices in mathematics lessons

In mathematics lessons (Table 5.2), Fourth Class pupils were most frequently asked to listen to their teacher explaining new content (73% of pupils in *every or almost every lesson*), and to listen to the teacher explaining how to solve problems (57%). These were the only two practices which a majority of pupils experienced in almost all mathematics lessons in Ireland.

Working in mixed-ability groups or same-ability groups were relatively infrequently experienced in Irish mathematics lessons, compared to other classroom practices. However, Irish pupils were much more likely to be given problems to work on while their teacher was occupied by other tasks than were their peers in other countries – about 55% of Fourth Class pupils did this in at least half their lessons (compared to 34% internationally), while only 10% of pupils in Ireland never did so (compared to 30% internationally). This practice may be related to the relatively high percentage of pupils in multigrade classrooms in Ireland, with about one-third of pupils (32%) in multigrade classrooms working on problems in *every or almost every lesson* while the teacher is otherwise occupied and only 8% *never* doing so, compared to 21% and 10%, respectively, in single-grade classes.

Table 5.2: Percentage of pupils, by teaching practices in mathematics lessons

		Every or almost every lesson	About half the lessons	Some lessons	Never
Listen to me explain new mathematics content	IRL	73	20	7	<1
	TIMSS	65	22	11	1
Listen to me explain how to solve problems	IRL	57	26	16	<1
	TIMSS	59	24	16	1
Memorise rules, procedures, and facts	IRL	34	35	32	0
	TIMSS	33	27	36	4
Work problems (individually or with peers) with my guidance	IRL	40	53	7	0
	TIMSS	52	32	15	<1
Work problems together in the whole class with direct guidance from me	IRL	34	43	22	<1
	TIMSS	40	31	27	2
Work problems (individually or with peers) while I am occupied by other tasks	IRL	24	31	35	10
	TIMSS	15	19	35	30
Take a written test or quiz	IRL	8	17	74	<1
	TIMSS	14	19	66	1
Work in mixed ability groups	IRL	21	27	47	5
	TIMSS	20	29	47	4
Work in same ability groups	IRL	14	30	48	8
	TIMSS	12	24	49	14

In general, there was little substantive variation in mathematics teaching practices by teachers' level of experience. 'New' teachers were less likely to give their pupils a written test or quiz (11% of the pupils of 'new' teachers, compared to 25-33% of pupils of more experienced teachers) or to ask their pupils to work on problems while the teacher was occupied with other tasks (36% of pupils of

'new' teachers, compared to 52-60% of pupils of more experienced teachers). The latter may be related to classroom organisation since, as noted earlier, young teachers were also more likely to be working in densely populated urban areas (in a single-grade classroom) and older teachers were more likely to teach in rural areas (where multigrade classes are more common).

Teaching practices in science lessons

Teachers were also asked about the practices that occur during science lessons. As noted at the beginning of this chapter, comparatively little time is spent on science instruction in Ireland in Fourth Class. Perhaps for this reason, Irish teachers reported that their pupils experience almost all of the specified activities (Table 5.3) on a less frequent basis than was reported internationally. Irish pupils were asked to memorise scientific facts and procedures or to take a written test in science lessons particularly rarely, compared to the international averages.

Listening to the teacher explain new science content, reading textbooks or other resources, and working in mixed-ability groups were the most commonly-used practices in science lessons. Half of pupils in Ireland (50%, vs 60% internationally) were asked to listen to the teacher explain new science content in almost every science lesson, with about one-sixth of pupils (17%) covering new content only in some lessons. By comparison, about three-quarters of Irish pupils (73%) were presented with new mathematics content in almost all of their mathematics lessons (Table 5.2).

A majority of Fourth Class pupils engaged in the conceptual (design and planning; 53%) and procedural (conducting experiments; 64%) elements of scientific experimentation in their science lessons on a regular basis, doing so more regularly than the TIMSS averages (43% and 48%, respectively). Compared to the frequency of these conceptual and procedural aspects of experimentation, Irish pupils were less likely to practise presenting or interpreting the data arising from such experiments, or to use experimental evidence to support any conclusions. Most pupils (94%) took part in field work outside the class at least occasionally (although 6% never experienced field work outside the classroom during a science lesson).

Table 5.3: Percentage of pupils, by teaching practices in science lessons					
		Every or almost every lesson	About half the lessons	Some lessons	Never
Listen to me explain new science content	IRL	50	33	17	0
	TIMSS	60	24	16	1
Observe natural phenomena such as the weather or a plant growing and describe what they see	IRL	15	38	44	2
	TIMSS	25	34	39	1
Watch me demonstrate an experiment or investigation	IRL	14	36	48	3
	TIMSS	22	25	49	4
Design or plan experiments or investigations	IRL	14	39	41	6
	TIMSS	15	28	52	5
Conduct experiments or investigations	IRL	18	46	35	1
	TIMSS	17	31	51	2
Present data from experiments or investigations	IRL	9	36	51	4
	TIMSS	14	27	55	4
Interpret data from experiments or investigations	IRL	12	32	52	4
	TIMSS	15	29	52	4
Use evidence from experiments or investigations to support conclusions	IRL	12	38	48	3
	TIMSS	18	30	48	4
Read textbooks or other resource materials	IRL	27	39	28	6
	TIMSS	40	30	27	4
Have pupils memorise facts and principles	IRL	5	18	50	26
	TIMSS	25	24	39	11
Do field work outside the class	IRL	2	10	82	6
	TIMSS	5	15	69	11
Take a written test or quiz	IRL	1	11	53	35
	TIMSS	14	19	60	7
Work in mixed ability groups	IRL	24	42	30	4
	TIMSS	26	31	40	3
Work in same ability groups	IRL	4	30	39	26
	TIMSS	9	22	48	21

Teachers' responses to a subset of these items were used to create a measure of the extent to which scientific investigation is emphasised in science lessons. This provides an overall indicator of the extent to which children were exposed to *active* scientific methods – namely, observing natural phenomena, watching the teacher demonstrate experiments, designing experiments, conducting experiments, presenting data from experiments, interpreting data from experiments, using experimental evidence to draw conclusions, and doing field work outside the classroom – in their science lessons. Table 5.4 shows the percentages of pupils in Ireland and in the comparison

countries who were taught by teachers who regularly emphasised scientific investigation (defined as doing so in *about half or more than half* of their science lessons) and those whose teachers did so less frequently.

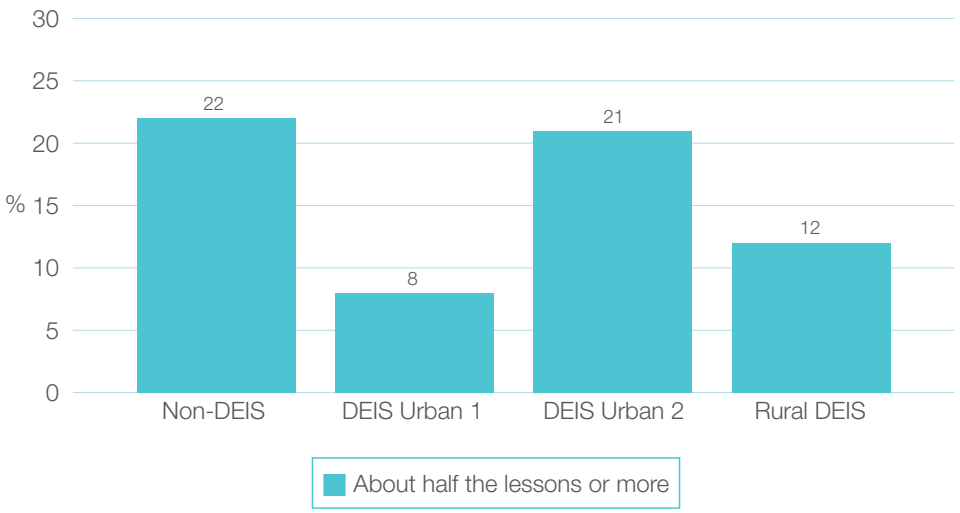
As shown, scientific investigation was emphasised to a very high degree in the Republic of Korea, but was a very rare occurrence in Northern Ireland and Finland. In many countries, the difference in performance on the TIMSS science assessment between pupils who experienced scientific investigation frequently and those who did not was small. The difference was larger than average, but not statistically significant, in Ireland (14 points).

