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Her Majesty's Inspectorate
for Education and Training in Wales

Good practice in mathematics at key stage 3

February 2015

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Introduction

This report is published in response to a request for advice from the Welsh Government in the Minister's annual remit to Estyn for 2013-2014. The report examines standards in mathematics at key stage 3 and the factors affecting achievement, and includes case studies of best practice.

The report is set in the context of the Welsh Government's priorities for improving standards of numeracy and mathematics and builds on Estyn's thematic survey report 'Good practice in mathematics at key stage 4' (2013).

The findings of the survey are based on an analysis of the outcomes of Estyn inspections from 2010 to 2013 and visits to 15 secondary schools. During the visits to schools, inspectors observed lessons at key stage 3, held discussions with senior and middle leaders, interviewed pupils and scrutinised pupils' work and departmental documents. While an appendix to the report summarises national outcomes for key stage 2 and key stage 3 teacher assessments and key stage 4 examination results, the section of the report on standards of achievement does not present a national picture because the sample of schools visited for the survey is generally of schools with stronger mathematics departments.

The report is intended for the Welsh Government, headteachers, staff in schools, local authorities and regional consortia, and teacher trainers.

Background

Mathematical knowledge, understanding and skills are increasingly important for everyday life. It is therefore crucial that pupils experience the best possible mathematics education. Improving mathematical skills is also key to the Welsh Government's vision for developing a highly-skilled workforce and an innovative and modern economy.

Previous Estyn thematic reports provide the background to this report. 'Good practice in mathematics in key stage 4' (Estyn, 2013) concluded that pupils who gain the expected level of attainment at the end of key stage 3 are not prepared well enough in number and algebraic skills to gain a C grade at GCSE. At key stage 4, mathematics was the lowest performing core subject in Wales in 2014, with almost 40% of pupils not achieving a level 2 qualification.

'Numeracy in key stages 2 and 3: a baseline report' (Estyn, 2013), noted that numeracy skills are built on as pupils progress through key stage 3 in preparation for key stage 4. The report stated that, if pupils do not have a basic level of mathematical knowledge and understanding, they will not be able to develop effective numeracy skills. It reported that, in around two-fifths of the primary schools and half of the secondary schools inspected in 2010-2012, many pupils have weak numeracy skills or do not apply them well enough across the curriculum.

The second numeracy report, ‘Numeracy in key stages 2 and 3: an interim report’ (Estyn, 2014), found some improvement in numeracy skills with pupils beginning to show a secure grasp of basic mathematical skills.

To address concerns about the standards in mathematics and numeracy, the Welsh Government has, among other steps: introduced the National Numeracy Programme; plans to introduce two mathematics GCSEs from 2015 (one covering numeracy and the other aspects of mathematics techniques); included mathematical outcomes in the National School Categorisation System; and revised the National Curriculum Areas of Learning and programmes of study (statutory from September 2015) to provide alignment with the two new GCSEs in mathematics and to strengthen PISA-type skills.

Main findings

1 In 2014, teachers assessed that 86.5% of pupils achieved the expected level 5 or above in mathematics at the end of key stage 3. This is an improvement of 13 percentage points since 2009. Pupils who are eligible for free schools meals are significantly less likely to achieve the expected level 5 or above at the end of key stage 3 (71%) when compared with those who are not eligible (90%).

2 In 2013, the percentage of pupils in Wales attaining level 5 or above in mathematics was the same as in England. However, the proportion of pupils achieving higher levels does not compare favourably, with 21% of pupils in Wales achieving level 7 or above compared with 32% in England.

3 The Programme for International Student Assessment (PISA) reported in 2012 that boys in Wales significantly outperformed girls in mathematics. This seems at odds with key stage 3 teacher assessment and key stage 4 examination results, where girls consistently outperform boys. There is no generally agreed explanation for this discrepancy and it requires further investigation.

4 The schools visited for the purpose of this survey are 'good practice' schools. Pupils' standards of achievement are good or better in the majority of the mathematics lessons observed in the survey. In the minority of lessons, where standards were adequate, pupils were slow to recall prior learning, unable to make connections between different mathematical topics, and did not receive work that was suitable for their needs or stretch them enough.

5 Teaching is good or better in the majority of the lessons observed. In these lessons, many teachers display secure subject knowledge and plan lessons with clear objectives. In a few lessons, pupils do not make enough progress because the lesson content does not build on previous learning or tackle the difficulties they have with mathematics. Conversely, more able pupils are not challenged enough because there is too much repetition of simple topics or they do not have enough opportunity to explore mathematics through independent learning.

6 Even in strong mathematics departments, pupils do not have enough opportunities to apply or extend their knowledge skills and understanding in a wide range of problem-solving contexts. In the few lessons where pupils were involved in problem-solving activities, a majority interpret real-life contexts thoughtfully and choose appropriate strategies to solve increasingly complex problems.

7 Many of the mathematics departments visited have developed a network for sharing good practice with their local primary schools. The arrangements include the sharing of data on progress and the development of agreed methods for teaching mathematics topics. However, in a minority of schools, transition arrangements are restricted to the exchange of electronic performance data.

8 In the majority of the schools visited, teachers' marking is consistent in terms of frequency and quality. Challenging targets are set for pupils and groups of pupils and monitored through well-structured assessment and pupil tracking systems. In a

few schools, there are important shortcomings in assessment and tracking, particularly in tracking the progress of pupils who participate in mathematics intervention lessons after they return to mainstream lessons.

9 The key stage 3 mathematics curriculum in many of the schools visited provides pupils with an appropriate foundation to prepare them for the next stage of learning. However, in a few cases, a shortage of suitably qualified and experienced mathematics teachers is restricting arrangements for delivering the curriculum. This is most notable in Year 7, where, in a few schools, pupils have more than one teacher for their mathematics lessons and the staff concerned have limited or no recent experience of teaching mathematics. This affects the standards that Year 7 pupils achieve in a few schools.

10 In the majority of schools visited, the leadership of mathematics departments is good or better. In these schools, heads of the mathematics departments work closely with their staff, communicating high expectations for pupil outcomes and ensuring all staff have a secure understanding of effective teaching methods in mathematics. In a minority of schools, departmental self-evaluation and improvement planning are not robust enough and do not provide a suitable basis to secure improvement.

11 In a majority of schools visited, mathematics teaching staff benefit from a range of varied professional development opportunities to improve their teaching and pupils' learning experiences. In a few schools, there are not enough opportunities for staff to share best practice within the department or school, or with other local or family schools.

12 Overall, the degree of support and challenge for mathematics departments is not consistent across local authorities and the regional consortia. Only a few mathematics departments receive support to network with other schools to share and develop good practice. In these schools, there is challenge to improve their practice from experienced subject specialist advisers, to complement the support of the school leadership team.

Recommendations

To improve standards of mathematics at key stage 3:

Mathematics departments should:

R1 monitor the performance of pupils eligible for free school meals and offer targeted interventions as necessary

R2 meet the needs of pupils who experience difficulties or are more able

R3 increase the level of challenge for all pupils by making sure that:

- lessons are structured to engage, motivate and stretch all pupils
- mathematical problem-solving skills are developed and applied to a wide range of real-life contexts

R4 ensure that assessment and tracking procedures are robust

R5 improve departmental self-evaluation and improvement planning

R6 share best practice across the school and evaluate new ways of working

Local authorities and regional consortia should:

R7 facilitate networks for sharing best practice between mathematics departments

R8 provide support, challenge and professional development opportunities for mathematics departments and individual teachers

The Welsh Government should:

R9 investigate the difference in outcomes between boys and girls in mathematics

R10 address shortages in the supply of qualified mathematics teachers

Standards

Teacher assessment

Performance at the end of key stage 3

13 At the end of key stage 3, teacher assessment data shows that pupil outcomes in mathematics at the expected level 5 and above have improved markedly over the last five years. In 2014, 86.5% of pupils attained a level 5 or above in mathematics, which is 13 percentage points higher than outcomes in 2009 (see Appendix – Figure 6).

