Mathematics Task and Finish Group

Report and recommendations

November 2015

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Audience

Teachers, headteachers and governing bodies of maintained schools in Wales; local authorities; regional education consortia; initial teacher training providers; teacher unions and school representative bodies; church diocesan authorities; national bodies in Wales with an interest in education.

Overview

This document is the report of the Mathematics Task and Finish Group, set up by the Minister for Education and Skills in January 2015.

Action required

All primary and secondary schools to review practice in the light of the Group's findings, in particular section 5 'What effective teaching and learning looks like'. All governing bodies to discuss the Group's findings with senior leadership in their schools.

Further information

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Additional copies

This document can be accessed from the Welsh Government's website at www.gov.wales/educationandskills

Related documents

Successful Futures: Independent Review of Curriculum and Assessment Arrangements in Wales (Welsh Government, 2015)

Good practice in mathematics at key stage 3 (Estyn, 2015)

 WG25979 Digital ISBN 978 1 4734 5023 3

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1. Chair's foreword

When the Minister for Education and Skills launched the first Welsh Government national "Mathematics for Life" conference on January 28th 2015, and announced the establishment of an independent Mathematics Task and Finish Group, he referred to Wales "raising its game in educational standards and performance". The Minister noted the record high percentage of pupils gaining 5 GCSE or equivalent qualifications at grade A* to C including English or Welsh first language and mathematics in 2014, as well as the positive trend in the performance of pupils eligible for free school meals. However, he identified mathematics as "one of the areas where progress was not happening as fast as we would like".

The Minister and the Task and Finish Group both recognise the crucial role that mathematics plays in our daily lives, and in the economic health of the nation. Without mathematics, young people are unable to pursue careers in a wide variety of professions, especially STEM (science, technology, engineering and mathematics) ones. Their very livelihood is often dependent on their ability to calculate and interpret numerically and identify the appropriate mathematical method(s). As a Task and Finish Group we have come to the conclusion that the often heard quote "I'm just no good at maths" is a myth. This belief is often a feature of western culture, whereas in countries that perform best in international tests, for example some countries in the Far East, inborn talent is considered less important than hard work, persistence, resilience, good teaching and self confidence.

The Group looked at the literature and research findings on high quality mathematics teaching and outcomes across the world, and also had discussions with a wide variety of experts, practitioners, academics and students. Shaped by the Minister's brief, the Group focussed its attention on what excellent teaching and learning looks like, and what are the characteristic features of the most effective leaders, including leaders of mathematics. The Group also looked at what measures Government could deploy to ensure we recruit the best mathematics teachers in future, and what approaches could ensure the best professional development and training for those mathematics teachers already within the workforce.

My colleagues on the Mathematics Task and Finish Group and I are of the opinion, having looked at the literature, research findings and inspection reports, that we need to establish, in Wales, a Centre of Excellence for Mathematics. This would be responsible for identifying and promoting excellent mathematics pedagogy, for co-ordinating professional training, and for undertaking research. Linked to the Centre would be mathematics hubs based in English and Welsh medium schools which had a record of developing excellence in mathematics teaching. Our other recommendations are contained in the body of this report, and all are aimed at developing world class mathematics teaching and learning in Wales in order to maximise pupil outcomes.

During deliberations the Group were acutely aware of the major changes likely to develop in the Welsh education system in the near future, especially those proposed in the "Successful Futures" report by Professor Graham Donaldson on the curriculum; Professor John Furlong's report on Initial Teacher Training; and the implications of the 'New Deal for the Education Workforce'. The Group considers that the recommendations in this report are in alignment with planned wider change.

I would like to record my heartfelt thanks to my colleagues on the Task and Finish Group for their dedication, innovative ideas, hard work and enthusiasm. A special mention must be made of Joanne Sharp (Welsh Government Senior Policy Manager) and Meinir Edwards (Welsh Government Policy Officer) for their impressive expertise, advice and dedication in supporting the work of the Group, and to Pat McCarthy (Welsh Government Head of Core Subjects) for his invaluable advice and expertise in the field of policy formulation.

Michael Griffiths, OBE

2. Recommendations

The key recommendations from the Task and Finish Group are that the Welsh Government:

Recommendation 1: In collaboration with Consortia, local authorities, school leaders and governors evaluate current practice at school and consortium level as to what excellent mathematics teaching and learning looks like.

Recommendation 2: Should consider researching and developing common resources for the primary sector to support teachers in the development of pupils' conceptual understanding and procedural fluency.

Recommendation 3: Considers establishing a National Centre of Excellence for Mathematics that would be responsible for identifying and promoting excellent mathematics pedagogy, for developing resources, for coordinating professional training and for undertaking best practice, evidence-based research into mathematics and mathematics teaching.

Recommendation 4: Considers establishing school based mathematics hubs across all education settings, which would work collaboratively and in partnership with the Centre of Excellence for Mathematics in considering needs and identifying priorities, developing and delivering courses and resources and in undertaking research.

Recommendation 5: In collaboration with the proposed Centre of Excellence for Mathematics, establishes an accredited national programme of leadership training for curriculum leaders of mathematics.

Recommendation 6: In collaboration with the proposed Centre of Excellence for Mathematics, establishes a recognised national programme of training for all teachers and support staff of mathematics in Wales. As a first step, the Welsh Government should map existing mathematics professional development opportunities available to teachers in Wales, and make that information readily available electronically.

Recommendation 7: Reviews the arrangements for financial incentives for mathematics graduates to train in Wales in the light of the disparity with other providers in the UK.

Recommendation 8: Explores recognised professional training routes to facilitate the recruitment of suitably qualified applicants into the teaching profession. This could include part time Initial Teacher Education Training (ITET) provision or Subject Knowledge Enhancement programmes to support suitable applicants in meeting entry requirements to secondary mathematics training programmes.

Recommendation 9: Considers an accredited mathematics teaching programme that would allow existing qualified teachers to specialise in mathematics.

Recommendation 10: Ensures that common requirements for mathematics and numeracy initial teacher training are incorporated into the accreditation process for all ITET providers in Wales.