Table 5.4: Percentage of pupils and mean science achievement, by teachers' emphasis on scientific investigation

	About half the lessons or more		Less than half of the lessons	
	% students	Science	% students	Science
Australia	22	529	78	526
England	26	540	74	537
Finland	4	559	96	553
Hong Kong SAR	10	570	90	554
Ireland	20	540	80	526
New Zealand	14	505	86	506
Northern Ireland	3	504	97	521
Rep. of Korea	60	590	40	589
Russian Fed.	16	572	84	567
Singapore	34	596	66	588
Slovenia	12	541	88	544
United States	24	546	76	545
TIMSS	27	508	73	505

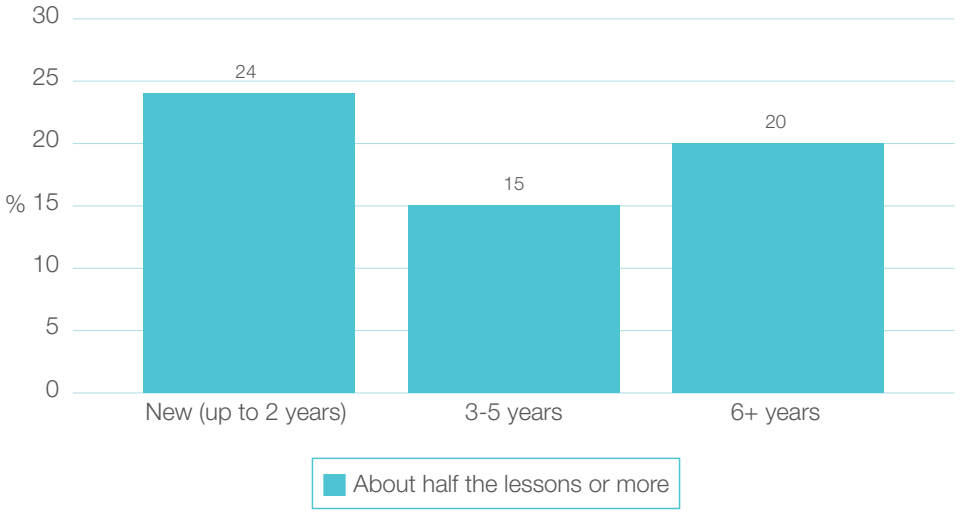
As teaching methodologies can be expected to differ according to the circumstances in each classroom (see, e.g., Chapter 2 and McCoy et al., 2012), these teaching practices were examined with reference to schools' resources, as reported by school principals, and DEIS status. There was only a slight relationship between a school's level of resources and the extent to which active scientific methods were used in science lessons. Specifically, 23% of pupils in schools where the principal said that instruction was *not affected* by science resource shortages engaged in scientific investigation in at last half their lessons, compared to 20% of pupils in schools where principals reported that instruction was *somewhat affected* or *affected a lot* by lack of resources. However, some differences were found by schools' DEIS status. Active scientific methods were found to be used less frequently in DEIS Urban Band 1 schools and in DEIS Rural schools than in non-DEIS or Urban Band 2 schools (Figure 5.4).

Figure 5.4: Teachers' use of active scientific methods, by DEIS status (percentage of pupils engaging in active scientific methods in *at least half the lessons*)



Active scientific methods were used most frequently by 'new' teachers, with about one-quarter of pupils taught by new teachers (24%) experiencing scientific investigation in at least half of their science lessons (Figure 5.5). This was the case for 20% of pupils of teachers who had been teaching for six years or more, and for 15% of pupils of teachers who had been teaching for between three and five years.

Figure 5.5: Teachers' use of active scientific methods, by teacher experience (percentage of pupils engaging in active scientific methods in *at least half the lessons*)



Assessment

Teachers were asked about their use of various types of assessment to monitor pupils' progress in mathematics and science, including teachers' own assessment of pupils' work and more formal, external assessments (e.g., standardised tests). For most pupils, in Ireland and internationally, ongoing assessment of pupils' work was teachers' preferred method of assessing progress in both mathematics and science (Table 5.5).

In mathematics, teachers' assessment practices in Ireland tended to be broadly similar to the international average. Teachers' assessment of pupils' ongoing work was given a major emphasis in judging progress by the teachers of most (90%) Fourth Class pupils in mathematics, compared to 61% of pupils whose teachers placed major emphasis on more structured classroom tests and about one-third (32%) of pupils whose teachers emphasised national achievement tests to a major degree.

For science, some different patterns emerged. On average across TIMSS countries, all three forms of assessment were given slightly less emphasis for assessing science than mathematics progress (Table 5.5). However, in Ireland, the gap was much greater. For example, while the vast majority of Irish pupils had a teacher who placed major emphasis on assessing their ongoing work to judge their progress in mathematics (90%), only half (53%) had a teacher who assessed their progress in science in the same way. By comparison, the corresponding TIMSS average percentages were much closer, at 85% and 77% respectively. For mathematics, no Irish pupils were in classes where the teacher placed little or no emphasis on judging progress through pupils' ongoing work or through classroom tests; however, for science, the corresponding figures were 7% and 33%, respectively.

National achievement tests were not regarded as a major source of information on pupils' scientific progress by the teachers of many Fourth Class pupils, reflecting much lower use of standardised testing for science (e.g., the IPSA-T tests) at primary level than for mathematics or reading.[7] Teachers in Ireland placed a much lower emphasis on assessing pupils' progress in science – for all three categories of assessment – than was reported in other countries.

Table 5.5: Percentage of pupils, by teachers' emphasis on various forms of assessment

		Mathematics			Science		
		Major Emphasis	Some emphasis	Little or no emphasis	Major Emphasis	Some emphasis	Little or no emphasis
Assessment of pupils' ongoing work	IRL	90	10	0	53	40	7
	TIMSS	85	14	1	77	21	2
Classroom tests (for example, teacher-made or textbook tests)	IRL	61	39	0	18	49	33
	TIMSS	68	30	2	58	34	8
National or regional achievement tests	IRL	32	61	6	4	15	81
	TIMSS	33	47	20	26	40	34

ICT in the classroom

The Primary School Mathematics Curriculum (DES/NCCA, 1999b) provides for the use of calculators in mathematics lessons from Fourth Class onwards. In TIMSS 2015, teachers reported that most Fourth Class pupils (71%) were allowed to use calculators in their mathematics classes on a restricted basis (i.e., in some circumstances but not in others), with very few pupils either in Ireland (2%) or internationally (2%) allowed unrestricted use of calculators. More than a quarter of Fourth Class pupils (28%) were not given any access to calculators during mathematics lessons. This marks a major change since 1995, when 88% of Fourth Class pupils never or almost never used calculators in their mathematics classes (Mullis et al., 1997). In the current study, no significant difference in

7 Unlike mathematics and reading, standardised testing of science is not compulsory at any point at primary level.

mathematics performance was found between Fourth Class pupils who had access to calculators and those who did not.

Calculator use at Fourth grade was more common in Northern Ireland (with just 12% of pupils given no access) and Australia (13%) than in Ireland. In contrast, most pupils in the Republic of Korea (57%), Hong Kong (79%), Slovenia (96%) and Singapore (97%) were given no access to calculators in their lessons.

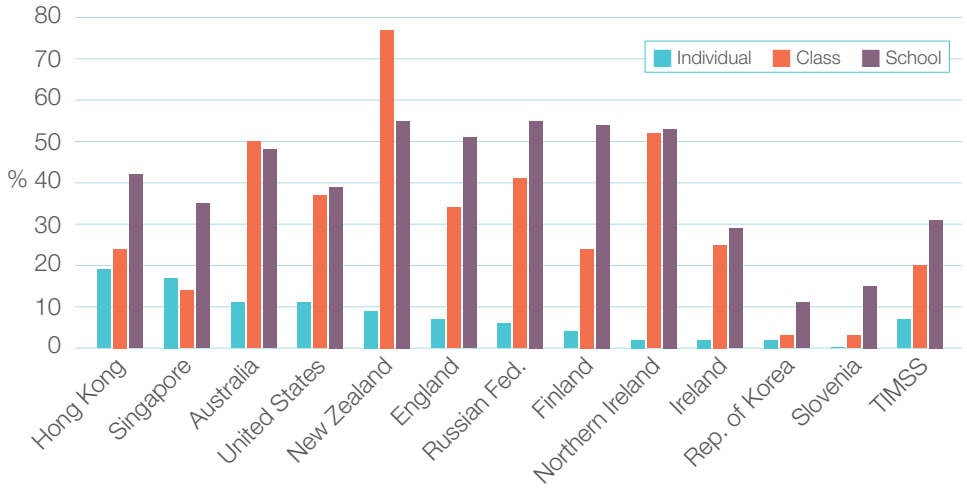
Irish teachers' reports suggest that 40% of pupils had some form of access to computers or tablets during mathematics lessons, which is similar to the international average, and to Singapore (Table 5.6). Access to computers during mathematics lessons was more common in New Zealand and Northern Ireland (71% and 89%, respectively) than in Ireland, and was less common in the Republic of Korea and Slovenia (14% and 16%, respectively). In most countries, access to computers was marginally more common for science lessons than for mathematics lessons. This was the case to a greater extent in England (71% of pupils with access to a computer in science lessons vs 58% in mathematics lessons) and in Singapore (49% in science lessons vs 37% in mathematics lessons).