14 Over the last five years, the proportion of key stage 3 pupils attaining the higher level 6 or above in mathematics has also increased steadily. In 2014, over half of pupils attained level 6 or above, with nearly one-quarter achieving level 7 or above (see Appendix – Figure 7).

Performance of groups of learners

15 From 2009 to 2014, the gender gap at each level has widened and girls' attainment at the higher levels improved at a faster rate than that of boys. In 2014, girls' attainment was better than boys' at all levels, with a four percentage point gap between boys and girls at level 5 or above (see Appendix – Figure 3).

16 Over the past five years, at the end of key stage 3, there has been a significant difference between the performance of pupils eligible for free school meals at the expected level 5 or above in mathematics and those who are not eligible. In 2014, the percentage of key stage 3 pupils who achieved the expected level or above in mathematics and do not receive free school meals is just over 90%. Yet, the percentage of pupils eligible for free school meals achieving the expected level or above is around 71%. This means that at the end of key stage 3, almost a third of pupils eligible for free school meals have not achieved the expected level. Over the past five years, the gap in performance (at level 5 or above) between pupils eligible for free school meals has decreased, to around 20 percentage points in 2014 (see Appendix – Figure 4).

Performance in comparison with other countries

17 In 2013, the percentage of pupils in Wales attaining level 5 or above in mathematics was similar to that in England. However, in Wales, although the proportion of pupils who achieved level 7 and above in mathematics is significantly above that in other core subjects, this proportion does not compare favourably with the performance of pupils in mathematics in England. In 2013, 21% of pupils achieved level 7 and above in Wales compared with 32% of pupils in England (see Appendix – Figure 5).

Standards of achievement in lessons and in pupils' work

18 In the schools visited for the survey, standards are good or better in the majority of the lessons observed.

19 In the lessons where standards in mathematics are good or better, the majority of pupils can:

- recall mathematical facts quickly and accurately from previous lessons
- use a range of mental and written methods correctly, using calculators proficiently, where appropriate
- manipulate and apply algebraic formulae with confidence
- collect, represent, analyse and interpret data skilfully and communicate their findings clearly and succinctly
- apply mathematics systematically to explore unfamiliar situations and choose suitable techniques to solve problems
- use key mathematical concepts and language to communicate their work confidently to others
- interpret mathematical information presented in a variety of forms well
- recognise the relationship between different topics in a range of mathematical contexts

20 However, in a minority of lessons pupils, do not make enough progress. This is most often because they are slow to recall their prior learning, in particular, basic mathematical facts or skills, and apply it to their current, more complex work. For example, in a Year 9 lesson on sequences, a few pupils need reminding about the concept of square numbers, with a very few not recognising 100 as a square number. In another Year 8 lesson on data handling, a minority of pupils could not recall what is meant by the 'mode'.

21 Across the ability range, a significant minority of pupils have difficulty with basic topics such as fractions and long division in multi-step questions. Often this is because they do not understand and make connections between different mathematical topics. As a result, they struggle to apply the skills learned in lesson to contexts that vary slightly from worked examples.

22 In the lessons where pupils' standards are only adequate, this is frequently because pupils are not working at a level appropriate to their needs. Often the work does not challenge or stretch them enough, particularly the more able, because of too much repetition of simple topics. In a very few of the lessons observed, the pace imposed on the lesson constrains learning at both ends of the ability spectrum. There was too much whole-class stopping and checking by the teacher at each method stage for each question. When more able pupils have finished each task, they wait for their peers to catch up, and for the teacher to go over the question or give the whole class the next task. This 'stop-start' approach results in more able pupils being off-task and other less able pupils are pressured to complete their work more quickly. Overuse of this approach can mean that pupils, particularly the more able, do not have enough time or opportunity to explore and consolidate their mathematical understanding through independent learning or challenge themselves to do better.

23 In a few lessons, where pupils are involved in problem-solving activities they interpret real-life contexts thoughtfully and choose appropriate strategies to solve complex problems. However, the greatest challenge for a minority of pupils in these lessons is to identify relevant mathematical information in order to solve the question. A few pupils find reading and understanding the question difficult and challenging, and do not have the ability to extract key information from the text. This prevents them from using and applying their mathematical skills to solve the problem. Once the question is interpreted as a numerical or algebraic problem, many of these pupils are able to find a solution.

24 The standard of pupils' work in the majority of books reviewed is good or better. In these books, pupils display secure skills in mathematical techniques and in their ability to apply them in different contexts. In the majority of cases, pupils show good knowledge of the need to consider the suitability of the results they obtain and use estimates of numerical calculations well. They write clear explanations of the methods they have used or describe appropriately the conclusions they come to after a piece of work, such as drawing conclusions from statistical data they have collated and analysed.

25 The work in the majority of pupils' books is neatly presented in a systematic and often meticulous way. This helps pupils to solve problems accurately, for example when trying to trace the methods they have used previously in their files and books.

26 However, a minority of pupils do not present their work neatly and methodically. This includes not recording the individual steps of a question, drawing untidy diagrams in geometry and shape to accompany work, and unnecessary messy crossing-out when pupils re-think their approach to a problem. These shortcomings often impair the accuracy of their work.

Participation and enjoyment in learning

27 In the mathematics lessons observed, many pupils have a positive attitude to learning. They participate well and are eager to demonstrate their understanding of the topic being studied. Many pupils arrive promptly for lessons, respond enthusiastically and are fully involved from the starter tasks at the beginning of the lesson. They approach the challenges set for them eagerly and complete more complex questions as their confidence and competence develop during the lesson.

28 The majority of pupils have a sound understanding of their own ability and they respond positively to suggestions to improve their work. Teachers provide good oral feedback to pupils during the lesson and pupils respond positively in order to develop their understanding, improve their work and make progress. Pupils respond less well to teachers' written advice, although it is often very helpful, on how they can improve their work.

Cardiff High School, Cardiff

Context

Cardiff High School is an 11-18 mixed comprehensive school, situated near to the City centre. There are 1,525 pupils on roll with 6% eligible for free school meals, and 12% with special educational needs.

Focus: Year 8, higher ability set, algebra – multiplication of brackets

Action

The teacher begins the lesson with an effective starter activity linked to the main part of the lesson to test pupils' understanding of algebraic multiplication. Pupils respond well and use mini-whiteboards to answer questions quickly and accurately. Nearly all pupils have outstanding recall of prior learning. All pupils listen attentively and demonstrate real enthusiasm for the subject. The teacher has an excellent working relationship with the class and shows a real passion for mathematics. The lesson is well planned to meet the needs of all pupils, allowing more able pupils to progress quickly onto more complex questions. The pace of the lesson is brisk, with valuable opportunities to challenge pupils.

The teacher has secure knowledge of mathematics and provides firm guidance to pupils about the algebraic methods used to multiply brackets. Very effective questioning techniques are used to target and challenge pupils of differing abilities to extend their understanding. Pupils are given a mix of questions and they have to prove themselves on easier questions before self-selecting more difficult questions.

Impact

Pupils show maturity and a strong sense of ownership for their own learning. There is a willingness to try questions that are more difficult, such as a mixture of signs or the multiplication of two brackets. They demonstrate good thinking and reasoning skills, asking appropriate questions to one another to achieve solutions. Nearly all pupils make excellent progress during the lesson and enjoy the challenge of solving more complex problems, which increases their confidence.

29 In a few lessons, the behaviour of a very few pupils is poor. They lack concentration and cause low-level disruption that inhibits their own learning and other pupils' progress. This occurs most often when the pace of the lesson is too slow or the tasks set do not meet the full range of pupils' needs.