Recommendation 11: Undertakes a review of the length and balance of teacher training programmes in order to facilitate consistent training in numeracy and mathematics, and to support the development of specialist primary mathematics teachers.

Recommendation 12: Considers an expansion to the current number of places offered by Teach First Cymru for mathematics graduates, and considers extending the Teach First initiative to the primary sector for mathematics graduates, subject to a successful evaluation of the current pilot.

Recommendation 13: Considers extending the number of funded Graduate Training Programme (GTP) training programme places for mathematics in order to attract more mathematics graduates, subject to meeting the appropriate quality assurance processes.

Recommendation 14: Monitors the numbers for both post 16 and graduate level mathematics study in Wales in order to inform future recruitment and training needs.

3. Introduction

In January 2015 the Minister for Education and Skills, Huw Lewis AM, set up an independent Task and Finish Group to consider how to improve mathematics teaching and learning in Wales.

> *"Good numeracy is the best protection against unemployment, low wages and poor health".*
>
> Andreas Schleicher, OECD, 2013

The Mathematics Task and Finish Group considered a range of issues of what works well in mathematics teaching and learning and what could realistically be improved in the short, medium and long term in Wales.

The Group considered the following questions:

- What does effective mathematics teaching and learning look like?
- What can be done to improve the quality of mathematics teaching and learning?
- What measures can be taken to improve the quantity and quality of mathematics teachers available?

The Group was asked to recommend realistic and deliverable actions that will have an impact on the teaching and learning of mathematics in Wales whilst taking into account both Professor Graham Donaldson's 'Successful Futures' and Professor John Furlong's 'Teaching Tomorrow's Teachers', as well as the 'New Deal for the Education Workforce'.

The Group carried out its work in a series of meetings between January and July 2015, gathering evidence from organisations and high performing schools and undertook a study visit to gain valuable insight on how Project Maths is implemented in the Republic of Ireland. This report sets out the Group's vision and the recommendations are based on the conclusions drawn from the Group's work over seven months.

Members of the Group were chosen to reflect expertise in mathematics and comprised academics and teachers from high-performing schools in the field of mathematics. Membership of the Task and Finish Group is listed at Appendix 2 and detailed of presenters and other individuals consulted during the Group's review can be found at Appendix 3.

4. Context

The Task and Finish Group as part of its deliberations looked at a wide range of literature and research findings on mathematics and mathematics teaching, including the selection of quotations and documents referred to below. The full list of sources considered can be found in Appendix 4 of the report.

> "Mathematics helps children and young people to make sense of the world around them and to manage their lives. It gives them skills they need to interpret and analyse information, solve problems and make informed decisions. Taught well through relevant contexts, mathematics can engage and fascinate children and young people of all interests and abilities. It provides strong support for the development of wider skills, particularly critical thinking and problem solving, planning and organisation, and creativity and innovation. It enables people to communicate ideas in a concise, unambiguous and rigorous way, using numbers and symbols. A high level of numeracy and mathematical competence is important for the prosperity of the country."
>
> *Successful Futures*, Professor Graham Donaldson, February 2015

GCSE results at Key Stage 4

The number of pupils achieving a grade C or above in GCSE mathematics has increased by eight percentage points since 2007. However on the basis of 2014 data, mathematics was the lowest performing core subject at Key Stage 4 (KS4) in Wales. Encouragingly, the gap between the percentage of girls and boys achieving a grade C or above in GCSE mathematics has decreased over the last six years.

This is in contrast to performance in mathematics at Key Stage 3 (KS3). Progress from KS3 to the end of KS4 is weaker in mathematics than in the other core subjects. The proportion of pupils who achieve level 5 or above at KS3 compared to the proportion of pupils who achieve a grade C or above two years later is lower in mathematics than in the other core subjects. This is despite attainment at level 6 and level 7 being stronger in mathematics at KS3.

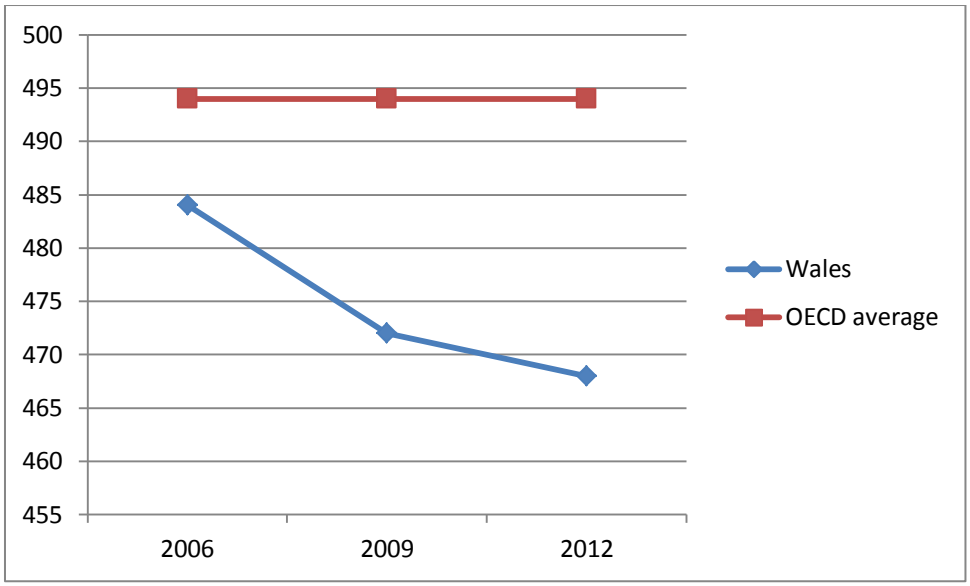
Findings PISA 2012

The Programme for International Student Assessment (PISA) is a survey of the educational achievement of 15-year-olds organised by the Organisation for Economic Co-operation and Development (OECD). PISA assesses students' mathematics, science and reading skills. Mathematics was the major domain in PISA 2012, which reported Wales' performance as significantly below the OECD

average, as well as below the positions of all of its closest neighbours in the UK and of most of those in the EU. The PISA 2012 results show that Wales' performance in mathematics has declined since 2006. The results show there is also a widening gap between high and low achievers in Wales. In 2012 boys continued to outperform girls in mathematics, although there is a smaller gap between boys' and girls' performance than in 2009.