Table 5.6: Percentage of pupils with any access to a computer or tablet in lessons

	Mathematics	Science
Australia	60	63
England	58	71
Finland	56	64
Hong Kong SAR	45	47
Ireland	40	42
New Zealand	89	91
Northern Ireland	71	76
Rep. of Korea	14	22
Russian Fed.	62	66
Singapore	37	49
Slovenia	16	22
United States	46	47
TIMSS	37	46

These summary figures combine different types of access to ICT – from one device per pupil to occasional shared access – which can obscure broader patterns. In Ireland, 2% of Fourth Class pupils had access to individual computers (TIMSS: 7%), 25% were in classrooms with computers that pupils could share (TIMSS: 20%), and 29% had occasional access to computers elsewhere in the school (TIMSS: 31%). The corresponding percentages varied widely across our comparison countries (Figure 5.6, arranged in descending order of pupils' having individual access to computers).

Figure 5.6: Percentage of pupils with varying types of access to computers/tablets during maths lessons



Beyond the availability of ICT resources in the classroom, there is the question of the use to which such resources are put. Internationally, the use of computers for particular activities tended to follow the availability of computers for use in lessons – that is, pupils used computers in their mathematics and science lessons more frequently in countries where computers were more widely available. There were, however, some exceptions to this broad pattern. For example, computers were widely available in Japanese Fourth grade mathematics (50%) and science (65%) lessons, but were rarely used (10-14% pupils using them at least monthly for mathematical activities and 12-35% using them for scientific activities).

Table 5.7 shows that, in Ireland, teachers' use of computers to explore mathematical principles and concepts with their pupils is slightly more frequent than their international counterparts', and the use of computers to practice mathematical skills and to look up mathematical ideas are in line with international practice. However, computers are used less frequently in science lessons in Ireland than internationally, for each of the four uses that teachers were asked about. Usage is particularly low for more active scientific activities such as doing experiments or scientific procedures (only 14% of pupils doing so *at least monthly*) and practising scientific skills (22%), compared to the passive use of computers to look up scientific facts (36%).

Table 5.7: Percentage of pupils, by use of computers *at least monthly* for various activities in lessons

	Mathematics			Science			
	Explore maths principles & concepts	Practise skills & procedures	Look up ideas & information	Practise skills & procedures	Look up ideas & information	Do scientific procedures/ experiments	Study natural phenomena through simulations
Australia	53	57	49	39	60	37	46
England	49	52	45	43	69	42	54
Finland	32	50	30	48	61	25	22
Hong Kong	33	35	29	29	37	33	27
Ireland	31	34	27	22	36	14	22
New Zealand	78	86	76	46	87	52	55
N. Ireland	58	68	58	37	69	23	39
Rep. of Korea	7	8	8	14	19	18	16
Russian Fed.	49	60	58	59	62	45	39
Singapore	30	34	28	36	43	35	31
Slovenia	9	12	12	15	20	11	17
United States	38	43	32	30	40	28	27
TIMSS	26	33	27	31	41	26	28

Chapter 6: Teacher confidence and professional development

This chapter covers topics related to the professional practice of teachers in the study, specifically addressing teachers' confidence in effectively teaching aspects of mathematics and science; their participation in various types of subject-specific CPD; and the extent to which they engage in collaborative practices with other teaching colleagues.

Confidence teaching mathematics and science (practices)

Teachers were asked to indicate their level of confidence in relation to different aspects of the teaching of mathematics and science.[8] Within Ireland, Fourth Class teachers were considerably more confident teaching mathematics than science (Table 6.1). For example, although most pupils had teachers who expressed *high* or *very high* levels of confidence in inspiring their pupils to learn mathematics (93%) and science (69%), there was a wide gap between the two domains. Teachers were also more confident that they could adapt their teaching to engage pupils' interest in mathematics (86%) than in science (71%), and similarly for helping pupils to learn the value of each subject (90% for mathematics, 72% for science).

Fewer pupils had teachers who were confident in teaching science, particularly in relation to improving the understanding of pupils who were struggling (51%), assessing pupil comprehension (45%), and helping pupils to develop higher-order thinking skills (55%). Only about one in three pupils were taught by a teacher whose confidence in providing tasks for the highest-achieving pupils in science lessons was *high* (30%) or *very high* (4%). At 34% combined, the latter figure is less than half the corresponding percentage for Irish teachers' confidence that they can provide appropriate tasks for high-achieving pupils in mathematics (79%).

In general, it is clear that Fourth Class teachers tend to be less confident teaching science lessons than when teaching mathematics. It is notable that the percentages of Fourth Class pupils taught by teachers who endorsed the highest level of confidence in their teaching ranges from 18-37% across the various mathematics-related topics, but from just 4-19% for science-related topics.

8 Direct comparisons to 2011 are not possible because of a change in the presentation of the question. In 2011, teachers were asked to choose one of three options (*very confident, somewhat confident,* or *not confident*) whereas, in 2015, four options were given (*very high confidence, high confidence, medium confidence,* and *low confidence*).

Table 6.1: Percentage of pupils, by teachers' confidence with various aspects of maths and science teaching

			Teachers' confidence			
			Very high	High	Medium	Low
Inspiring students to learn maths/science	Maths	IRL	36	57	6	1
		TIMSS	38	51	11	<1
	Science	IRL	17	52	28	3
		TIMSS	40	46	13	1
Providing challenging tasks for the highest achieving students	Maths	IRL	27	52	19	1
		TIMSS	28	49	21	2
	Science	IRL	4	30	51	15
		TIMSS	18	41	34	7
Adapting my teaching to engaging students' interest	Maths	IRL	27	59	14	<1
		TIMSS	30	55	14	<1
	Science	IRL	11	60	24	5
		TIMSS	31	52	16	1
Helping students appreciate the value of learning maths/science	Maths	IRL	30	60	9	0
		TIMSS	36	52	12	1
	Science	IRL	15	57	26	3
		TIMSS	34	50	15	1
Assessing student comprehension of maths/science	Maths	IRL	20	62	18	0
		TIMSS	30	56	14	<1
	Science	IRL	6	39	44	11
		TIMSS	26	52	21	2
Improving understanding of struggling students	Maths	IRL	18	65	17	1
		TIMSS	26	54	20	1
	Science	IRL	8	43	43	6
		TIMSS	22	49	27	2
Making maths/science relevant to students	Maths	IRL	29	57	14	0
		TIMSS	33	53	14	<1
	Science	IRL	19	53	22	5
		TIMSS	34	50	15	1
Developing students' higher-order thinking skills	Maths	IRL	23	55	21	1
		TIMSS	23	50	25	2
	Science	IRL	9	46	37	8
		TIMSS	22	47	28	3
Teaching science using inquiry methods *	Science	IRL	13	37	41	9
		TIMSS	22	44	30	4
Explaining concepts/ principles by doing science experiments *	Science	IRL	11	47	35	7
		TIMSS	26	43	28	3
Showing students a variety of problem solving strategies *	Maths	IRL	27	57	15	<1
		TIMSS	36	52	12	<1

*Question only applicable to one domain.

Irish teachers' confidence in various aspects of mathematics instruction tended to be close to, or slightly below, the international averages. By contrast, Fourth Class teachers expressed substantially

less confidence in teaching science than their counterparts in other countries. For example, a majority of Irish pupils (55%) were taught by a teacher with only *medium* or *low* confidence that they could assess pupils' understanding of science (compared to 23% internationally). Similarly, about half of pupils in Ireland (49%) had a teacher who expressed only *medium* or *low* confidence that they could improve the understanding of pupils who were struggling with science (compared to 29% internationally). Large differences in teachers' confidence are also seen for other areas, such as using inquiry methods to teach science, inspiring pupils to learn science, and providing appropriately challenging tasks for higher-achieving pupils.

Confidence teaching mathematics and science (content)

Teachers were also presented with a list of specific topics covering the various mathematical and scientific content areas that are assessed by TIMSS, and were asked to indicate how well prepared they felt to teach each of those topics. Seventeen topics were presented for mathematics, and 23 for science.[9] Thus, some information is available on teachers' perceptions of their readiness to teach particular *content* areas within the two domains, as well as the pedagogical *activities* they use with their classes (discussed in the previous section).

The responses to these questions indicated that most pupils in Ireland (at least 85% for almost all topics) were taught by a teacher who felt *very well prepared* or *somewhat prepared* to teach most of the mathematics and science topics. The percentage of Fourth Class pupils whose teachers felt only *somewhat prepared* ranged from 2% to 23% across mathematical topics, and from 21% to 54% across scientific topics,[10] indicating, generally, less confidence with science than with mathematics topics. Internationally, too, teachers generally reported feeling better prepared to teach mathematics than science.