Communication and thinking skills

30 Many pupils develop their communication and thinking skills suitably in mathematics and most pupils enjoy discussing their work with the teacher and their peers. They listen carefully to each other and build on the ideas shared. The majority of pupils communicate their ideas clearly, using appropriate mathematical vocabulary to explain their thoughts and reflect on their understanding of the processes required to

answer questions correctly. More able pupils use subject-specific terms accurately, often with an extensive vocabulary, to make thoughtful and well-considered responses to questions.

31 Many pupils work productively together to solve mathematical tasks, such as when they develop their ideas and support others in small groups.

32 In the majority of lessons, many pupils use and develop their thinking skills. In these lessons, pupils apply their thinking skills to:

- process information by locating and collecting relevant information
- choose suitable mathematical techniques to solve problems by drawing on their previous learning and taking logical next steps
- explain and justify the strategies they have used
- test outcomes through forming suitable hypotheses
- review their work and consider whether their answers are sensible

33 Where pupils' communication and thinking skills are not well developed, it is because teaching does not provide enough opportunities for pupils to solve mathematical problems in real-life contexts. A few pupils lack the confidence to use trial and error techniques in their work. This approach may be used to solve an equation where there is no exact answer and pupils often rely too heavily on the teacher or other pupils to provide solutions for this style of question.

Factors affecting standards

Transition

34 The mathematics departments of the majority of secondary schools visited for the survey have strong working relationships with their local primary schools, which have a positive impact on pupils' learning. For example, over half have developed effective bridging units in mathematics with common methodology, which key stage 2 and key stage 3 teachers use to help ensure continuity and progression. This includes a consistent approach to teaching mental and written number calculations and how to present data in graphs and charts.

Cardinal Newman R.C. Comprehensive School, Rhondda Cynon Taf

Context

Cardinal Newman R.C. Comprehensive School is an 11-18 co-educational school, in Rhondda Cynon Taf. There are 732 pupils on roll, with 16% eligible for free school meals, and 14% with special educational needs.

Focus: transition from key stage 2 to key stage 3

Strategy

The school has a strong relationship with its partner primary schools, with transition activities starting in Year 5. A member of the school's mathematics department was

appointed to a half-time contract to share good practice in teaching and learning and to work with primary schools to accelerate the progress of pupils when they reach key stage 3. This post is funded mainly by the secondary school, although each primary school contributed to the cost of this project. A key aim of the transition project is to ensure that pupils have a flying start at key stage 3 in mathematics.

Mathematics teachers at each of the primary schools and the secondary school have attended joint professional development activities. This has improved the use of common methodology in mathematics and the sharing of good practice across the schools. In Year 7, around half of the form tutors are also mathematics teachers, which, together with the transition links for mathematics, successfully supports the school's twice-weekly numeracy hour and pupils' numeracy development.

Impact

This initiative has improved teaching and learning in mathematics in Year 7 by strengthening continuity and progression between key stages 2 and 3 and results in improved outcomes. Over the last five years, at key stage 3, the portion of pupils gaining level 5 or above in mathematics has improved by around 14 percentage points. During this same period, at key stage 4, the proportion of pupils gaining level 2 in mathematics has improved by around 30 percentage points, with 80.5% of pupils achieving a GCSE grade C or above in 2014, which is well above the national average and the percentage in similar schools.

35 In the majority of schools, key stage 2 and key stage 3 mathematics curriculum leaders meet regularly as part of established cluster arrangements. They share data and curriculum planning, including assessment moderation, across key stages 2 and 3. This helps to improve teachers' understanding of pupils' mathematical development in each key stage. It also provides details of the specific attainment and needs of individual pupils in key stage 2, which are often used to help inform teaching and placement in groups for Year 7 mathematics lessons on transfer to key stage 3. In a minority of schools, transition arrangements are restricted to the exchange of key stage data only, often by electronic transfer. This limits progress for pupils, because staff at key stage 3 have only a narrow view of pupils' understanding.

Teaching

36 In the majority of lessons observed for the survey, teaching is good or better. In these lessons, most teachers display secure subject knowledge and the majority plan lessons effectively with clear objectives.

37 Where teaching is good, this is most often because of:

- comprehensive planning with a range of activities and tasks that link different strands of pupils' mathematical skills
- teachers' high expectations, secure knowledge of pupils' potential and setting appropriately challenging tasks with stimulating materials

- clear references to previous learning, with good starter or introductory activities that effectively recap a previously taught topic
- plenty of useful opportunities for pupils to develop their number skills, both mentally and written, often within limited time constraints
- well-paced and enthusiastically delivered lessons that engage and enthuse pupils, and meet their different abilities
- an emphasis on accurate use of mathematical terminology, which helps learners express themselves and develops their thinking skills well
- skilful questioning, provoking discussion and probing pupils' understanding to deepen their understanding, as well as identifying common misconceptions

38 A few lessons observed for the survey were excellent. In these lessons, teachers displayed particularly strong subject knowledge and an infectious enthusiasm for mathematics. They communicated extremely high expectations and engaged pupils in a range of challenging activities. The lessons had a significant impact on pupils' confidence and enjoyment, and resulted in high levels of performance.

Cwmtawe Community School, Neath Port Talbot

Context

Cwmtawe Community School is an 11-16 mixed comprehensive school, in Neath Port Talbot. There are 1,276 pupils on roll, with 18% of pupils eligible for free school meals, and 38% with special educational needs.

Focus: Year 9 – problem solving

Action

The lesson is one of a series where pupils are investigating the mathematics of a dartboard. The teacher begins the lesson with a useful starter involving mental arithmetic. The activity stimulates pupils' interest, reinforces prior learning and develops their thinking skills. The lesson is well planned, with probing questions to investigate the geometry of a dartboard.

Pupils work in pairs and the lesson links topics studied in mathematics throughout key stage 3, such as geometry, mental arithmetic, the circumference and area of a circle, measuring angles and construction techniques. More able pupils progress to calculate the length of an arc and the area of a sector of a circle. Activities are well designed and enable pupils to improve their thinking and problem-solving skills. Pupils discuss possible solutions and strategies in detail before sharing findings with the rest of the class.

Impact

Pupils are well motivated and play a full and active part in the lesson, which contributes to the rapid progress most pupils make. They successfully link previously studied topics and justify their solution with thoughtful explanations, demonstrating confidence and an ability to listen attentively to other pupils and to provide helpful comments on alternative methods or solutions.

39 In the majority of lessons, where there are teaching assistants to support pupils' learning, good planning by the classroom teacher helps the teaching assistant to provide valuable support to pupils during the lesson. In these lessons, teaching assistants are often deployed with small groups or individual pupils who are low attaining or have special educational needs. The teaching assistants who are most effective show initiative in helping pupils to overcome difficulties in understanding concepts or the methods used. Overall, this helps teachers to differentiate the work and increase the pace of the lesson.

40 In a few lessons, where problem-solving is successful, pupils work particularly well together. They are encouraged to discuss and ask questions with one another and the teacher. Pupils enjoy these lessons and are well motivated, typically finding more than one method to solve a problem, which increases their confidence and understanding. However overall, pupils do not have enough opportunities to apply and extend their knowledge, skills and understanding in a wide range of problem-solving contexts. For example, 'problem solving' in a very few schools involves pupils only experiencing examination questions. This limits their understanding and application of mathematics, with not enough opportunities to apply their mathematical skills to a range of different real-life contexts and new situations.

41 A very few teachers still view mathematics as a series of topics to be studied and tested in isolation. As a result, pupils in their lessons find it difficult to make connections between mathematical topics, which limits pupils' progress across the full range of mathematics at key stage 3.

42 In a minority of lessons visited, pupils do not make enough progress. This is most often because the content of the lesson does not build on previous learning effectively and the pace of the lesson is too slow. In these lessons, the needs of pupils of differing abilities are not met well enough and the work does not challenge or stretch pupils, particularly the more able. In a few lessons, pupils do not make enough progress because of overuse of a 'stop-start' approach that is taken with the whole class.