For the four content areas in mathematics, Wales achieved its highest score on the 'uncertainty and data' scale and its lowest on the 'space and shape' scale. In the three process areas Wales scored best on the ability of pupils to interpret, evaluate and apply, and lowest on the ability to formulate situations mathematically. Pupils are 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,* or that require them to *formulate* situations mathematically in order to solve a problem.

Table: Mathematics achievement in the PISA tests in Wales since 2006



More information can be found at (http://wales.gov.uk/statistics-and-research/achievement-15-year-olds/?lang=en)

The Minister for Education and Skills has set two targets for PISA in Wales:

- achieve a mean score of 500 in all three of the PISA domains by 2021; and
- significantly reduce the percentage of learners achieving PISA level 2 or below.

Estyn findings

Estyn's *Good practice in mathematics at key stage 4* report (October 2013) evaluated the standards achieved by pupils and the quality of mathematics provision. The report highlighted areas for improvement including:

- ensuring that pupils develop secure number, algebraic and problem-solving skills at key stage 3 and that these are developed and applied in new contexts at key stage 4;
- using assessment to inform pupils about how they are doing and what they need to do to improve;
- minimising early entry for GCSE in mathematics and ensuring that pupils follow courses of study that allow them to achieve the highest grades;
- sharing best practice within and between schools and using it to support teachers' professional development;
- supporting schools and regional consortia in raising standards in mathematics for all pupils; and
- reviewing the National Curriculum level descriptors at key stage 3 with a view to raising levels of expectation at level 5 in number and algebraic skills.

> "A lack of numeracy skills significantly impacts upon young people's career choices and affects a person's role in the economy. Adults with an equivalent of a Level 1 (expected at the end of Year 9) ability in numeracy or above, earn on average 26% more than adults with skills below this level".
>
> National Numeracy Programme, Welsh Government, 2012

The *Good practice in mathematics in key stage 3* Estyn report (February 2015), evaluates the standards achieved by pupils and the quality of mathematics provision at KS3. A summary of the main findings concluded that at the end of KS3, teacher assessment data shows that pupil outcomes in mathematics at level 5 and above have improved markedly over the last five years. In 2014, almost 86.5% of pupils attained a level 5 or above in mathematics, which is 13 percentage points higher than outcomes in 2009. However, pupils who are eligible for free schools meals are significantly less likely to achieve level 5 or above at the end of KS3 (71%) when compared with those who are not eligible (90%).

> "A YouGov poll commissioned in 2012 found that 80% of adults questioned would be embarrassed to admit that they could not read or write properly. By comparison, only 56% would be embarrassed to admit that they were bad at mathematics/ numeracy."
>
> National Numeracy Programme, Welsh Government, 2012

End of foundation phase outcomes and National Curriculum teacher assessment of mathematics at Key Stages 2 and 3

Foundation Phase

All learners in their final year of Foundation Phase must be assessed through teacher assessments and the general expectation is that the majority of 7 year olds will attain outcome 5 in each area of learning. The results for pupils achieving the expected outcome in the Mathematical Development Area of Learning rose from 88.7% in 2014 to 89.7% in 2015.

Key Stage 2 and 3

The percentage of pupils achieving the expected level in mathematics at KS2 in 2015 increased by 1.3 percentage points from 2014, whilst at KS3, the increase was 2.2 percentage points. Mathematics had the highest percentage point increase of all the core subjects at KS3 in 2015. However the rate of improvement at KS3 has been faster than improvement at KS2 since 2010.

	Key Stage 2 (L4+)			**Key Stage 3 (L5+)**		
	2014	**2015**	**% point change 2014/15**	**2014**	**2015**	**% point change 2014/15**
English	88.4	89.6	1.2	85.9	87.9	2.0
Welsh	88.1	90.5	2.4	90.1	90.9	0.8
Mathematics	88.9	90.2	**1.3**	86.5	88.7	**2.2**
Science	90.3	91.4	1.0	90.4	91.8	1.4
Core Subject Indicator	86.1	87.7	1.6	81.0	83.9	2.9
Reading, Writing and Mathematics	80.6	82.3	1.8	75.1	77.9	2.8
Reading, Writing, Maths and Science	80.4	82.3	1.8	74.4	77.3	2.9

Table: Key Stage 2 and 3 summary for 2014-2015
Percentage of pupils achieving at least the expected level at Key Stage 2 and 3

Mathematics teachers in the secondary sector

In March 2015, English had the highest number of registered teachers (1,659 / 10.8%) followed by mathematics (1,562 / 10.2%).

The following data shows the number and percentage of mathematics teachers who possess a mathematics degree and those who have studied mathematics as a subject during their Initial Teacher Education Training (ITET)

Number of registered school teachers teaching mathematics by first degree subject

Degree Subject	Total Number of School Teachers	%
Mathematics (including pure mathematics, applied mathematics and statistics)	**776**	**52.5**
Accounting	36	2.4
Economics	35	2.4
Civil Engineering	27	1.8
Physics	25	1.7
Mechanical Engineering	22	1.5
Business Studies	22	1.5
Psychology	21	1.4
Physical Education	19	1.3
Sports Science	17	1.2
Chemistry	17	1.2
Accountancy	16	1.1
Electrical Engineering	15	1.0
Computer Science	14	0.9
Biology	12	0.8
Combined / General Science	11	0.7
Mathematics and Science	10	0.7
Chemical Engineering	10	0.7
Other *	331	22.4
Blank or Unknown	41	2.8
Total	**1477**	**100**

* Other relates to all subjects where less than 10 registered school teachers have a degree subject other than mathematics recorded on their record. Over 180 possible subjects are included such as Electronic Engineering, Welsh, Zoology, Geology, Management Studies, Business and Management Studies, Mathematical Science, Mathematical Statistics.