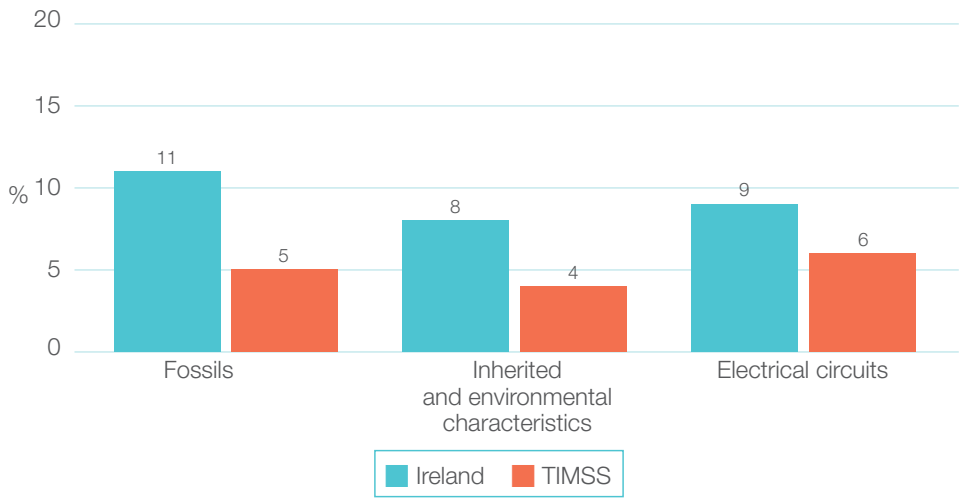
There were few mathematics topics that teachers reported as posing particular difficulties. The most problematic topic was 'reflections and rotations' (Geometry), which the teachers of 4% of Irish pupils felt *not well prepared* to teach. 'Reflections and rotations' was also identified as the most problematic topic at the TIMSS international average (3% of pupils).

On the other hand, there were three science topics that teachers in Ireland reported as being especially problematic (Figure 6.1). These were: 'understanding what fossils are and what they can tell us about past conditions on Earth' (an Earth Science topic for which the teachers of 11% of pupils felt *not well prepared*); 'electricity & simple circuits' (a Physical Science topic for which the teachers of 9% of pupils felt *not well prepared*); and 'understanding that some characteristics are inherited and some are the result of the environment' (a Life Science topic for which the teachers of 8% of pupils felt *not well prepared*). The former two topics were also among those for which Fourth grade teachers in other countries felt least prepared to teach (5% and 6% *not well prepared*, respectively, at the TIMSS average).

9 Examples of mathematics topics included: 'concepts of fractions' (Number), 'comparing and drawing angles' (Geometric Shapes & Measures), and 'drawing conclusions from data displays' (Data Display). Examples of science topics included: 'life cycles of common plants and animals' (Life Science), 'mixtures and how to separate a mixture into its components' (Physical Science), and 'understanding how seasons are related to the Earth's annual movement around the sun' (Earth Science).

10 For clarity of presentation, a complete presentation of teachers' preparedness for each of the 40 topics is not given here. The associated tables are included in the accompanying e-appendix (see www.erc.ie/timss).

Figure 6.1: Percentage of pupils whose teachers felt *not well prepared* to teach selected topics



These three science topics were also among the topics that teachers reported to have received the least coverage in classrooms (to near the end of Fourth Class). As reported by Clerkin et al. (2016), the topic of 'fossils' was *not yet taught or just introduced* for 56% of Fourth Class by the time of the TIMSS assessment, while 'electricity and circuits' was *not yet taught or just introduced* for 34% of pupils, and 'heredity and environment' for 55% of pupils.[11]

Participation in Continuing Professional Development

As part of TIMSS 2015, teachers were presented with a series of questions related to their participation in CPD in the two years prior to the study. They were asked to indicate the number of hours they had spent on mathematics- or science-related CPD, and also whether they had participated in any of several specified types of CPD. In Ireland, although participation in mathematics-related CPD increased slightly between 2011 and 2015, participation in science-related CPD dropped slightly over the same period (see Clerkin, 2013, for comparison).

In Ireland, 37% of pupils had teachers who had attended between six and 35 hours of mathematics-related CPD within the previous two years (Table 6.2). A substantial minority of pupils (28%) had teachers with no recent participation in mathematics CPD, as was also the case in other TIMSS countries (27%). Only 4% of Fourth Class pupils' teachers had attended more than 35 hours of mathematics CPD (compared to 12% internationally).

In both Ireland and internationally, the average uptake of science-related CPD was lower than for mathematics. However, this pattern was particularly pronounced in Ireland. Most pupils in Ireland (67%) had a teacher who had not participated in any science CPD in the previous two years, compared to 41% of pupils internationally. Only 16% of pupils in Ireland had teachers who had participated in more than six hours of science CPD, less than half the corresponding figure (36%) across all TIMSS countries.

11 The only other topics to receive similarly little coverage were 'chemical changes' (55%) and 'mixtures' (45%) (Chemistry), followed by 'seasons' (Earth Science) and 'classifying materials' (Physical Science) (both 32%).

Table 6.2: Percentage of pupils, by teachers' participation in mathematics- or science-related CPD in the two years prior to TIMSS

		None	Less than 6	6-15 hours	16-35 hours	More than 35 hours
Maths	Ireland	28	30	26	11	4
	TIMSS	27	22	24	14	12
Science	Ireland	67	16	10	5	1
	TIMSS	41	24	19	9	8

Looking at teacher participation in specific areas of mathematics-related professional development (Table 6.3), pupils in Ireland were less likely than their international peers to have a teacher who had attended CPD that focused on mathematics instruction (Ireland: 37%; TIMSS average: 45%), assessment of mathematics (Ireland: 25%; TIMSS: 35%), or addressing individual pupils' needs (Ireland: 27%; TIMSS: 42%). However, slightly higher proportions of pupils in Ireland had teachers who had recently participated in CPD related to improving critical thinking and problem-solving (Ireland: 45%; TIMSS: 40%) and mathematics content (Ireland: 46%; TIMSS: 42%).

By contrast, attendance at specified types of science-related CPD was very low in Ireland compared to many other countries. The percentages of pupils whose teachers had attended CPD were lower than the international averages for each of the eight specified aspects of science-related professional development (Table 6.3). Participation in CPD ranged from a low of only 7% of Fourth Class pupils whose teachers had recent CPD in science assessment (compared to 25% internationally), to a high of 24% of Fourth Class pupils whose teachers had attended CPD focused on integrating science with other subjects (compared to an international high of 33% for CPD related to problem-solving).

Participation in science-related CPD in Ireland was much lower, for all the specified content areas, than CPD related to mathematics. It was also slightly lower than the corresponding figures from 2011 (Clerkin, 2013).

Table 6.3: Percentage of pupils, by teachers' participation in CPD related to specified aspects of mathematics and science teaching

	Maths		Science	
	Ireland	TIMSS	Ireland	TIMSS
Content	46	42	18	32
Instruction	37	45	14	32
Curriculum	38	39	20	32
Integrating ICT into maths/science	34	35	12	30
Assessment	25	35	7	25
Critical thinking / problem-solving	45	40	17	33
Addressing individuals' needs	27	42	13	32
Integrating science into other subjects	-	-	24	29

Collaborative practices

Collaborative practices, such as sharing information and resources, or providing (and seeking) advice from colleagues, can be viewed as a form of informal professional development that offers access to pedagogical expertise and experience. The informal development that arises from interactions with colleagues may be useful for all teachers, but especially for younger or more recently-qualified

teachers (who, as seen in Chapter 3, make up a particularly high proportion of the Irish teaching workforce). No less importantly, collegial relationships can provide a source of emotional and social support at work, thus helping to support teachers' wellbeing and protecting against burnout (see, e.g., Collie, Perry, & Martin, 2017).

The TIMSS 2015 data, like those from TIMSS 2011 (Clerkin, 2013), show that collaborative practices are generally less common in primary schools in Ireland than in most countries (Table 6.4). There was only one activity – working as a group to implement the curriculum – that teachers in Ireland engaged in to a greater degree than teachers in other countries, with 67% of Irish pupils' teachers *often* or *very often* doing so (TIMSS: 62%). In contrast, Irish teachers were less likely than their international counterparts to *often* or *very often* share teaching experiences with colleagues (53% vs 71%), discuss how to teach a particular topic (51% vs 70%), work together to try out new ideas (38% vs 53%), or work with teachers from other grades to ensure continuity in learning (45% vs 49%)

Most notably, teachers in Ireland were far less likely than average to have visited another classroom to learn more about teaching. Two-thirds of pupils in Ireland (66%) had a teacher who *never or almost never* visited a colleague's classroom, compared to a TIMSS average of 28%.

It may be noted that Irish teachers also reported relatively low levels of collaboration 20 years ago. Mullis et al. (1997) report that almost half (46%) of the Irish pupils who took part in TIMSS 1995 had a teacher who *never* met with their colleagues to discuss teaching approaches or did so only *once or twice each year.* Although direct comparisons are difficult to draw when response options differ, this is not dissimilar to the 49% of pupils whose teachers *sometimes* or *never or almost never* discussed teaching with colleagues in 2015 (Table 6.4).