Assessment and tracking

43 In the majority of the schools visited, there is consistency in the frequency and quality of teachers' marking. Teacher comments provide helpful advice for pupils to improve their work and, in a few cases, additional examples for pupils to try, which many do. There is clear evidence of the majority of pupils correcting mistakes, which provides them with useful insights into misconceptions and plays a vital part in developing their understanding.

44 In many lessons observed, dialogue between the teacher and pupil is central to the classroom assessment process. The teacher listens intently to pupils' explanations and then makes counter responses to probe and assess pupils' understanding. This provides useful opportunities to address any misunderstandings early, when pupils are engaged in their learning.

45 Effective peer and self-assessment is used in a minority of lessons. This, together with appropriate praise and meaningful explanatory feedback, develops pupils' confidence and motivates them. For example, in a Year 7 lesson for pupils who have the greatest difficulty with mathematics, the teacher uses red, amber and green labelling for pupils to audit their understanding of the topic and self-select questions on this basis. At each stage there is effective communication between the teacher and pupils, with the teacher providing valuable feedback on what the pupils have achieved in relation to the task and how they could do better.

46 In the majority of schools visited, challenging targets for pupils and groups of pupils are set and monitored through using a well-structured assessment and pupil tracking system. This identifies pupils who are underachieving and helps teachers to plan future learning.

47 However, in a very few schools, teachers do not monitor progress after intervention lessons closely enough when pupils return to mainstream mathematics lessons.

48 In a few schools, there are important shortcomings in assessment and tracking processes in mathematics. This is most often because senior and middle leaders do not secure consistency in teachers' marking, and do not challenge pupil under-achievement. As a result, the majority of pupils in these schools do not fully understand what they need to do to improve and suitable targets are not set for improvement at individual pupil and subject level.

49 In a few lessons, teachers are too generous with their oral and written praise and pupils do not get realistic feedback on their achievements. In these lessons, pupils do not make the progress they are capable of, particularly the more able pupils, because they are not challenged well enough.

Curriculum

50 The organisation of the curriculum in many of the schools visited for the survey provides pupils with a minimum of three hours of mathematics teaching each week at key stage 3. This is generally enough to enable pupils to progress to the next stage of their learning.

51 A minority of schools also provide an additional numeracy lesson for Year 7 pupils, focusing on teaching the rules and procedures of mathematics in relation to solving real-life problems.

52 A very few schools have comprehensive arrangements for pupils to develop their communication and thinking skills more widely through activities such as a whole-school problem-solving strategies approaches or a discrete 'thinking skills' lesson. These are recent developments aimed at supporting pupils' learning in subjects across the curriculum and it is too early to assess the impact of these arrangements on pupils' standards.

53 Many schools provide a range of intervention strategies to help pupils develop the mathematical skills to ensure progress. These strategies are predominantly for pupils experiencing difficulty with number and often consist of additional lessons, which take place over a short period of time, usually six to eight weeks. Generally, pupils make good progress in these lessons, although follow-up in mainstream

lessons is not robust enough. In many instances, once the intervention programme is complete, pupils' progress is not always monitored to ensure that any gains made are sustained. The main characteristics of a successful intervention scheme are effective management and training for teachers to ensure that they have specific teaching skills and strategies to support and develop pupils' skills.

54 At key stage 3, many schools group pupils for their mathematics lessons, either in parallel ability bands or sets. Often, pupils are placed in these groups, either on entry to the school by using pupils' attainment in teacher assessments in mathematics at the end of key stage 2 and data from the National Numeracy Tests, or a term after entry, based on internal assessments. The availability of national numeracy test data is making the placement of pupils in these groups more secure.

55 About half of the schools visited for the survey group pupils in mixed-ability classes for mathematics lessons only for Year 7 pupils. This means that classes contain pupils with a wide range of mathematical ability, which requires skilful planning and organisation to ensure that all pupils' needs are met. In a very few schools, the curriculum organisation for Year 7 pupils means that they have more than one teacher for their mathematics lessons. This arrangement requires skilful organisation and planning to ensure continuity between lessons and teachers of the same class. In these schools, this approach is not the preferred mode for teaching pupils mathematics in Year 7 because of the risk of lack of continuity. It is used because there are not enough qualified mathematics teachers to meet the school's requirements.

56 There is a shortage of suitably qualified mathematics teachers in a few schools. This shortage is reflected in the headteachers' response in the PISA 2012 National Report for Wales. In the report, the most frequent staffing problem in Wales, cited by 17% of headteachers, was a lack of qualified mathematics teachers. This is an increase of nine percentage points when compared with answers to the same question in the PISA 2009 National Report for Wales. This thematic survey confirms that the shortage of suitably qualified mathematics teachers is having an impact on the quality of provision for mathematics education at the start of key stage 3, because it constrains arrangements for curriculum delivery.

57 Many departments in the schools visited have constructed well-planned schemes of work that cover the National Curriculum for mathematics appropriately. Typically, each scheme of work covers number, algebra, shape and space and statistics, and skills in reasoning are a central part of the curriculum. However, in a minority of schools, the plans for pupils' work do not include enough problem-solving activities and focus too much on topic-based examination questions. As a result, pupils do not have enough opportunities to choose and use mathematical techniques systematically to explore unfamiliar contexts and to develop a secure understanding of mathematical principles in different situations. In a very few schools, schemes of work do not include level 8 work and higher-level thinking and reasoning skills to stretch and challenge more able pupils.

Leadership and management

58 In the majority of schools visited for the survey, leadership at middle and senior level is good or better. In these schools, senior leaders work closely with the mathematics department, and with other curriculum leaders, to drive forward whole-school priorities for improving standards and provision. The head of the mathematics department meets regularly with the senior manager who line manages them, typically every two weeks. These meetings have an appropriate emphasis on raising standards, improving the quality of teaching and supporting pupils' learning. Progress against the departmental improvement plan is discussed and pupil progress tracked against challenging targets. Action is taken quickly where underperformance is identified. These line-management arrangements help to ensure that staff in mathematics departments are held accountable for their work and for the standards pupils achieve.

59 In the majority of schools visited, heads of mathematics departments work closely with their staff, communicating high expectations for pupil outcomes and ensuring that all staff have a secure understanding of effective teaching methods in mathematics. Regular meetings focus on targets related to pupils' predicted performance and their progress towards meeting these, and on any interventions that may be required to support and accelerate pupils' learning. Feedback from monitoring activities such as regular book scrutiny and lesson observations is shared routinely, action points are taken and, in the best practice, they are rigorously followed up in a timely manner.

60 A common feature of the schools with a successful line management structure is the effective use of baseline assessment and performance data to set challenging targets and to monitor progress against them. In these schools, heads of department and the senior management team use data from assessments, at least each half term and frequently more often, to track classes and measure pupils' progress against their potential. This tracking enables the department to plan the next stage of a pupil's learning. Senior managers compare performance across subjects within the school, particularly at the higher levels, to challenge more able pupils, and identify clear priorities for action. Most schools use the All Wales Core Data Sets to compare their performance against that of other schools in their family, as well as nationally.

Caerleon Comprehensive School, Newport

Context

Caerleon Comprehensive School is an 11-18 mixed comprehensive school, in Newport. There are 1,545 pupils on roll, with 5.8% eligible for free school meals, and 15% with special educational needs.

Focus: Leadership and quality improvement

Strategy

The head of department carries out a critical role in management, quality of teaching and learning within a school. Data is used strategically to identify strengths and areas for development and staff training.