Number of registered school teachers teaching mathematics by first Initial Teacher Education Training (ITET) subject trained

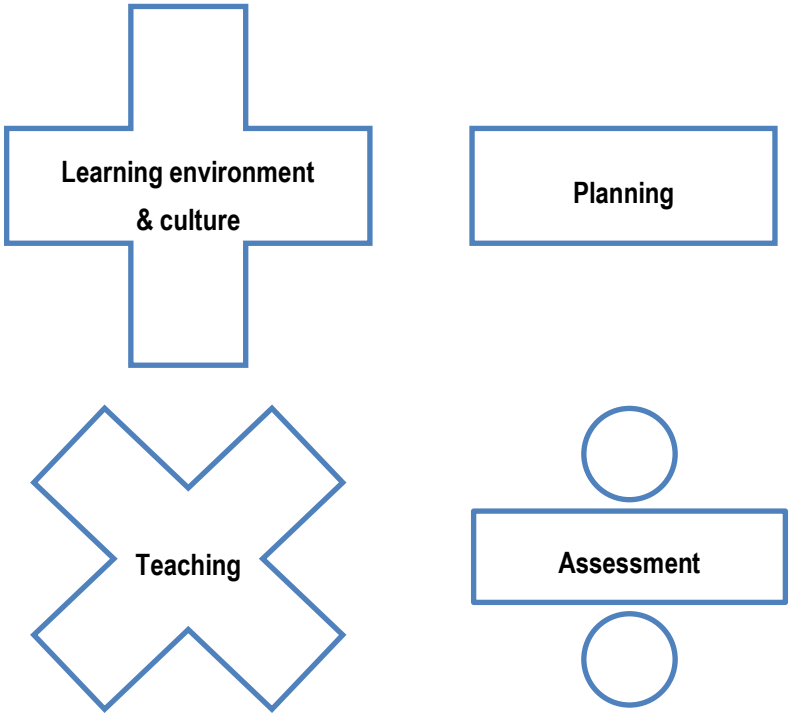
First ITET subject trained	Total Number of School Teachers	%
Mathematics	**1141**	**77.3**
Mathematics and Science	10	0.7
Physical Education	33	2.2
Biology	27	1.8
Combined / General Science	25	1.7
Chemistry	12	0.8
Information and Communication Technology	12	0.8
Physics	12	0.8
Other*	116	7.9
Blank	89	6.0
Total	**1477**	**100**

*Other relates to all subjects where less than 10 registered school teachers have an ITET subject other than mathematics recorded on their record. Over 40 possible subjects are included such as Business Studies, General Primary, English, Geography, Design and Technology.

5. What effective teaching and learning looks like

Whilst the definition of what effective mathematics teaching and learning looks like will depend, in part, on what purpose is assigned to teaching mathematics, there will be certain characteristics and themes that are ever present. A review of international research, including from countries that achieve the best outcomes in the world, reveals that there are four essential components to effective teaching in mathematics across all phases.

These are:



1. Learning environment and culture

Research evidence indicates that in effective schools and countries, teachers:

- set high expectations for all pupils and their philosophy is that everyone "can do mathematics";
- create an ethos where the characteristics of persistence, resilience and hard work are valued equally alongside innate ability;
- develop strong working relationships with pupils and create an environment where they are not frightened to take risks or make mistakes;
- enable pupils to take on responsibility for their own learning in a supportive way;
- create stimulating classrooms that promote the intrinsic fascination and power of mathematics;
- are reflective and pragmatic practitioners and base their teaching methods and approaches on what is proven to work well;

- have regular opportunities to discuss and develop teaching and learning and regularly share resources and ideas with each other;
- of mathematics work effectively with other curriculum areas that contribute significantly to pupils' mathematical development.

2. Planning

Research evidence indicates that in effective schools and countries, teachers:

- map out the cyclical development of skills and concepts building on pupils' skills, experiences and interests systematically;
- develop pupils' conceptual understanding by using relevant concrete, visual and abstract experiences;
- are supported well by resources such as textbooks, schemes and ICT packages that assist teachers to develop pupils' conceptual understanding and procedural fluency;
- incorporate focused assessments that revisit, refresh, consolidate and extend previously learnt skills and concepts;
- use homework activities that encourage independent learning and consolidate and extend work in class, or are used to revisit previously learnt skills.

3. Teaching

Research evidence indicates that in the most effective schools and countries, teachers:

- have strong mathematical subject knowledge;
- model mathematical language and communicate concepts and processes in a straightforward manner that pupils are able to follow;
- plan activities that focus strongly on developing pupils' conceptual understanding and procedural fluency in relevant contexts;
- use multiple representations, such as concrete, visual, tabular, graphical or algebraic, to communicate mathematical concepts and patterns;
- ensure pupils are actively engaged in doing mathematics;
- ensure that pupils have a wide range of experiences that focus on developing key number skills such as number bonds, multiplication tables, the four rules of number, place value, integers, decimals, fractions, negative numbers, ratio and percentages;
- promote fluency with key number skills and provide pupils many opportunities to use these in other aspects of mathematics and in other curriculum areas;
- use intelligent practice to extend pupils' thinking and reveal the underlying structures and patterns in mathematics;
- influence pupils' learning by asking challenging and interesting questions that are planned to structure their conceptual understanding;

- set problem solving and extended tasks in meaningful real-world contexts and require pupils to use multiple skills;
- plan activities that develop pupils' cognitive skills to solve problems in logical and systematic ways;
- plan activities that develop pupils' metacognitive skills, such as summarising, reasoning, evaluating and identifying misconceptions and key aspects of learning.

4. Assessment

Research evidence indicates that in the most effective schools and countries, teachers:

- regularly monitor pupils' progress in lessons and provide immediate feedback that deals with common mistakes and misconceptions as they arise;
- use regular summative and formative assessment processes to know how well pupils are doing and what they need to do to improve;
- quickly identify pupils that need support and provide rapid intervention for these pupils;
- use high quality assessments that accurately inform learning and track pupils' progress over time;
- use assessment opportunities to develop pupils' habits of self-learning.