Table 6.4: Percentage of pupils, by teachers' engagement in various collaborative practices

		Very often	Often	Sometimes	Never or almost never
Discuss how to teach a particular topic	IRL	26	25	44	5
	TIMSS	29	41	28	3
Collaborate in planning or preparing instructional materials	IRL	25	31	31	13
	TIMSS	28	38	28	6
Share what I have learned about my teaching experiences	IRL	22	31	41	6
	TIMSS	29	42	26	2
Visit another classroom to learn more about teaching	IRL	2	9	23	66
	TIMSS	9	20	43	28
Work together to try out new ideas	IRL	12	26	46	15
	TIMSS	18	35	40	7
Work as a group to implement the curriculum	IRL	20	47	27	7
	TIMSS	24	38	30	7
Work with teachers from other grades to ensure continuity in learning	IRL	9	36	37	19
	TIMSS	15	34	38	12

Chapter 7: Teachers' views of the working environment

This chapter discusses teachers' experience of the teaching profession, their working conditions, and their sense of job satisfaction. It is divided into four main sections. The first section contains details on the challenges faced by teachers, considering factors that limit their ability to teach and broader issues that may impact their working conditions. The second and third sections deal with the broader school environment, focusing on reports of school safety and the emphasis placed on academic success in the school. The final section describes teachers' sense of career satisfaction.

Challenges

The TIMSS teacher questionnaire included seven questions about teaching that focused on factors that might present difficulties when teaching a class.

About 10% of pupils in Ireland were in classes where the teacher reported that they felt limited *a lot* by pupils' lack of knowledge or skills that might have been expected to have been learned in earlier grades (Table 7.1). In addition, substantial proportions of pupils – close to or more than half – had teachers who reported *some* difficulties or *a lot of* difficulties due to some pupils coming to class without having had sufficient sleep, from pupils' disruptive behaviour or lack of interest, or relating to pupils with mental, emotional or psychological difficulties.

Table 7.1: Percentage of pupils, by teachers' reports of issues that limit their ability to teach their class

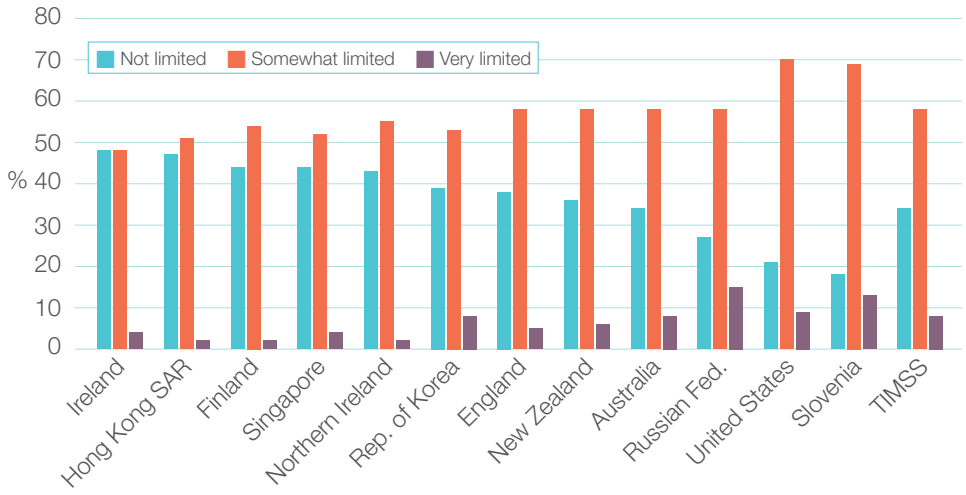
		Limited a lot	Limited to some extent	Not at all limited
Disruptive pupils	IRL	7	52	41
	TIMSS	19	54	27
Uninterested pupils	IRL	4	64	32
	TIMSS	15	62	23
Pupils lacking prerequisite knowledge or skills	IRL	10	65	25
	TIMSS	19	65	16
Pupils with mental, emotional, or psychological impairments	IRL	6	42	52
	TIMSS	10	48	42
Pupils with physical disabilities	IRL	<1	13	87
	TIMSS	2	14	84
Pupils suffering from not enough sleep	IRL	3	59	38
	TIMSS	9	50	42
Pupils suffering from lack of basic nutrition	IRL	2	23	75
	TIMSS	5	28	67

These reports are broadly similar to those given by Fourth Class teachers in 2011 (Clerkin & Creaven, 2013). That aside, teachers in Ireland were less likely to express concern than teachers in most countries. For example, disruptive pupils and uninterested pupils were far more likely to be seen as a problem across TIMSS as a whole than in Ireland.

Teachers' responses to these statements were aggregated and used to construct a single indicator of the extent to which their teaching is limited by these issues. In Ireland, this aggregated measure shows that Fourth Class pupils were almost evenly divided between teachers who reported that their teaching was *not limited* (48%) and teachers who reported that their teaching was *somewhat limited* (48%). Only 4% of pupils in Ireland were in classes where teachers felt *very limited* in their teaching as a result of the issues presented in Table 7.1.

These reports indicate that the working conditions in Ireland are relatively favourable compared to the TIMSS international average (34% *not limited*, 58% *somewhat limited*, and 8% *very limited*) and among our comparison countries (Figure 7.1, presented in descending order of the *not limited* percentage). For comparison, only five countries reported that more than half of their Fourth grade pupils were in classes where teachers' practice was *not limited* due to issues presented by their pupils: Serbia (51%), Slovak Republic (54%), Czech Republic (57%), Indonesia (58%) and Japan (71%).

Figure 7.1: Percentage of pupils, by teachers' reports of the extent to which their teaching is limited



There were also several broader issues that were sources of dissatisfaction for teachers (Table 7.2). More than half of pupils in Ireland (54%) had a teacher who agreed *a lot* that they had too many pupils in their classroom, compared to 29% internationally. However, across countries, there is not a clear link between teachers' responses to this question and actual average class size. For example, five of our comparison countries had higher average class sizes than Ireland (Australia, England, Hong Kong, New Zealand; and Singapore; see Table 4.1), yet comparatively fewer pupils in those countries had a teacher who agreed *a lot* that class size was a challenge (ranging from 13% of pupils in England to 26% in Australia and New Zealand). [12]

Issues that were more likely to be perceived as a significant challenge in Ireland included not having enough time to assist individual pupils (Ireland: 71%; TIMSS: 53%), having too much material to cover (Ireland: 49%; TIMSS: 30%), having too many administrative tasks (Ireland: 36%; TIMSS: 28%), and not having enough time to prepare for class (Ireland: 33%; TIMSS: 27%).

On the other hand, having too many teaching hours, keeping up with changes to the curriculum, and feeling too much pressure from parents were seen as lesser challenges among Irish teachers.

12 This question was not administered in Singapore.

For example, only 6% of pupils in Ireland had a teacher who agreed *a lot* that they feel too much pressure from parents (in contrast to, for example, 14% of pupils in Hong Kong and 17% in Slovenia).

Table 7.2: Percentage of pupils, by teachers' reports of work-related challenges

		Agree a lot	Agree a little	Disagree a little	Disagree a lot
There are too many pupils in the classes	IRL	54	25	11	9
	TIMSS	29	32	23	16
I have too much material to cover in class	IRL	49	40	8	3
	TIMSS	30	42	22	6
I have too many teaching hours	IRL	2	20	45	33
	TIMSS	13	26	37	23
I need more time prepare for class	IRL	33	43	19	6
	TIMSS	27	42	23	9
I need more time to assist individual pupils	IRL	71	25	3	1
	TIMSS	53	38	7	2
I feel too much pressure from parents	IRL	6	28	35	31
	TIMSS	7	26	42	25
I have difficulty keeping up with all the changes to the curriculum	IRL	8	42	30	20
	TIMSS	8	30	38	24
I have too many administrative tasks	IRL	36	38	16	10
	TIMSS	28	31	23	18

Safe and orderly school environment

Teachers were asked to respond to eight statements describing the extent to which the school is perceived to provide a safe and orderly environment for learning. Example items include "the students respect school property" and "this school's rules are enforced in a clear and consistent manner". These eight items were combined to construct an overall scale of the *safe and orderly* school environment.

Ireland's primary schools were rated by teachers as amongst the safest learning environments for Fourth grade pupils across all TIMSS countries (Table 7.3). Almost all pupils in Ireland were attending schools which their teachers reported as being either *very safe and orderly* (83%) or *safe and orderly* (14%). Only Northern Ireland (85% and 15%) and Indonesia (89% and 11%) had higher proportions of pupils attending similarly-rated schools. Very few pupils in Ireland (2%) were in schools that were considered to be *less than safe and orderly.* Such schools were also rare in England (<1% of pupils) and absent in Northern Ireland (0%), but were relatively more common in Slovenia (7%) and the United States (7%).