The school has strong links with partner primary schools and has devised a level 6 portfolio to help staff understand levelling and moderation arrangements. The head of department liaises with other Newport heads of departments to discuss emerging issues. The department also meets termly with other heads of departments in the consortia. Good practice is shared across the department and contributes to the school's 'good practice group'. Mathematics teachers are linked to another subject to support staff in the implementation of the literacy and numeracy framework. There is a reciprocal arrangement to supply the mathematics department with context questions from different subjects to introduce into mathematics lessons. The department has a head of each key stage responsible for the scheme of work. The member of staff responsible for key stage 3 is also the mathematics transition co-ordinator.

The head of department is line managed by the headteacher and link meetings are regularly scheduled. Regular discussion takes place on standards within the department. The head of department monitors the quality of lessons and pupils' work through scrutiny of work within departmental reviews.

Impact

The school continues to increase the percentage of pupils achieving at least level 5. Currently, 92% achieve at least level 5 in mathematics. This compares favourably with the family, local authority and Wales averages. This improvement is also reflected at the end of key stage 4, with 76% of the cohort achieving an A*-C grade in mathematics and placing the department in benchmark quartile 2.

61 Many of the schools visited are strengthening their arrangements for sharing best practice in teaching and learning. The few schools with the most effective management teams have a culture of sharing best practice within and across departments. This includes teachers pairing up to observe each other's lessons and provide constructive feedback, with regular team meetings to discuss different teaching methods and ideas for improvement. Although staff share best practice in many schools, in only a minority do they share best practice with other schools.

62 The processes of self-evaluation and development planning for mathematics are thorough in a majority of the schools visited. In these schools, self-evaluation procedures are well established. Effective use is made of a suitable range of first-hand evidence such as performance data, lesson observations, scrutiny of pupils' work and listening to the views of pupils to make an accurate evaluation of the department's strengths and identify areas for development. This is then used to link directly to the department's improvement plan and set challenging targets.

63 However, in a minority of schools, departmental self-evaluation and improvement planning are not robust enough. In these schools, performance data is not analysed thoroughly to identify trends in performance at different levels and of different groups of pupils, and comparisons are not routinely made with other subjects in the school, family and nationally. As a result, these schools do not have an accurate picture of the strengths and areas for improvement in mathematics and this lack of rigour limits the ability to set realistic and challenging targets for improvement. In a very few schools, there is no formal system for senior leaders or the head of the mathematics department to gather pupils' views on the quality of teaching and monitor the quality of learning and teaching through the scrutiny of pupils' work. This means that these schools do not always address important areas for development. These arrangements do not provide a suitable basis to plan and secure improvement.

Continuous professional development

64 In a majority of schools visited for the survey, mathematics teaching staff benefit from a range of professional development opportunities to improve the quality of their teaching and pupils' learning experience. Examples of professional opportunities include:

- making use of an expert in a particular area for the stretching of more able pupils
- coaching an individual teacher in a particular skill such as maximising progress through differentiation
- working with others within the school through a planned peer observation programme to identify excellence in teaching and learning
- collaborating with other mathematics departments from the family or other schools to share ideas and recent developments in teaching and assessment
- working with an initial teacher training provider to support trainee teachers and to inform teaching and learning within the school

65 In the schools where standards in mathematics are high, there is a strong culture of collaborative learning within the department and across the school. For example, one school visited encourages all its teachers to introduce and trial new teaching practices, methodologies and technologies to engage and inspire pupils. Good and excellent practice is shared and disseminated through the school's 'learning forum'. Pupils are involved in developing and evaluating various lesson planning styles. This has a positive impact on improving classroom practice.

66 In many schools, robust subject reviews and performance management arrangements ensure that professional development needs are identified. However,

in a few schools, needs are not identified because formal review arrangements are absent. Too often, teachers in these schools work in isolation and do not have the opportunity to engage in professional dialogue about their subject and practice. When this occurs, standards are usually low.

67 In the schools visited, the overall support from the regional consortia and local authority to help teachers of mathematics to improve their practice varies too much. For example, only a few mathematics departments have received effective levels of support and challenge from experienced challenge advisers or subject specialist advisers.

Data appendix

Key stage 2

Performance at the end of key stage 2

Since 2009, at key stage 2 the percentage of pupils attaining the expected level 4 or above in National Curriculum teacher assessments in mathematics has increased year-on-year. In 2014, almost 89% of pupils attained a level 4 or above in mathematics, which was an increase of six percentage points when compared with 2009. In 2014, just over one in ten pupils entered the start of key stage 3 without attaining the expected level. In 2014, the percentage of pupils attaining the higher level 5 in mathematics was almost 38%. This is an increase of nine percentage points when compared with 2009. There is little difference between attainment in mathematics, English and science at key stage 2 (see Appendix – Figure 2).

Performance of groups of learners

Since 2009, boys' performance at level 4 or above has improved at a faster rate than girls' performance, while girls' performance at level 5 or above has improved faster than boys'. In 2014, girls' attainment at level 4 was about four percentage points higher than boys', while the attainment of boys at level 5 was similar to girls'.

In 2014, the percentage of key stage 2 pupils eligible for free school meals achieving the expected level or above in mathematics is over 14 percentage points lower than for those who are not eligible. During the last five years the gap between these groups of pupils has decreased by only two percentage points

Figure 1 – Analysis of the percentage of pupils eligible for free school meals achieving level 4+ at key stage 2 in mathematics compared to pupils not eligible for free schools meals

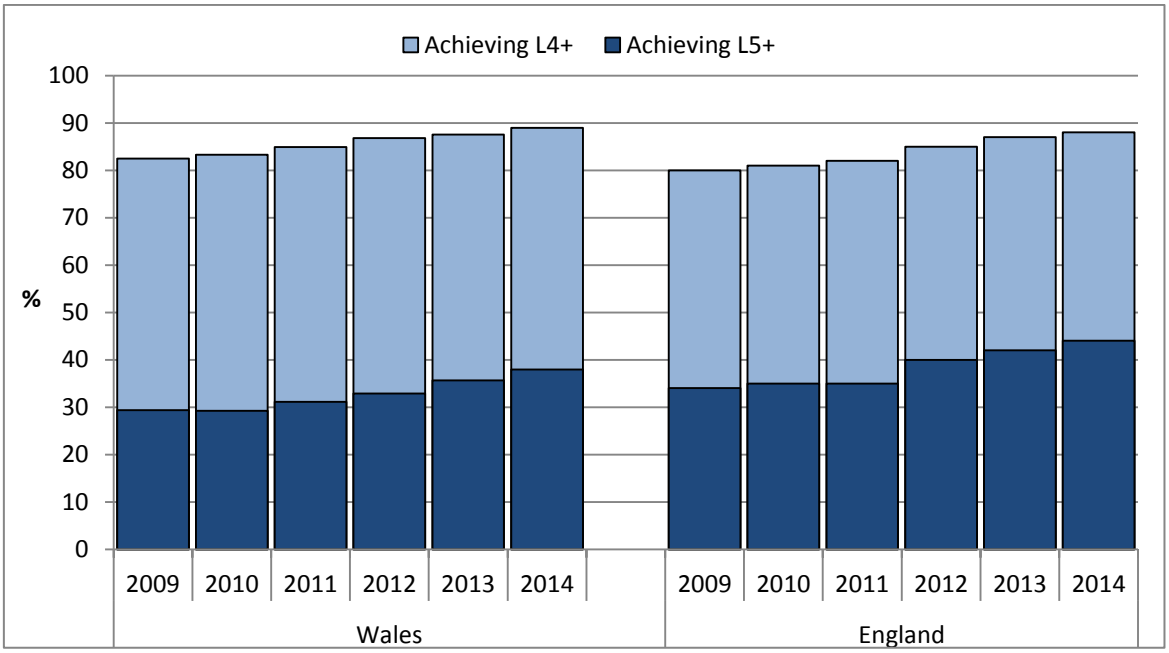
Year	Percentage of pupils eligible for free school meals achieving level 4+	Percentage of pupils not eligible for free school meals achieving level 4+	Percentage point difference between the two groups of pupils
2009	68.3%	85.7%	17.4
2010	67.8%	87.1%	19.3
2011	71.0%	88.5%	17.5
2012	73.7%	90.1%	16.4
2013	75.3%	90.7%	15.4
2014	77.3%	91.8%	14.5

Source: School Statistics, Welsh Government

Performance in comparison with other countries

The performance of pupils at level 4 or above in mathematics at the end of key stage 2 has been broadly similar in Wales to that in England for the past five years. However, the percentage of pupils achieving level 5 or above in England has been at least four percentage points higher than in Wales over the last five years.