Recommendations

That Welsh Government

Recommendation 1:
In collaboration with Consortia, local authorities, school leaders and governors evaluate current practice at school and consortium level as to what excellent mathematics teaching and learning looks like.

Recommendation 2:
Should consider researching and developing common resources for the primary sector to support teachers in the development of pupils' conceptual understanding and procedural fluency.

6. Improving the quality of mathematics teaching and learning

The Chief Inspector of Schools for Wales highlights in Estyn's most recent annual report (2014) the important link between the quality of leadership and the quality of outcomes for learners, as identified in inspection reports over a five year period. The Chief Inspector also identifies the trend towards more distributed leadership, with roles being shared across all levels within schools. However, Estyn also identifies the need for greater investment in strategies to build capacity in the workforce, including leadership capacity.

In schools that gained an excellent rating in school inspections, leaders had rigorous systems to establish high expectations of pupils and consistency in teaching and assessment across the school. In primary schools that had an excellent rating for teaching, the lessons were deemed to be creative, stimulating and challenging. A similar pattern emerged in secondary schools, with those schools deemed excellent displaying a high level of consistency in the quality of teaching across all subjects, with challenging activities, engaging the pupils' imagination fully.

> "It is recognised internationally that the problems associated with mathematics and science teaching and learning have their source mainly in the teachers' subject content knowledge and pedagogical content knowledge rather than in generic pedagogy or in any aspect of general educational theory."
>
> National Centre of Excellence in Mathematics and Science Teaching and Learning Review, 2008-2011

It is evident from Estyn's Annual Report, and from research literature, that the quality of mathematics teaching in schools and colleges is likely to be highest when there is a whole school strategic understanding of what excellent pedagogy looks like, with an agreed common teaching and learning approach used in the classroom. The Task and Finish Group also believes that all schools should develop a strategic approach to teaching mathematics, if such an approach is not already in place.

The Group considers that an informed balance should be struck between the support and challenge offered to heads of department by senior leadership and governors. This requires support from senior leadership for appropriate professional development, but also challenge through regular line management meetings. Heads of department and their departmental colleagues should be held to account for pupil outcomes and departmental performance.

The Task and Finish Group also welcomes the Welsh Government's 'New Deal for the Education Workforce', as an initiative aimed at developing a national model for professional learning. The Group believes that prospective heads of department should be expected to undertake leadership training and mentoring in advance of taking up a leadership post. The 'New Deal' initiative will also help establish defined

career pathways and professional development opportunities, which the Group commends.

In the context of the specific leadership of mathematics departments, despite there appearing to be a paucity of literature and research in this area, it would appear reasonable to assume that the generic characteristics of high quality leaders will not be radically different from those required of high quality heads of mathematics. It is evident from the literature and research on generic school leadership traits and characteristics that effective leaders establish a culture of high expectations, promote distributed leadership, and look beyond the day to day work of the school to a vision that demonstrates an aspiration to maximise pupil outcomes.

Similarly, the literature on effective middle leadership emphasises the following qualities of the best middle leaders in schools:

- setting a compelling vision, based on the accurate evaluation of the department's strengths and areas for development;
- modelling best practice and challenging colleagues to be innovative and creative;
- setting high expectations of both pupils and teaching colleagues;
- using data and other forms of evidence such as pupil voice to set challenging targets;
- using robust monitoring and self evaluation processes to develop ambitious plans aimed at improving pupil outcomes;
- using departmental meetings primarily to share and develop teaching and learning strategies, and create regular opportunities for mutual observation of lessons; and
- providing regular and focused training, including coaching and mentoring.

The Task and Finish Group feels strongly that the roles and responsibilities of heads of mathematics, as is indeed the case for other middle leaders, have changed radically in recent years, but that their training and developmental needs have not necessarily kept pace with these changes. Mathematics leaders play a key role in managing change effectively and improving the culture and performance of their departments in order to maximise pupil outcomes. It is imperative that they are equipped with the comprehensive set of skills and aptitudes necessary to fulfil this role.

Our recommendations highlight the clear need for a national leadership course for all curriculum leaders of mathematics. Such a course or programme would focus both on leadership aspects of the role, and on pedagogy, particularly what research informs us about the mathematics pedagogy used by the most successful nations of the world. It would also recognise the key importance of the leadership of teaching, which is likely to have the single biggest impact on standards.

The Task and Finish Group also considers that there should be a recognised national programme of training for all teachers and support staff for mathematics, in order to ensure that a strategic national understanding of what mathematics excellence looks like emerges. Such a course would necessarily need to align with

the new pedagogy required to meet the needs of the Literacy and Numeracy Framework (LNF) and the new GCSE Mathematics and GCSE Mathematics - Numeracy qualifications.
As referred to in the foreword, the Group recommends the establishment of a National Centre of Excellence for Mathematics in Wales, possibly in partnership with a Higher Education Institution, which would have a strategic national role in the development of world class mathematics teaching, training and research. We also recommend the creation of mathematics hubs, based in schools which have a proven record of developing excellence in mathematics teaching. They would work closely with the Centre of Excellence for Mathematics in the delivery of courses, the development of resources, and in undertaking research. We envisage the creation of school based hubs distributed appropriately across Wales.

Recommendations

That Welsh Government

Recommendation 3:
Considers establishing a National Centre of Excellence for Mathematics that would be responsible for identifying and promoting excellent mathematics pedagogy, for developing resources, for coordinating professional training and for undertaking best practice, evidence-based research into mathematics and mathematics teaching.

Recommendation 4:
Considers establishing school based mathematics hubs across all education settings, which would work collaboratively and in partnership with the Centre of Excellence for Mathematics in considering needs and identifying priorities, developing and delivering courses and resources and in undertaking research.

Recommendation 5:
In collaboration with the proposed Centre of Excellence for Mathematics, establishes an accredited national programme of leadership training for curriculum leaders of mathematics.

Recommendation 6:
In collaboration with the proposed Centre of Excellence for Mathematics, establishes a recognised national programme of training for all teachers and support staff of mathematics in Wales. As a first step, the Welsh Government should map existing mathematics professional development opportunities available to teachers in Wales, and make that information readily available electronically.