There was a positive relationship between a safe and orderly school environment and average student achievement in both mathematics and science. For example, pupils in Ireland who attended *very safe and orderly* schools had an average mathematics score of 551, compared to those in *safe and orderly schools* whose mean score was 536.[13] Internationally, Fourth grade pupils attending schools that were reported as being *very safe and orderly* achieved an average mathematics score of 511, compared to those enrolled in *safe and orderly* schools (497) and those in *less than safe and orderly* schools (464).

13 The percentage of pupils in *less than safe and orderly schools* is too small to give a reliable estimate of achievement.

Table 7.3: Percentage of pupils and mean achievement, by teachers' reports of the safety of the school environment

	Very safe and orderly			Safe and orderly			Less than safe and orderly		
	%	Maths	Science	%	Maths	Science	%	Maths	Science
Australia	75	529	533	23	490	502	2	-	-
England	76	550	541	24	536	524	<1	-	-
Finland	37	540	558	60	534	553	3	509	511
Hong Kong SAR	64	616	562	34	612	551	2	-	-
Ireland	83	551	534	14	536	511	2	-	-
New Zealand	71	504	517	26	461	480	3	446	469
Northern Ireland	85	576	523	15	554	506	0	-	-
Rep. of Korea	44	615	595	54	603	585	2	-	-
Russian Fed.	55	566	568	43	562	567	2	-	-
Singapore	63	619	599	35	616	576	2	-	570
Slovenia	29	522	547	64	521	543	7	510	533
United States	55	552	560	38	526	531	7	500	510
TIMSS	56	511	513	40	497	498	4	464	469

Emphasis on academic success

An indicator of the emphasis on academic success within the school was derived from teachers' responses to 14 items related to teachers' expectations for student achievement, students' respect for classmates who excel in school, students' desire to do well in school, parental expectations and support for student achievement, and collaboration between teaching colleagues and between teachers and school leadership relating to student instruction.

Primary schools in Ireland placed a comparatively high level of emphasis on the academic success of pupils (Table 7.4). For example, one-fifth of Fourth Class pupils (20%) attended a school with a *very high emphasis* on academic success (TIMSS average: 7%) while an additional 67% of pupils were in schools with a *high emphasis* on academic success (TIMSS: 56%). About 13% of pupils in Ireland were reported to be in a primary school with a *medium emphasis* on academic success (compared to 36% of pupils internationally).

Among our comparison countries, only the Republic of Korea (29%) and Northern Ireland (22%) had a higher proportion of pupils in schools which were reported to place a *very high emphasis* on academic success. In contrast, very few pupils were in such schools in the Russian Federation, Hong Kong, and Slovenia.

This, perhaps, is illustrative of the difficulties in comparisons of attitudes and beliefs across (rather than within) countries. Teachers in Hong Kong or the Russian Federation, for example, might not see their school as having a particularly high emphasis on academic success *by comparison to other schools in Hong Kong/Russian Federation*, but their school might still be judged by an impartial observer to emphasise academic achievement more strongly than some schools in other countries (which, in turn, would judge themselves against *other schools within their own reference group).*

Within country, but not between countries, teachers' reports of the emphasis placed on academic success were generally positively associated with average achievement in mathematics and science. Looking at mathematics achievement in Ireland, we see that pupils who attended schools where

there was a *very high emphasis* on academic success scored an average of 562, compared to 548 for those in schools with a *high emphasis* on their academic success. Those who attended schools where there was only a *medium emphasis* on academic success, on average, scored significantly lower than pupils in the other two groups (518). A similar pattern was observed at the TIMSS average and in many other countries, although some exceptions (e.g., Slovenia) can be noted.

Table 7.4: Percentage of pupils and mean achievement, by teachers' reports of their schools' emphasis on academic success

	Very high emphasis			High emphasis			Medium emphasis		
	%	Maths	Science	%	Maths	Science	%	Maths	Science
Australia	9	555	522	63	526	527	28	488	504
England	15	575	561	56	552	542	29	521	516
Finland	2	-	-	64	538	557	34	530	547
Hong Kong SAR	<1	-	-	71	624	564	29	591	542
Ireland	20	562	545	67	548	530	13	518	495
New Zealand	12	510	523	68	499	513	20	454	473
Northern Ireland	22	585	529	67	574	522	11	539	500
Rep. of Korea	29	627	601	57	603	586	15	590	574
Russian Fed.	<1	-	-	54	570	574	46	557	560
Singapore	4	639	629	52	637	609	44	594	562
Slovenia	1	-	-	61	521	544	38	519	541
United States	8	576	585	51	547	554	41	520	526
TIMSS	7	529	528	56	518	514	36	493	491

Career satisfaction

Teachers were presented with seven statements which asked them to indicate how often they felt positively about their work as a teacher. Most teachers internationally, but particularly teachers in Ireland, reported high levels of job satisfaction in response to these statements.[14] There were particularly high proportions of pupils in Ireland who were taught by teachers who *very often* felt satisfaction teaching in their particular school (68% in Ireland vs 53% internationally), felt enthusiasm for their job (65% vs 53%), and felt proud of their work (64% vs 57%).

The responses to this set of statements were combined to form an overall measure of job satisfaction (Table 7.5). Teachers in Ireland reported relatively high levels of career satisfaction compared to those in other participating countries. As shown, the vast majority (95%) of Fourth Class pupils were taught by teachers who were *very satisfied* or *satisfied* in their jobs. Only 5% of pupils had a teacher who was *less than satisfied.* Among Ireland's comparison countries, Hong Kong (33%) and Singapore (37%) had the lowest proportions of pupils whose teachers were *very satisfied* at work, while England (12%) had the highest percentage of pupils taught by *less than satisfied* teachers.

Teachers' level of job satisfaction was associated with pupil achievement at the TIMSS average and in several of our comparison countries, with pupils whose teachers reported greater satisfaction performing at a higher level on the assessments (e.g., Australia, Hong Kong, United States). A similar

14 The seven statements, and a table showing the responses, are presented in full in the e-appendix.

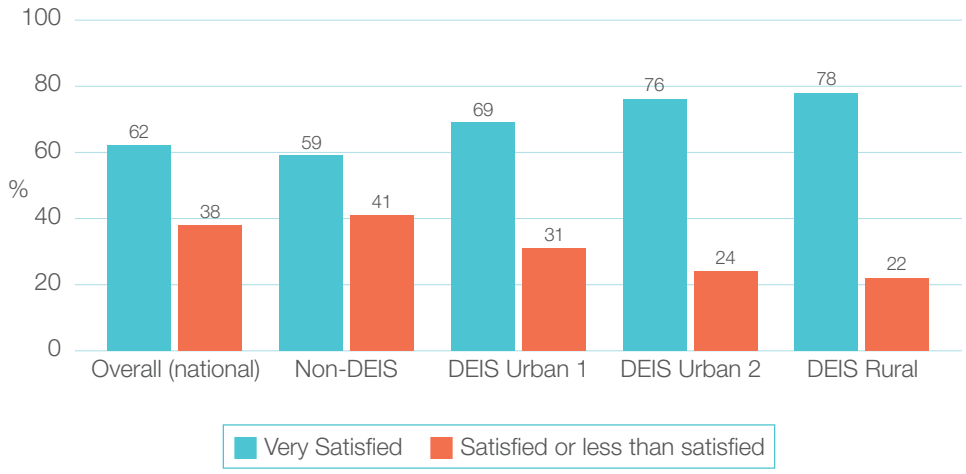
pattern was observed in Ireland at post-primary level (Clerkin, Perkins & Chubb, in press). However, there were no substantive differences in pupil performance at primary level in Ireland relative to teachers' satisfaction (Table 7.6).

Table 7.5: Percentage of pupils and mean mathematics achievement, by teachers' overall career satisfaction

	Very satisfied		Satisfied		Less than satisfied	
	%	Maths	%	Maths	%	Maths
Australia	52	522	45	514	3	507
England	42	550	46	547	12	532
Finland	45	535	50	535	6	530
Hong Kong SAR	33	620	59	613	9	605
Ireland	62	548	33	547	5	545
New Zealand	50	494	43	487	7	482
Northern Ireland	59	574	37	572	4	563
Rep. of Korea	55	613	38	602	7	602
Russian Fed.	48	560	51	567	1	-
Singapore	37	625	53	612	11	620
Slovenia	52	520	47	521	0	-
United States	47	542	45	538	7	521
TIMSS	52	508	42	503	6	501

Some variation in teachers' career satisfaction was found when comparing responses from teachers working in more disadvantaged environments, categorised by the schools' receipt of additional supports under the DEIS programme. As noted above, a majority of pupils nationally (62%) were taught by a teacher who reported being *very satisfied* in their career. This proportion was higher in all categories of DEIS schools than in non-DEIS schools (Figure 7.2). In particular, more than three-quarters of Fourth Class pupils in Urban Band 2 schools (76%) and DEIS Rural schools (78%) had a teacher who was *very satisfied* in their career.