Figure 2 – The percentage of pupils achieving levels 4+ and 5+ in England and Wales in mathematics, based on teacher assessments, at the end of key stage 2, 2009-2014



Source: School Statistics, Welsh Government; National Pupil database, Department for Education

Key stage 3

Performance at the end of key stage 3

Figure 3 – Performance by level and gender at key stage 3, 2009 to 2014

	2009	2014	Percentage point difference
L5+ boys	72.1%	84.5%	+12.4
L5+ girls	74.9%	88.6%	+13.7
L6+ boys	43.0%	53.8%	+10.8
L6+ girls	44.4%	58.7%	+14.3
L7+ boys	16.7%	23.3%	+6.6
L7+ girls	16.6%	24.8%	+8.2

Source: School Statistics, Welsh Government

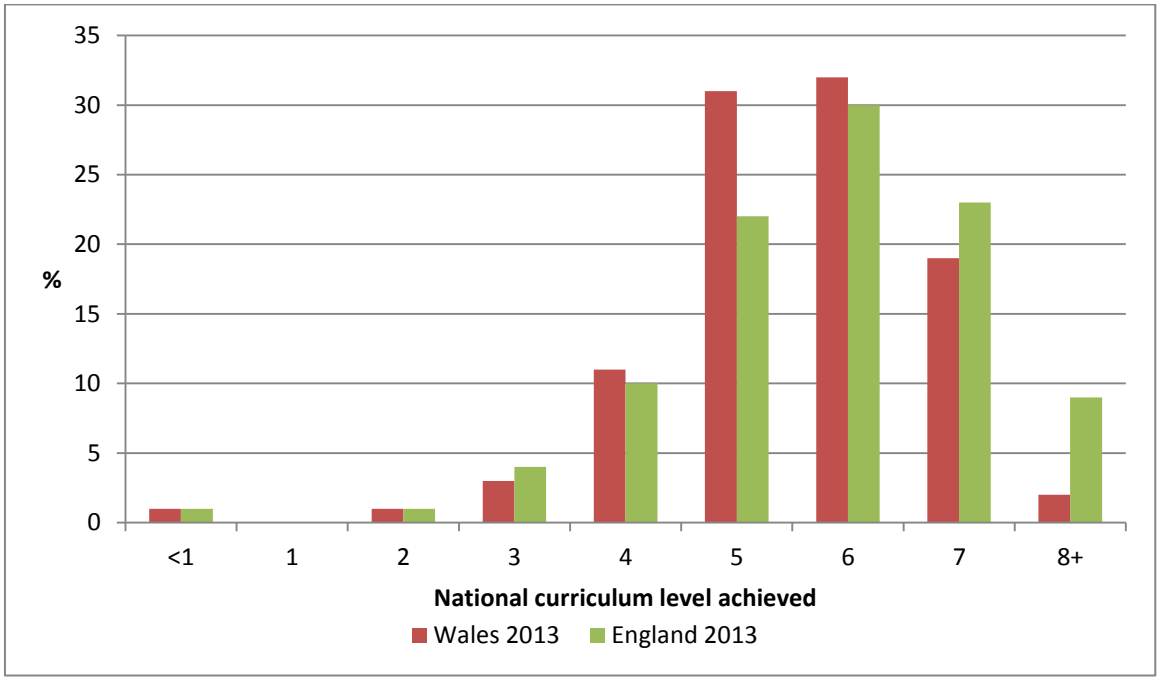
Figure 4 – Analysis of the percentage of pupils eligible for free school meals achieving level 5+ at key stage 3 compared to pupils not eligible for free schools meals

Year	Percentage of pupils eligible for free school meals achieving level 5+	Percentage of pupils not eligible for free school meals achieving level 5+	Percentage point difference between the two groups of pupils
2009	51.3%	78.1%	26.8
2010	54.1%	80.1%	26.0
2011	58.2%	82.4%	24.2
2012	61.9%	85.5%	23.6
2013	65.0%	88.1%	23.1
2014	70.7%	90.2%	19.5

Source: School Statistics, Welsh Government

Performance in comparison with other countries

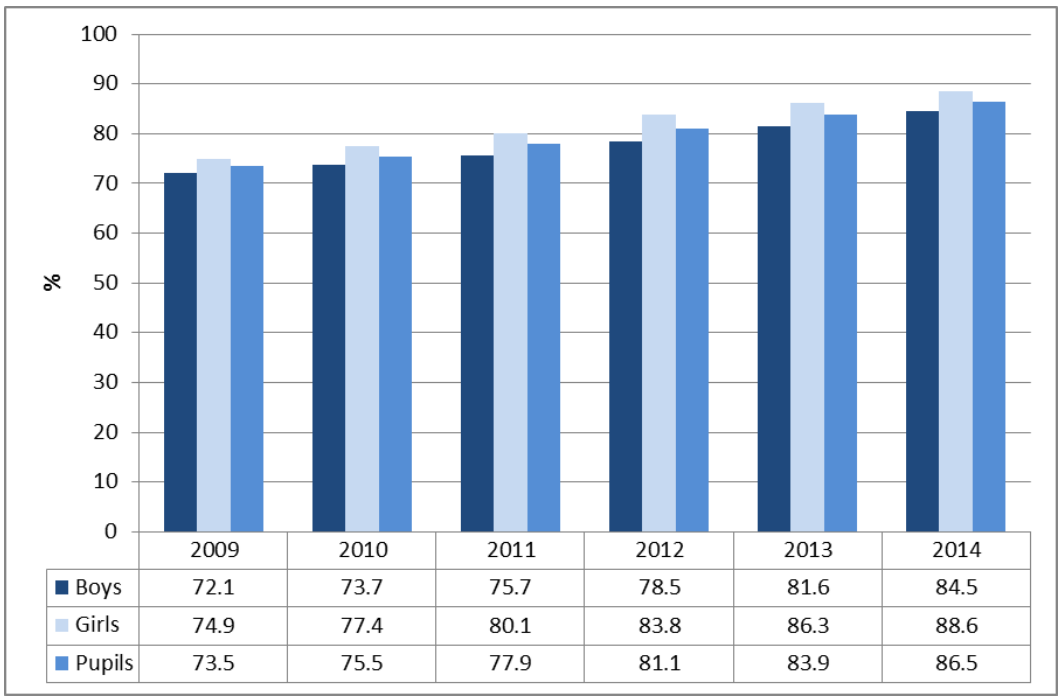
Figure 5 – The percentage of pupils achieving different levels in Wales and England in 2013 in mathematics, based on teacher assessments, at the end of key stage 3*



* Data for 2013 is used in this chart so that data for the same time periods can be used in this comparison. Key stage 3 data for 2014 onwards is no longer published in England so comparisons for 2014 data cannot be made.