7. Improving the quantity and quality of mathematics teachers

There appears to be a shortage of suitably qualified mathematics specialists in both the primary and secondary sectors in Wales. Secondary heads of department and advisers report that recruitment of suitably qualified mathematics teachers is particularly problematic for schools, and they have difficulty in recruiting those qualified to teach post 16. The Royal Society 'Vision' report, published in 2014, highlighted the severe shortage of science and mathematics teachers across the UK. The problem was also acknowledged by the 2015 School Teachers' Review Body, which found that the salary of teachers was below that of many graduate professions. In addition, there are also concerns about mathematics teacher retention, and the Task and Finish Group were conscious of the need to ensure that clear and strong career pathways and structured professional development opportunities were provided in future.

> "There was striking unanimity across the literature review, the case studies and the online survey that schools and colleges which are successful in science and mathematics provision are collaborative and inclusive."
>
> Royal Society Vision Report, August 2013

Initial Teacher Education Training (ITET) institutions report that it is very difficult to attract trainee secondary mathematics teachers to ITET programmes in Wales. For example, providers informed the Task and Finish Group that they had not recruited their full allocation of mathematics students for the 2015/16 academic year. One ITET provider reported that there was a relationship between the numbers of applicants to the programme and the number of students graduating in mathematics in that region. The Furlong report into ITET in Wales (March 2015) states that "financial incentives offered to students are in some cases more generous in England than in Wales". In England, for 2015/16, mathematics candidates with a first class mathematics degree will be offered £25,000, compared to the Welsh offer of £20,000. Candidates with a 2:1 or Master's degree will be offered £20,000 in England. In Wales, a candidate with a 2:1 in mathematics will be offered £10,000. Also, all eligible PGCE trainees who are domiciled in Wales and meet the residency criteria will receive a £5,190 tuition fee grant. The UCAS system for application to teacher training programmes now allows applicants to apply to multiple providers at the same time (rather than in 'ranking' order) which tends to result in the same 'pool' of applicants applying to the centres in Wales.

Although there are supplement incentives available for mathematics specialists with a first degree classification in the primary sector, the number of trainees who may be considered primary mathematics specialists at the start of training is low. All applicants to training programmes must pass a numeracy skills test, and since 2014 must also have a 'B' grade or equivalent at GCSE. Typically the highest mathematics qualification of most primary trainees is GCSE level. It is important to note that some research suggests that the quality of primary mathematics teaching

does not directly link with the level of mathematics qualification. The literature suggests it is the acquisition of ‘a combination of deep subject knowledge and pedagogical skill’ which is vital in ensuring effective primary mathematics teaching. Thus the way in which such understanding can be acquired both in training and through professional development should be considered.

The Task and Finish Group also looked at other routes into teaching, both in Wales and the other countries of the UK, to explore whether offering a variety of routes into mathematics teaching could increase the number of mathematics teachers in secondary schools. One such route is to train existing teachers of subjects other than mathematics. This is reported to be successful in some schools, but is not associated with any accreditation for the teacher. A similar programme (Post Graduate Diploma in Mathematics Teaching and Learning for ‘out-of-field’ teachers of mathematics) was considered effective in increasing capacity in Ireland. This was developed by the National Centre for Excellence in Mathematics and Science Teaching and Learning and a university.

Subject Knowledge Enhancement courses are also offered in England to suitable candidates prior to applying to training institutions. These are fully funded for suitable applicants with bursaries depending on length of courses. Such courses allow candidates to boost subject knowledge in order to apply for a training programme.

‘Teach First’ is a charity that runs a salaried, two year Leadership Development Programme, placing exceptional graduates in schools that serve low income communities. Supported by the Welsh Government, Teach First Cymru is operating in Wales as a school improvement programme under the employment-based teacher training programme. In the first two years that the pilot initiative has been running in Wales, Teach First report that they have recruited, placed and supported just under seventy participants across twenty-eight schools in eleven authorities in South Wales, and in the next academic year will expand into North Wales. Sixty participants are expected to make up the 2015 cohort, with eighteen mathematics recruits. Participants must commit to a minimum of two years at their partner school, where they teach a Newly Qualified Teacher (NQT) timetable. Although ‘Teach First’ recruits both primary and secondary participants in England, the current pilot contract between Welsh Government and ‘Teach First Cymru’ is limited to secondary participants. ‘Teach First Cymru’ is a three year pilot which is currently being evaluated by Estyn and another independent organisation.

Whilst the results of these two evaluations of Teach First Cymru are not expected until later on this year, evaluations of the Teach First programme in England have been very positive. The University of Manchester evaluation in 2010 indicated that "Teach First teachers have a positive impact in schools", and the Institute of Education, University of London evaluation in 2013 concluded that the Teach First programme "most likely produced school-wide gains in GCSE results ... around one grade in each of the pupils' best eight subjects".

The Graduate Teacher Programme (GTP) is an employment based route into teaching in Wales which offers a way to qualify as a teacher while you work. Trainees undertake an individual programme designed to enable them to meet the

Qualified Teacher Status (QTS) standards. In addition to fulfilling all the entry requirements for an initial teacher training programme, candidates for the GTP must first hold a first degree or equivalent in an appropriate qualification. The programme normally lasts one year full time, but trainees with suitable previous experience and qualifications may complete the programme in a shorter time.

Recommendations

That Welsh Government

Recommendation 7: Reviews the arrangements for financial incentives for mathematics graduates to train in Wales in the light of the disparity with other providers in the UK.

Recommendation 8: Explores recognised professional training routes to facilitate the recruitment of suitably qualified applicants into the teaching profession. This could include part time Initial Teacher Education Training (ITET) provision or Subject Knowledge Enhancement programmes to support suitable applicants in meeting entry requirements to secondary mathematics training programmes.

Recommendation 9: Considers an accredited mathematics teaching programme that would allow existing qualified teachers to specialise in mathematics.

Recommendation 10: Ensures that common requirements for mathematics and numeracy initial teacher training are incorporated into the accreditation process for all ITET providers in Wales.