Figure 7.2: Percentage of pupils, by teachers' degree of career satisfaction, by DEIS status



Satisfaction was higher amongst teachers of single-grade classes (where 64% of pupils had a *very satisfied* teacher, compared to 55% of pupils in multigrade classes) and among female teachers

(63% *very satisfied*, compared to 56% of the pupils of male teachers). There was a stronger sense of dissatisfaction among male teachers: 9% of the pupils taught by males had a teacher who reported being *less than satisfied* in the profession, compared to 4% of the pupils taught by female teachers.

Finally, teachers' experience was also related to their career satisfaction. 'New' teachers, in their first two years of teaching, reported high levels of satisfaction (72% of their pupils taught by *very satisfied* teachers). Similar levels of satisfaction were reported by teachers of three to five years' experience (73% *very satisfied*). However, teachers with six or more years of experience were more restrained, with only 58% of their pupils taught by *very satisfied* teachers. This was accounted for by a shift towards the middle category (*satisfied*) among more experienced teachers, rather than a strong sense of dissatisfaction per se. That is, only 6% of pupils taught by teachers of six or more years' experience had teachers who were *less than satisfied* in the profession, which is very similar to the 7% of pupils of teachers with three to five years' experience in the same category. (In contrast, all of the teachers within their first two years of teaching reported being at least *satisfied.*)

Chapter 8: Discussion

This concluding chapter takes a broad view of the data presented throughout this report, identifying some key findings, particularly those of relevance to an Irish population. The information on science teaching and learning that is gained from Ireland's participation in TIMSS is particularly valuable given the absence of an equivalent national assessment of science at primary level.

Indeed, some of the most striking findings arising from these data relate to various aspects of science instruction. For example, teachers' reports indicated that Fourth Class pupils in Ireland spent less time on science lessons than their peers in *any* other TIMSS country (32 hours over the course of the year, compared to an international average of 76 hours). Much of the content categorised as Earth Science in the TIMSS framework is taught as 'geography' in Irish classrooms, and these topics (comprising about 20% of the TIMSS assessment) might therefore not have been counted by responding teachers. This caveat notwithstanding, the time devoted to science instruction in Irish classrooms in 2015 has halved from the corresponding figure in 2011 (63 hours), when it was already the second-lowest reported across participating TIMSS countries. There is no indication that the drop has been counterbalanced by a concomitant increase in the amount of time spent teaching Earth Science topics in geography lessons.

Therefore, there has been a substantial reduction in the time that Fourth Class pupils have available for learning transferrable scientific skills – the concepts and skills that underpin experimentation, investigation of the natural world, and the use of evidence in drawing conclusions – as well as learning content related to the physical and life sciences. This is likely to be related to the greater share of time now being spent on reading and mathematics instruction (see Chapter 5; also Kavanagh et al., 2015) due to the implementation of the *National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020* (Circular 0056/2011).

Nonetheless, the performance of Fourth Class pupils on the TIMSS science assessment improved significantly between 2011 and 2015, as did pupils' mathematics performance (Clerkin et al., 2016). There are several factors that may have contributed to this improvement. One possibility is that an improvement in pupils' reading performance since 2011 could be supporting a greater comprehension of scientific and mathematical content, as well as a greater ability to demonstrate understanding in a written assessment. Pupils with stronger reading skills can find it easier to engage with standardised mathematics and science assessments such as TIMSS due to the 'reading load' of the questions that they answer (Mullis, Martin & Foy, 2013). The TIMSS items are deliberately written so as to be accessible and not to unduly disadvantage pupils with limited reading skills. For example, a recent analysis of the readability of the TIMSS 2015 Eighth grade (Second Year) mathematics assessment found that the items were written with relatively few difficult words and with an average reading level equivalent to First grade or Second grade (First Class or Second Class) (Cunningham, Close & Shiel, 2016). A similar analysis was not performed for the Fourth grade mathematics assessment, but it can be safely assumed that the reading level of the items was no higher. However, the necessity for some reading (and writing) ability is unavoidable in an assessment of this nature. In this sense, reading is a fundamental skill even when an assessment focuses explicitly on mathematics or science. This may not make a difference when items have a very low reading load (i.e., when little reading is involved or the reading is at a very low level), but could give stronger readers a better chance of answering mathematics or science questions with a

higher reading load. The 2014 National Assessments found that the reading performance of pupils in Second Class and Sixth Class had improved significantly between 2009 and 2014 (Shiel, Kavanagh & Millar, 2014), suggesting that corresponding improvements among Fourth Class pupils might also be expected. The results of PIRLS 2016, due to be released in December 2017, will shed more direct light on this question.

In addition, the high proportion of pupils in Ireland who are taught by relatively young or recently-qualified teachers is worth noting. 'New' teachers (those in their first two years of teaching) were found to make greater use of active inquiry-based approaches to learning science in their lessons – such as planning and conducting experiments – than more experienced teachers. Conversely, new teachers were less inclined to read science textbooks to their class or to have their pupils listen passively while they explained new science content. These differences in practice may be linked to changes in teacher education, with at least some programmes placing an increased emphasis on inquiry-based methods of science education in recent years (C. Murphy, personal communication, May 2017). Previous research has shown how the use of inquiry-based methodologies in primary school science lessons are associated with more positive attitudes to science among pupils as well as greater understanding and appreciation of the nature of scientific activities (e.g., that science is an iterative process of accumulating evidence rather than a static collection of facts; that experimentation requires imagination, creativity, and experimentation rather than simply being a series of step-by-step instructions, etc.) (Murphy, Murphy & Kilfeather, 2011; Murphy, Varley & Veale, 2012). Providing children with greater exposure to inquiry-based methods in school – which feature only rarely in some classrooms (Murphy et al., 2012; Varley, Murphy & Veale, 2013) – should therefore be seen as a positive step in enhancing pupils' knowledge of science and the acquisition of scientific thinking.

Bearing in mind the very limited amount of time currently allocated to science instruction, it seems important to ensure that the time available is used as effectively and as efficiently as possible. Teachers' reports of their confidence in daily pedagogical activities provide some pointers towards difficulties that need to be addressed. As was the case in 2011 (Clerkin, 2013), Irish teachers reported a much lower level of confidence in teaching science content than mathematics. They also reported less confidence teaching science than teachers in many other TIMSS countries. Murphy and Smith (2012) highlight a number of misconceptions held by a surprisingly high percentage of primary teachers in relation to key scientific concepts relating to living things and (most notably) energy and forces. They also report that most of the BEd students who took part in their study had studied biology (68%) to Leaving Certificate level, but that few had studied chemistry (17%), physics (8%), or physics/chemistry (2%) to the same degree. Combined with the fact that initial teacher education courses have tended to focus more on pedagogy than on developing teachers' scientific content knowledge (Murphy & Smith, 2012), this may suggest that Irish pupils' relative weakness in physics and chemistry topics on the TIMSS assessment, at both primary and post-primary levels (Clerkin et al., 2016), may in part be due to weaknesses in teachers' conceptual understanding of the relevant topics. It is difficult to see how a teacher could correct pupils' misconceptions or misunderstandings relating to, for example, the idea that heat travels from a cold body to a hot body if they also hold that misconception themselves.

In terms of pedagogical practices more generally, about half or more of the Fourth Class pupils in Ireland were taught by teachers with only *medium* or *low* confidence that they could improve the understanding of lower-performing pupils in science (49% of pupils) or, conversely, provide appropriately challenging tasks for higher-performing pupils in science (66%). Decisions as to how best to support pupils who are struggling or those who are ready for further challenges are further complicated by teachers' limited confidence in their capacity to accurately assess their pupils' understanding of science in the first place (55%). The latter issue is exacerbated by the relatively

limited use of assessment, in practice, in order to gauge pupils' progress in science lessons, whether by assessing pupils' ongoing work or through more formal classroom testing. Together, these reports suggest a need for much greater support for teachers in building confidence and competence relating to science instruction, both during initial teacher education (Murphy, 2013; Murphy & Smith, 2012) and continuing professional development (Murphy & Smith, 2012; Murphy et al. 2012).

Most Fourth Class pupils in TIMSS 2015 had teachers with some recent participation in mathematics-related CPD. By contrast, participation in formal science-related CPD in the two years prior to this survey was much lower in Ireland than in many other countries. Only one-third of Fourth Class pupils had a teacher with *any* recent CPD in science and, of those, about half fell into the 'fewer than six hours' category. This suggests that there is substantial scope for more in-depth development related to the teaching of science at primary level. Of relevance to the discussion presented in Chapter 2 on pedagogical content knowledge – and the variation in teachers' confidence in the teaching of both mathematics and science found in this study – is that the teachers of two-thirds of Sixth Class pupils in the 2014 National Assessments agreed that they would benefit from a course to improve *their own understanding* of the mathematics they teach to their pupils, separately to strong agreement that they would benefit from CPD on the *teaching* of mathematics (Kavanagh et al., 2015). Teachers were not asked about science in the National Assessments, so no corresponding data on teachers' understanding and teaching of science are available.