Source: National Data Collection, Welsh Government; National Pupil Database, Department for Education

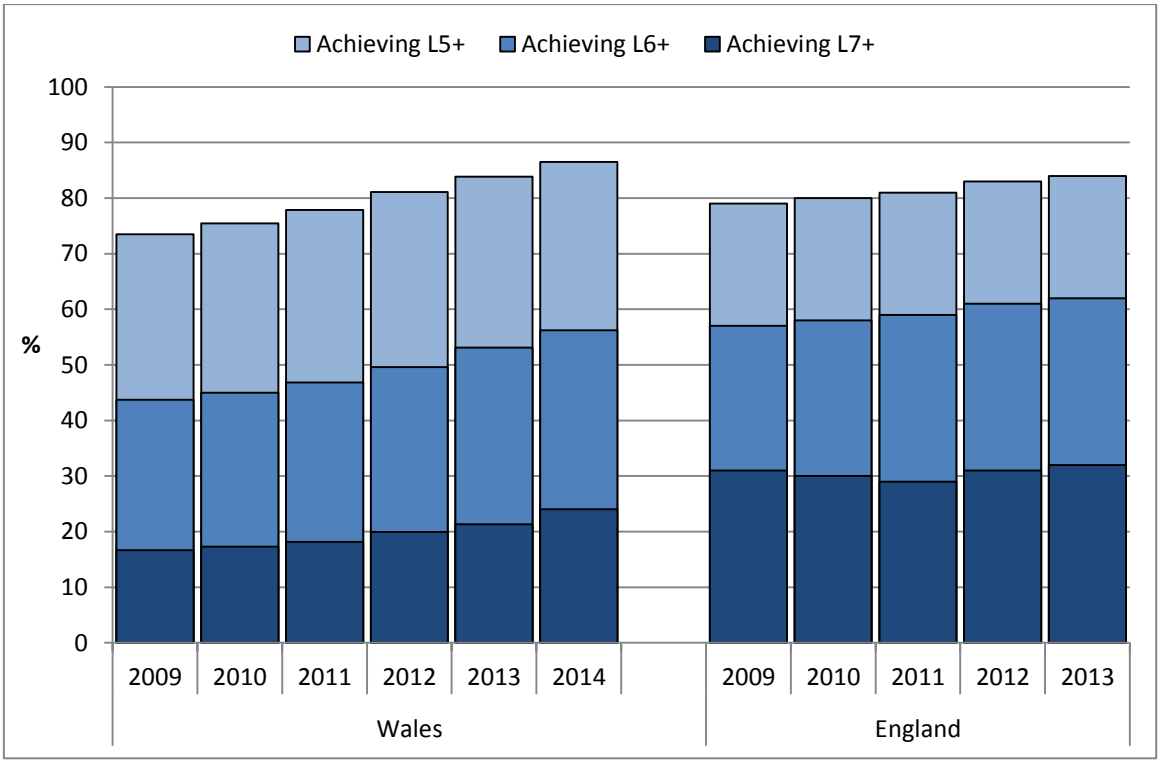
Figure 6 – The percentage of pupils achieving levels 5+ in Wales in mathematics, based on teacher assessments, at the end of key stage 3, 2009-2014



	2009	2010	2011	2012	2013	2014
Boys	72.1	73.7	75.7	78.5	81.6	84.5
Girls	74.9	77.4	80.1	83.8	86.3	88.6
Pupils	73.5	75.5	77.9	81.1	83.9	86.5

Source: National Data Collection, Welsh Government

Figure 7 – The percentage of pupils achieving levels 5+, 6+ and 7+ in England and Wales in mathematics, based on teacher assessments, at the end of key stage 3



Source: National Data Collection, Welsh Government; National Pupil Database, Department for Education

Key stage 4

General Certificate of Secondary Education (GCSE)

Although there has been a steady increase in the number of pupils who achieve a level 2 qualification in mathematics over the last five years, mathematics remains the lowest performing core subject at key stage 4. There is a large difference between the proportion of pupils who achieve a level 2 qualification in mathematics at the end of key stage 4, and the proportion of pupils who achieve the expected performance, level 5 or above, at the end of key stage 3. For example, in 2014, 61.7% of pupils at key stage 4 gained a GCSE mathematics grade C or above. This represents a 19 percentage point decrease when compared with the same cohort of pupils' performance at the expected level in mathematics when they were at the end of key stage 3, in 2012.

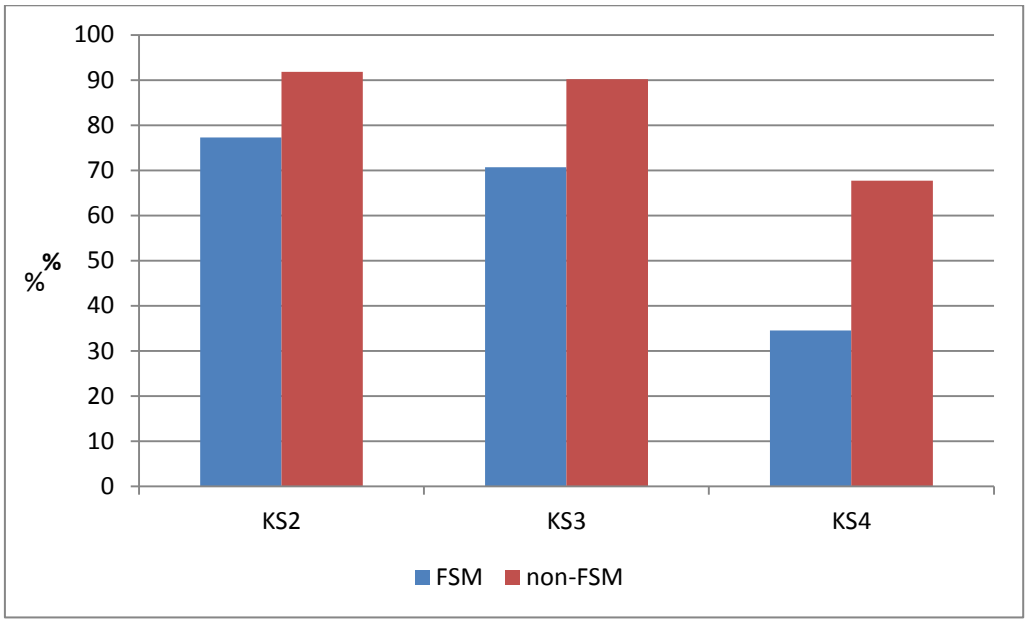
Although pupils' performance at the end of key stage 3 at the expected level 5 is higher in mathematics when compared with English, the percentage of pupils gaining a GCSE grade C or above in English is higher than in mathematics.

Performance of groups of learners

Over the last five years, the gap between the performance of boys and girls at GCSE mathematics grade C or above has been less than two percentage points, with girls outperforming boys. In English, girls outperform boys consistently by about 17 percentage points during the same period of time.

In 2014, at key stage 4, the proportion of pupils eligible for free school meals achieved substantially less well at the expected level than those who are not. There is over 33 percentage points difference between pupils achieving at least a grade C when free-school-meal eligibility is considered (see Figure 8). When compared with pupils' performance at the expected level in mathematics in 2012 at the end of key stage 3, the gap between the performance of the group of pupils eligible for free school meals and those who are not is 10 percentage points wider at the end of key stage 4.