Recommendation 11: Undertakes a review of the length and balance of teacher training programmes in order to facilitate consistent training in numeracy and mathematics, and to support the development of specialist primary mathematics teachers.

Recommendation 12: Considers an expansion to the current number of places offered by Teach First Cymru for mathematics graduates, and considers extending the Teach First initiative to the primary sector for mathematics graduates, subject to a successful evaluation of the current pilot.

Recommendation 13: Considers extending the number of funded Graduate Training Programme (GTP) training programme places for

mathematics in order to attract more mathematics graduates, subject to meeting the appropriate quality assurance processes.

Recommendation 14: Monitors the numbers for both post 16 and graduate level mathematics study in Wales in order to inform future recruitment and training needs.

Appendix 1: Terms of reference

The Task and Finish Group will consider the range of issues of what works well in mathematics teaching and learning and what can realistically be improved in the short, medium and long term in Wales.

It is a time-bound Group, with the objective of producing final recommendations to the Minister for Education and Skills.

In Scope

a) What does effective mathematics teaching and learning look like?

The Group will consider this question in the light of broader development of the model for effective teaching, and consideration of the current knowledge and skills levels of mathematics teachers in Primary and Secondary schools; quality of teaching; teaching strategies; levels of professional learning and approaches used by high performing countries. Within this, the Group will wish to explore:

- factors that impact boys and girls attainment levels and progression rates;
- whether there are weaknesses in teaching particular areas of mathematics, e.g. numerical reasoning, in line with the findings from the PISA 2012 NFER results;
- if there could or should be approved methodologies for teaching or applying certain mathematics procedures based on proven successful practice – which might lead to a text book of sorts; and
- if there is a particular need for capacity to lift the performance of our more able and talented, or whether the need is greater in the 'average' range.

b) What can be done to improve the quality of mathematics teaching and learning?

The Group will assess what support is currently available in Wales (and elsewhere) which raises the quality of mathematics, with a particular emphasis on proven interventions and approaches. Within this, the Group will wish to explore:

- the value and content of exemplar checklist/checkpoints that teachers can use to assess their current practice against;
- if any perceived weakness in mathematics teaching capacity is larger in primary or secondary schools, or at particular key stages;
- whether there is a training issue in keeping up with up-to-date teaching and learning practice of mathematics techniques;
- if the capacity of specialist mathematics teachers is sufficiently high, and whether there is potential to re-train teachers of other numerate subjects to teach mathematics subjects, and how; and
- the importance of leadership and that all pupils experience good and consistent teaching experiences.

c) What measures can be taken to improve the quantity and quality of mathematics teachers available?

Taking what is within scope of the Group into account, the Group will wish to explore realistic and (where possible) proven options for enhancing the supply of quality mathematics teachers. Within this, the Group will wish to explore:

- the factors that affect the quantity and quality of current mathematics teachers across Wales;
- methods of up-skilling, subject knowledge enhancement courses, and conversion courses and their relative merits and application;
- entry criteria for mathematics teacher recruitment support; and
- any other avenues they think might be appropriate to help aid recruitment and development in the future.

Out of Scope

The Task and Finish Group should consider the following items out of scope:

- Curriculum change
- Qualifications change
- Major structural reform of Consortia working
- Structure of delivery of ITT
- Assessment arrangements, including national numeracy tests

Deliverables

The Group will produce final recommendations to the Minister for Education and Skills' consideration, which is both fit for purpose and deliverable. The final report will detail actions that we can move swiftly on and take into account the Welsh educational infrastructure and current levels of resource.

Meetings

Meetings will be held on a regular basis and will be time-tabled in advance. Substitutes are discouraged unless agreed in advance by the Chair or in extreme circumstances. The Chair may invite non-members to attend meetings to disseminate information or to listen to other professionals' views.

The Task and Finish Group may wish to receive evidence from other groups, e.g. Initial Teacher Training Institutions, employers, Professor Graham Donaldson, Further Mathematics Support Programme leads and other specialist mathematics teaching experts, in addition to international comparative analysis.

The Curriculum Core Subjects Branch in DfES will provide the Secretariat to the Group.

Appendix 2: Task and Finish Group Membership

Name	Organisation
Michael Griffiths, OBE (Chair)	Educational Consultant working primarily in the field of school leadership development
Geoff Cresswell	Interim Headteacher, Bryn Hafod Primary School
Karen Williams	Assistant Headteacher, Bishop Gore Secondary School
Laura Morris	Central South Consortia Advisor (numeracy) and Welsh Government Mathematics Subject Expert
Linda Thomas	Challenge Adviser, South East Wales Consortia
Lona Jones-Campbell	Headteacher, Ysgol Gymraeg Bro Teyrnon
Rachel Wallis	Lead in Primary Mathematics and Numeracy, University of Wales Trinity Saint David
Rhian Carruthers	Head of Mathematics and Senior Teacher, Ysgol Gyfun Gymraeg Bro Myrddin
Richard Owen	Assistant Headteacher, Ferndale Community School
Rob Davies	Estyn HMI – Lead Inspector for Mathematics and Numeracy
Sue Painter	Inclusive Assessment Adviser to Welsh Government

Appendix 3: Organisations and individuals consulted by the Group

- Teach First Cymru - Jennifer Owen Adams and Hannah Burch
- St Joseph's R.C. Comprehensive - John Felton
- Head of Teaching and Learning Improvement, Welsh Government - Claire Thomas
- Initial Teacher Education and Training providers (ITET) - Steve McCarthy, Helen Denny (with input from Gwyn Jones)
- Education Consultant - Hugh Griffiths and National Support Programme Secondary Mathematics Lead - Jane Miller
- Hawthorn Primary School - Caroline Marshall
- Blaenavon Heritage V.C. Primary School - Debbie Woodward
- Open University - Rob Humphreys, Barbara Allen, Kevin Pascoe, Hannah Pudner and Chris Hughes
- Cefn / Craig yr Hesg Primary School - Andrew Manley
- St Gwladys Bargoed Primary School - Kathryn Evans and Nadine Cushion
- Earls Dudley High School, National Teaching School - Tom Johnston
- Further Maths Support Programme Wales - Dr Sofya Lyakhova
- WJEC - John Williams
- Bishop Gore Secondary School - Karen Williams
- Ysgol Gyfun Gymraeg Bro Myrddin - Rhian Carruthers
- National Centre for Excellence in the Teaching of Mathematics (NCETM) - Charlie Stripp
- Singapore Maths - Rachel Wallis
- Cabot Learning Federation - Lisa Pollard
- Head of Initial Teacher Training, Welsh Government - Gail Deane
- Deputy Director, Practitioner Standards and Professional Development Division, Welsh Government - Helen Arthur