However, Murphy and Smith (2012) strongly suggest that there is a need for professional development aimed at enhancing teachers' understanding of basic scientific content, stating that "we would question… whether they have sufficient scientific background knowledge to competently implement the science curriculum" (p .82). In part, this may be due to the limited provision of in-service training for teachers who were active when the current primary science syllabus was introduced in 2003 and, in many cases, limited exposure to scientific conceptual knowledge and science pedagogy during initial teacher education for teachers who have entered the profession since then (see Murphy, 2013). It is worth noting that the establishment of the Professional Development Service for Teachers through the amalgamation of several standalone support services in 2010 was followed closely by the introduction of the *National Strategy to Improve Literacy and Numeracy among Children and Young People, 2011-2020* (Circular 0056/2011). Prior to 2010, support services were expected to provide a "customised support to schools and teachers" (DES, 2010, p. 16) in a range of subject-specific and pedagogical areas, including the teaching of science, for which schools could request specific support. However, since 2010, the PDST has provided a "generic" (i.e., not subject-specific) service to primary schools that focuses primarily on literacy, numeracy, and cross-curricular topics such as school self-evaluation and school leadership (www.pdst.ie/about_us), in line with the *Literacy and Numeracy Strategy*. Compared to these other priorities, CPD related to the conceptual understanding of science or science pedagogy at primary level has been relatively rare in recent years.

Teachers' reports of professional collaboration are worth considering here, given that many Irish teachers make limited use of their colleagues' expertise in addressing areas of difficulty. One review of the research literature has noted that a recurring problem in efforts to enhance schools' effectiveness is that "much time is expended on inventing solutions that already exist or that are inferior to existing solutions" (Muijs, Harris, Chapman, Stoll & Russ, 2004, p. 161). Muijs et al. identify the building of learning communities among teachers as a solution to this problem, with the sharing of information and expertise among inquisitive colleagues being the key factor. They suggest that school management should "make sure that teachers can observe one another's lessons, as many instances of good practice will be found in any given school" (p. 162).

From this perspective, the finding that about half of all Fourth Class pupils were taught by a teacher who rarely discussed with a colleague how to teach a particular topic, or shared their own teaching experience, suggests that teachers' own expertise is a resource of which greater use could be made. The proportion of pupils in Ireland whose teachers ever visited another classroom to learn about teaching was particularly low by international standards. One contributory factor is that many teachers in Ireland work in small schools, with relatively few direct colleagues, and isolation – both professional and social – has previously been identified as a problem by teachers in some very small schools (Mulryan-Kyne, 2004). It seems possible that at least some lack of confidence in teaching skills might be ameliorated by a less isolated working environment, either within schools (where possible), or within small clusters of geographically-nearby schools that can facilitate interaction between teachers with a view to sharing expertise and cooperating in the formulation of organisational policies and practices (see Ó Slatara and Morgan, 2004).

Teachers also identified a number of broader challenges that are seen as constraining their ability to teach their pupils effectively. Chief among these is the issue of how their time is spent – clear majorities of Fourth Class pupils were taught by teachers who agreed that they need more time to assist individual pupils, that they have too much material to cover in the time available in class, that they need more time to prepare for class, and that they have too many administrative tasks to complete. In each case, these issues were seen as greater challenges in Ireland than internationally. This might, in part, reflect difficulties associated with the relatively high prevalence of multigrade classes in Ireland, which can add organisational complexity, time pressures, and more frequent interruptions to classroom teaching (INTO, 2003; Mulryan-Kyne, 2004). This interpretation is given some weight by the fact that teachers of multigrade classes in this study also reported lower (albeit still generally high) levels of satisfaction with their jobs. Conversely, having too many teaching hours was seen as a relatively minor problem by teachers in Ireland, both relative to the other challenges that were identified and relative to the international average. Despite these criticisms, it should be noted that, in general, when asked about their career as a teacher, the proportion of pupils in Ireland whose teachers expressed high levels of career satisfaction was greater than many of our comparison countries and above the international average. The high level of positive feeling is a promising sign of commitment to the profession.

The prominence of 'time' in the challenges just identified does not necessarily suggest that simply increasing the hours that pupils and teachers spend in the classroom would be a panacea to the problem of not having enough time to prepare for class effectively or to assist individual pupils to a greater extent. For example, we should also consider the impact of the administrative burden, as identified by Fourth Class teachers, on core instructional time. Sandoval-Hernandez et al.'s (2013) analysis of PIRLS data leads them to the clear conclusion that "increasing the total school hours per year probably does little to increase student learning" and that "there is promise in focusing on teacher activities in the classroom; specifically, allowing teachers more time to teach" (p. 7). Similarly, Gromada and Shrewbridge (2016) describe classroom time not as "a guarantor of success [but] simply a resource that can be more or less effectively used, depending on the quality of instruction and other factors" (p. 28). They note American research estimating the amount of time spent on non-instructional tasks in primary schools (e.g, transitioning from one subject lesson to another or maintaining classroom discipline) as ranging between 20% and 50% of overall instructional time. Data from the Teaching And Learning International Survey (TALIS) similarly suggest that about 20% of lesson time at post-primary level is lost to administrative tasks and disruption in class (OECD, 2014), with a better disciplinary climate associated with more time on task.

Allowing teachers *more time to teach* – in other words, using their professional skills – can therefore be seen as a pathway through which both pupils' and teachers' daily experience of school

could be improved. This aspiration would need to consider both the time that teachers are asked to spend on administrative tasks, and also maximising the available instructional time through teachers' own classroom management practices (e.g., maintaining discipline). Professional development targeted at enhancing teachers' capacity to use classroom time most effectively could therefore be useful in supporting pupil learning, alongside the provision of greater administrative support for classroom teachers. Classroom management should also be emphasised as an important factor in pupils' learning during initial teacher education. Newly-qualified teachers, and inspectors observing the lessons of new teachers, have previously identified a need for clear guidance during initial teacher education on the "practical matters" (p. 67) of teaching, such as classroom layout, lesson organisation, and the maintenance of discipline and pupil motivation (DES, 2005). The introduction of the Droichead programme (Smyth, Conway, Leavy, Darmody, Banks & Watson, 2016; Teaching Council, 2017) is intended to address these issues by providing greater systemic support for newly-qualified teachers at the beginning of their professional careers.

On one hand, the results of TIMSS 2015 point to substantial improvements in mathematical and scientific achievement over recent years, particularly among lower- and medium-performing pupils (Clerkin et al., 2016). These gains represent the fruits of concerted efforts that have been made to ameliorate the effects of educational disadvantage and to facilitate greater inclusion in the classroom, both at the system-level and the school-level. The role of the teacher is particularly crucial for disadvantaged or lower-performing pupils, who may depend to a greater extent on their teacher to support motivation and engagement in learning (through strong personal relationships and emotional support, classroom organisation and teaching practices, and other mediating pathways).

On the other hand, the improvements observed among pupils at the lower end of the performance distribution serve to highlight the relative absence of similar gains among higher-performing pupils.[15] When compared to the performance distribution of the countries that performed at a similar level to Ireland overall, the highest-achieving Irish pupils appear to be underperforming to some degree. This is consistent with previous findings suggesting that Ireland's above-average performance in international assessments is often driven by the strong performance of lower-performing students "rather than a strong performance across all ability levels" (Perkins & Shiel, 2016, p. 9). Such findings suggest that educators should consider ways to provide higher-achieving students with more challenging tasks and to encourage greater use of mathematical and scientific thinking and vocabulary over the coming years, while maintaining support for the needs of lower-achieving pupils. Fourth Class teachers' comparatively low levels of confidence in providing challenging tasks for higher-achievers in science should therefore be noted, with a view to supporting the needs of higher-achieving pupils.

Readers who are interested in teaching practices at post-primary level and the challenges faced by teachers of mathematics and science in Second Year are referred to the sister volume to the current report (Clerkin et al., in press), which will soon be available from www.erc.ie/timss. A comparison of some of the broader characteristics of the education systems in Ireland and in other TIMSS countries (e.g., languages of instruction, structure of the mathematics and science curricula) is available in Eivers and Chubb (2017). Other contextual factors relating to pupils' learning in general, and their mathematics and science performance in particular, will be explored in forthcoming reports.

15 A significantly higher percentage of pupils reached the Advanced Benchmark for mathematics in 2015 (14%) than in 2011 (9%), but the difference in performance at the 95th percentile was minimal (Clerkin et al., 2016). The percentage of pupils reaching the Advanced Benchmark for science was the same in 2015 as in 2011 (7%), with a slight disimprovement in performance among pupils at the 95th percentile.

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