Figure 8 – The percentage of pupils achieving the expected level in mathematics assessments / examinations in 2014 at each key stage, by free-school-meal eligibility

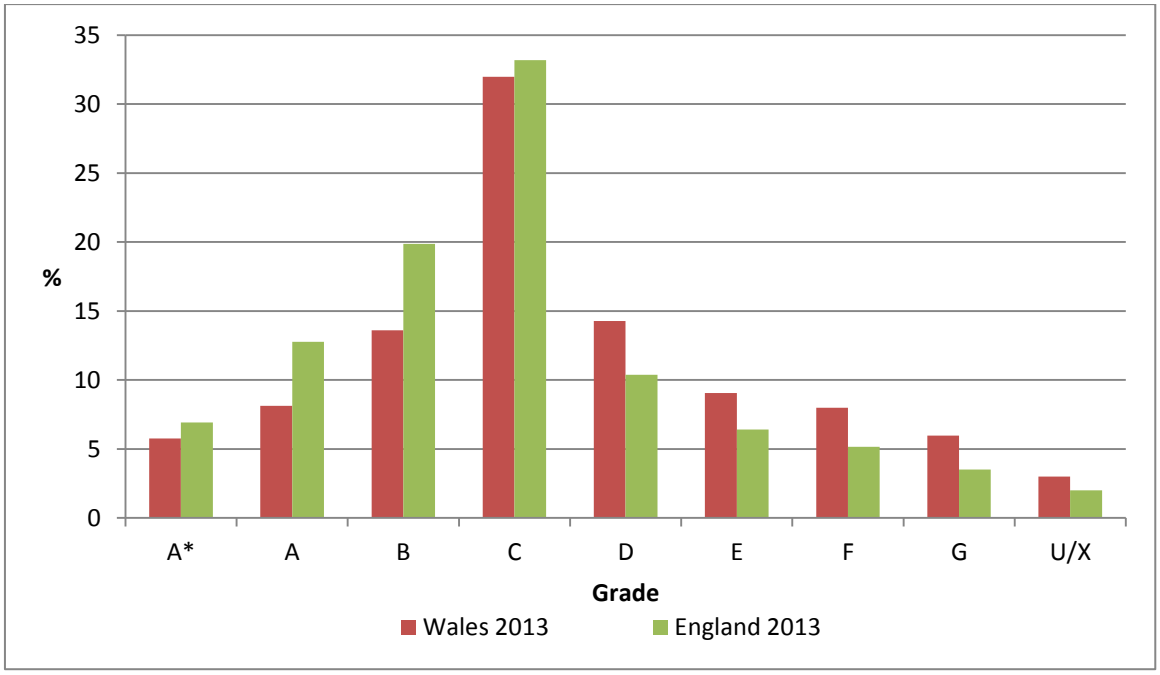


Source: School Statistics, Welsh Government

Performance in comparison with other countries

In 2013, the percentage of pupils in Wales attaining a grade C or above in mathematics was 13 percentage points lower than in England. The proportion of pupils in Wales attaining the higher grades B and above is markedly lower than the proportion of pupils who achieve these grades in England, although there are differences in methodology between UK countries.

Figure 9 – The percentage of pupils achieving GCSE mathematics grades in Wales and England, 2013 *



* 2013 data has been used in this chart because major changes have been made to methodology in England 2014. Therefore comparisons between Wales and England for 2014 data cannot be made.

Source: Examination results, Welsh Government; National Pupil Database, Department for Education

Programme for International Student Assessment (PISA)

The Programme for International Student Assessment (PISA) surveys the educational achievement of 15-year-olds and is organised by the Organisation for Economic Co-operation and Development (OECD). PISA assesses pupils' mathematics, science and reading skills. Mathematics was the main subject in PISA 2012[1] and was assessed in greater depth when compared with the other two areas.

In 2012, 38 countries significantly outperformed Wales in the PISA mathematics assessments, with the mean mathematics score of pupils in Wales lower in these assessments when compared with the previous PISA assessments in 2006 and 2009. In 2012, the mean mathematics score of pupils in Wales was 468, which was significantly lower than the OECD mean of 494. Further, Wales was the lowest performing country within the United Kingdom.

[1] Achievement of 15-Year-Olds in Wales: PISA 2012 National Report OECD Programme for International Student Assessment, National Foundation for Educational Research (NFER)

In 2012, in Wales, there was a small increase in the proportion of low achieving pupils and a decrease in the proportion of high achieving pupils, when compared with 2009 figures. Boys performed significantly better than girls, as was the case in nearly two-thirds of participating countries. This is a marked contrast to pupils' performance in mathematics at key stage 3 and key stage 4, where girls consistently achieve higher than boys. Currently, there is no clear explanation for this difference and it is an area requiring further investigation to improve outcomes.

In Wales, pupils' performance in PISA is relatively strong on the questions that focus on probability and statistics (uncertainty and data) or require them to interpret, apply and evaluate mathematical outcomes in order to solve problems. They are less strong on questions that focus on aspects of space and shape. In addition, pupils did not perform as well on questions that require them to formulate situations mathematically in order to solve a problem. The spread of performance in Wales is relatively narrow and there were only seven participating countries that had a smaller difference between their highest and lowest performing pupils. However, in 2012 this difference increased in Wales compared to previous PISA assessments.

Evidence base

The findings and recommendations in this report draw on visits to 15 secondary schools. The sample takes account of geographical location, socio-economic background, size of school and linguistic contexts. In these visits, HMI:

- observed lessons at key stage 3
- reviewed pupils' work and departmental documentation
- met representative groups of pupils
- held discussions with middle and senior leaders

Additional evidence was drawn from:

- inspection reports from 2010 to 2013
- National Curriculum teacher assessments at the end of key stage 2 and key stage 3
- a review of the PISA National Report (Wales, 2012)
- Improving schools in Wales: An OECD Perspective, 2014

List of schools visited

- Barry Comprehensive School, Vale of Glamorgan
- Caerleon Comprehensive School, Newport
- Cardiff High School, Cardiff
- Cardinal Newman Catholic Comprehensive School, Rhondda Cynon Taf
- Cefn Saeson Comprehensive School, Neath Port Talbot
- Connah's Quay High School, Flintshire
- Cwmtawe Community School, Neath Port Talbot
- Gowerton Comprehensive School, Swansea
- Milford Haven School, Pembrokeshire
- Morriston Comprehensive School, Swansea
- Penyrheol Comprehensive School, Swansea
- St Joseph's R.C. High School, Newport
- Ysgol Dyffryn Ogwen, Gwynedd
- Ysgol Y Creuddyn, Conwy
- Ysgol Y Grango, Wrexham

Glossary

Core subjects	English, Welsh first language, mathematics and science
OECD	Organisation for Economic Co-operation and Development
PISA	The programme for international student assessment. PISA is an international study that was launched by the OECD in 1997. It aims to evaluate education systems worldwide every three years by assessing 15-year-olds' competencies in the key subjects of reading, mathematics and science.
Level 2 qualification	A qualification equivalent to grades A*-C at GCSE
Level 2 threshold, including English or Welsh first language and mathematics	A volume of qualifications at level 2 equivalent to the volume of five GCSEs at grades A*-C including English, or Welsh first language and mathematics
Banding	Banding is defined by the Welsh Government as a way of using national data on school performance in context to group schools according to where they are on their improvement journey relative to other schools in Wales. It has now been replaced by national categorisation (see below).
National School Categorisation System	The system introduced by the Welsh Government assesses a school on the following: • a range of performance measures provided by the Welsh Government • robust self-evaluation from schools on their ability to improve in relation to leadership, learning and teaching • corroboration of the school's self-evaluation by education consortia challenge advisers

Explanation of words and phrases used to describe our evaluations

The words and phrases used in the left hand column below are those that we use to describe our evaluations. The phrases in the right hand column are the more precise explanations.

nearly all	very few exceptions
most	90% or more
many	70% or more
majority	60%
half	50%
around half	close to 50%
minority	below 40%
few	below 20%
very few	Less than 10%

References

Estyn publications

Her Majesty's Chief Inspector of Education and Training in Wales Annual Reports 2010-2011, 2011-2012 and 2012-13

An evaluation of the impact of the non-statutory Skills framework for 3 to 19-year-olds in Wales at key stage 2 (2011)

Closing the gap between boys' and girls' attainment in schools (2008)

Numeracy in key stage 2 and 3: a baseline study (2013)

Good practice in mathematics at key stage 4 (2013)

Other publications

National Numeracy Programme, Welsh Government (2012)

National Literacy and Numeracy Framework, Welsh Government (2013)

Achievement of 15-Year-Olds in Wales: PISA 2012 National Report, OECD, Programme for International Student Assessment

National Foundation for Educational Research (NFER)

Programme for International Student Assessment, OECD (2006, 2009)

Improving Schools in Wales: An OECD Perspective, OECD (2013)

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