A representation of the Task and Finish Group participated in a study visit to the Republic of Ireland to learn about "Project Maths" where the following gave presentations:

- Curriculum and Planning Unit of the Department of Education and Skills - Breda Naughton
- National Council for Curriculum and Assessment - Bill Lynch
- States Examinations Commission - Tom O'Connor
- Project Maths Development Team - Anne Brosnan
- Maths Inspectorate - Seamus Knox
- University of Limerick - Professor John O'Donoghue.

The study visit also included visits to two schools which were:

- St. Dominic's Secondary School, Ballyfermot, Dublin
- Luttrellstown Community College, Luttrellstown, Dublin

Appendix 4: Useful reference sources used by the Group

Successful Futures - Independent Review of Curriculum and Assessment Arrangements in Wales by Professor Graham Donaldson (February 2015)
http://gov.wales/docs/dcells/publications/150317-successful-futures-en.pdf

Teaching Tomorrow's Teachers: Professor John Furlong's report on the future of Initial Teacher Education and Training in Wales (March 2015)
http://gov.wales/docs/dcells/publications/150309-teaching-tomorrows-teachers-final.pdf

New Deal for the Education Workforce – Written statement by Minister for Education and Skills (March 2015)
http://gov.wales/about/cabinet/cabinetstatements/2015/newdealeducation/?lang=en

The Annual Report of Her Majesty's Chief Inspector of Education and Training in Wales 2013 – 2014
http://www.estyn.gov.uk/english/annual-report/annual-report-2013-2014/

Estyn report: Good practice in mathematics at key stage 3 (February 2015)
http://www.estyn.gov.wales/thematic-reports/good-practice-mathematics-key-stage-3-february-2015

Estyn report: Numeracy in key stages 2 and 3: an interim report (November 2014)
http://www.estyn.gov.wales/thematic-reports/numeracy-key-stages-2-and-3-interim-report-november-2014

Estyn report: Good practice in mathematics at key stage 4 (October 2013)
http://www.estyn.gov.wales/thematic-reports/good-practice-mathematics-key-stage-4-october-2013

Achievement of 15-Year-Olds in Wales: PISA 2012 National Report – NfER – (2013)
http://www.nfer.ac.uk/publications/PQUK02/PQUK02_home.cfm

Royal Society Vision Project - Report on Leadership and Workforce Issues within UK Science and Mathematics Education (August 2013)
https://royalsociety.org/~/media/education/policy/vision/reports/ev-8-vision-research-report-20140624.pdf

National Centre for Excellence in the Teaching of Mathematics (NCETM) - Mastery approaches to mathematics
https://www.ncetm.org.uk/public/files/19990433/Developing_mastery_in_mathematics_october_2014.pdf
https://www.ncetm.org.uk/resources/45776

Project Maths – Republic of Ireland
http://www.projectmaths.ie

NFER's evaluation of the Project Maths initiative in Ireland
http://ncca.ie/en/Conference/Impact-of-Project-Maths-Final.pdf

Article: New initiative to get more maths and physics teachers into classrooms
http://www.wired-gov.net/wg/news.nsf/articles/Major+push+to+get+more+maths+and+physics+teachers+into+our+classrooms+12032015101500

Maths hubs: blending subject specialism and system leadership – National College for Teaching and Leadership (NCTL)
https://nctl.blog.gov.uk/2015/03/17/maths-hubs-blending-subject-specialism-and-system-leadership/

How are specialist leaders of education being deployed? – National College for Teaching and Leadership (NCTL)
https://nctl.blog.gov.uk/2015/03/25/how-are-specialist-leaders-of-education-being-deployed/

Further Mathematics Support Programme
www.furthermaths.org.uk

Further Mathematics Support Programme/Institute of Education Gender Literature Review – Summary of Recommendations
http://www.furthermaths.org.uk/docs/Summary%20of%20recommendations%20from%20IoE%20Literature%20Review.pdf

Increasing Girls' Participation in A level Mathematics and Further Mathematics – Update March 2015
http://www.furthermaths.org.uk/docs/Girls%20in%20mathematics%20participation%20update%20Mar%202015%20v3.pdf

Sutton Trust report – What makes great teaching? Review of the underpinning research (October 2014)
http://www.suttontrust.com/wp-content/uploads/2014/10/What-makes-great-teaching-FINAL-4.11.14.pdf

Education Endowment Foundation – Early Numeracy Approaches (April 2015)
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Characteristics of effective teaching of mathematics: A view from the West
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The effective mathematics classroom
https://www.andrews.edu/sed/leadership_dept/webinars/presentationdocuments/the_effective_mathematics_classrroom.pdf

Effective primary pedagogical strategies in English and mathematics in key stage 2: A study of year 5 classroom practice drawn from the EPPSE 3-16 longitudinal study
http://learning.wales.gov.uk/docs/learningwales/publications/11effectiveprimary.pdf

Enhancing primary mathematics teaching and learning
http://www.cimt.plymouth.ac.uk/papers/epmtl.pdf

Article outlining the Japanese Curriculum in more detail
http://ncm.gu.se/media/kursplaner/andralander/Japanese_COS2008Math.pdf)

Document outlining the Finnish curriculum for Primary in more detail
http://www.cimt.plymouth.ac.uk/politeia/mathematics/finland.pdf)

The changing educational framework for the teaching of mathematics in China
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Characteristics of mathematics teaching in Shanghai, China: Through the lens of a Malaysian
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Excellence in Mathematics: Report from the Maths Excellence Group (Scottish Government (2011)
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